

Article

The Classification of Work and Offenses of Professional Drivers from Slovakia and the Czech Republic

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Abstract: To achieve the elimination of the negative impacts of transport on road safety, the European Union is taking various measures resulting from its commitment to improve road safety. The main objective of this paper is to assess the impact of social legislation on road transport safety using real research and to identify the factors influencing the violation of the legislation depending on the type of transport carried out in domestic or international road freight transport. Answers from the respondents are used in the segmentation of truck drivers based on input data describing the factors influencing the violation of traffic rules. Two-step cluster analysis is a suitable method for the segmentation of truck drivers based on input data. These data are obtained through a questionnaire from a total of 472 Czech and Slovak truck drivers. The results show that the optimal number of types of truck drivers with different characteristics is four. All of the clusters are described and compared. The majority of truck drivers do not violate social legislation for several reasons, such as traffic accidents (almost 67%), complications in meeting the loading or unloading deadline (less than 88%), poorly planned transport routes (more than 90%) and driving home (almost 80%).

Keywords: road freight transportation; truck drivers; social legislation; policymaking



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1. Introduction

Logistics is the process of planning and organization to ensure that resources are directed to the places in which they are needed so that an activity or process can take place effectively [1]. As part of logistics, we must highlight transport. Transport is one of the most important sectors of the economy. It is constantly expanding [2]. It is important to note that transportation has a negative impact on the environment, the economy and the standard of living of people in general [3]. Large truck safety has long been a focus of the accident analysis literature and a significant source of concern for the public and road safety authorities [4–6]. The high frequency and expenses of major truck accidents demonstrate how important it is to continue to improve the safety of transportation operations [7,8]. Since 1976, the maximum driving time, frequency and duration of required breaks and rest periods have all been defined in the AETR agreement. This agreement is applicable to both non-EU and EU members (provided that both parties are AETR agreement contracting nations for the full transportation route). In addition to the level of safety required by the nature of road transport, this agreement can only be applied to vehicles weighing more than 3.5 tonnes [9]. This agreement defines the permitted daily/weekly driving and rest periods. This is a significant problem, where the aim has been harmonization since 1985. The goal of harmonizing some of the social laws pertaining to road transportation is to enhance the working conditions and road safety while also aiming to balance the competitiveness amongst inland transportation options, particularly in the road transport industry [10]. As a result, there will be fewer accidents and increased traffic safety [11]. This problem is addressed in Regulation (EC) No. 561/2006 of the European Parliament and

of the Council of 15 March 2006 on the harmonization of certain social legislation relating to road transport. This regulation indicates that the daily driving time should not exceed nine hours. The daily driving time may be extended to, at most, 10 h, no more than twice during the week. The weekly driving time should not exceed 56 h and should not result in the maximum weekly working time laid down. The total accumulated driving time during any two consecutive weeks should not exceed 90 h. After a driving period of four and a half hours, a driver should take an uninterrupted break of no less than 45 min unless he takes a rest period. This break may be replaced by a break of at least 15 min, followed by a break of at least 30 min, each distributed over the period in such a way as to comply with the provisions of the first paragraph [10]. It is necessary to add that the driver must comply with the legislation of the country in which he is located. It is precisely this time that differs within individual continents or countries.

Table 1 shows the maximum driving times and minimum rest periods in selected countries [12]. As can be seen, there are two groups of states. The European Union, Australia and New Zealand have a shorter time for continuous driving compared to the USA and Canada. The European Union countries have the longest rest periods. Drivers in Australia have the shortest daily rest period (only 7 h). On the other hand, drivers in New Zealand have the longest two-week driving period.

Table 1. Maximum driving times and minimum rest periods [12].

Requirement	EU	USA	Canada	Australia	New Zealand
Continuous driving	4.5 h	8 h	13/15 h	5.25 h	5.5 h
Break	45 min	30 min	-	15 min	30 min
Daily driving time	9 h	11 h	13/15 h	12 h	13 h
Daily rest period	9 h	11 h	10/8 h	7 h	10 h
Weekly driving time	56 h	60/70 h	70/80 h	72 h	70 h
Weekly rest period	45 h	34 h	36 h	24 h	24 h
Bi-weekly driving time	90 h	120/148 h	147 h	144 h	166 h

According to Poliak et al. [12], the EU legislation governing driver employment offers the strictest working conditions possible, giving drivers ample time to rest during a reasonable vehicle drive. However, these conditions also encourage drivers to drive more quickly. In the research of Zalcmanis et al. [13], a significant percentage of the violations committed by international haulage truck drivers involved in serious auto accidents pertained to following the regulations for drivers' hours or total working hours.

With urban growth and the progressive increase in the number of transport vehicles on roads, the expansion of motorization on roads generally offers many benefits but also some drawbacks and risks [14,15]. Every year, 20–50 million people suffer financial or physical damage as a result of road traffic accidents, which claim the lives of around 1.35 million people worldwide [16]. Of course, the driving style also matters [17]. This corroborates the findings of Suthanaya and Sugiana [18], who report that, as Indonesia's population and automobile ownership have grown, so too has the number of accident deaths.

Jiang and Zhang also mention the frequency and severity of traffic incidents involving large vehicles. The mismatch in the number of variables in the “man–vehicle–environment” system is the cause of these accidents [19]. In the “human” domain, there are several factors that could have an impact on driving performance. Csiszar and Foldes [20] emphasize that 95 percent of accidents are caused by human error. At the neural level, notably in the context of driving, the integration of emotional elements in risky behavior processing has also been proven [21,22]. Several authors confirm, in their publications, that high blood alcohol concentrations and the use of drugs drastically increase the likelihood of occurrence of road traffic accidents [23,24]. Another indicator that can affect a driver's ability to drive safely is high temperatures, which can affect the physiology of the driver [25]. Different studies have looked at a range of safety-related issues regarding large trucks,

such as the impact of vehicle inspections on accidents [26], the effects of truck drivers' driving schedules and/or fatigue prior to accidents [27,28], the expenses associated with truck-related accidents [29], the factors influencing the severity of injuries [30,31] and the frequency of accidents involving large trucks [6,32].

However, there are exceptional cases in which up to 30 days could be granted for transport operations carried out in exceptional circumstances. For example, from 12 August 2022 to 30 September 2022, drivers engaged in all types of freight transport in Poland could increase their maximum daily driving time to 11 h. This was allowed because of the disruption to freight transport caused by Russia's invasion of Ukraine [33].

The paper aims to analyze the work of drivers in the Czech Republic and Slovakia. The most frequent offenses and drivers with the greatest likelihood of violating social regulations will be compared here. Figure 1 shows the flow chart of the used methodology.

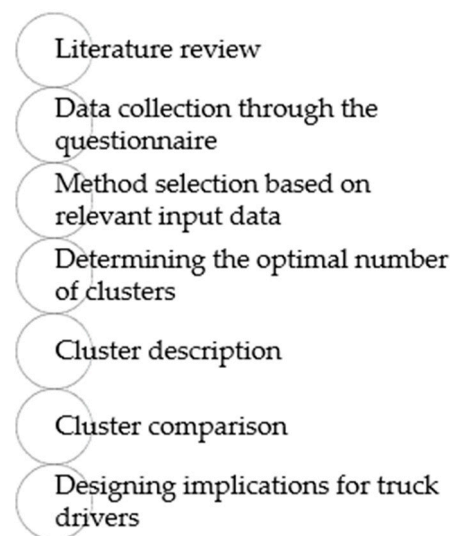


Figure 1. Flow chart of the used methodology.

2. Methodology

2.1. Sample

The initial sample includes 483 truck drivers, but 11 respondents are excluded due to missing data—for example, the age, country and type of road freight transport. Table 2 shows that the final sample consists of 472 truck drivers from the Czech and Slovak Republics, broken down into five age categories and three road freight transport types, such as domestic road freight transport, international road freight transport or both. The majority of the respondents are Slovak truck drivers (more than 58% of all). These truck drivers prefer international road freight transport (more than 40% of the final sample) compared to other types of road freight transport. However, the largest group consists of Slovak truckers driving for domestic and international road freight transport (108 respondents). On the other hand, Czech truck drivers driving for domestic road freight transport represent the smallest group (46 respondents). According to the age structure and road freight type, truck drivers aged 41 to 50 years old represent almost one third of all respondents, but the age category of 31–40 years old has similar representation (four respondents fewer). Finally, respondents aged 41 to 50 years and engaged in international road freight transport are most represented (almost 13% of the total sample). This group is equally represented in terms of nationality (29 Slovak and 31 Czech truck drivers). All other sample data are shown in Table 2, which were obtained from the data in Tables A1 and A2 in Appendix A.

Table 2. The initial sample.

Trucker Drivers Engaged in						
Country			Domestic Road Freight Transport	International Road Freight Transport	Domestic and International Road Freight Transport	Total
SK	Age	20–30 years	14	18	27	59
		31–40 years	27	30	35	92
		41–50 years	18	29	29	76
		51–60 years	4	18	14	36
		61–70 years	3	6	3	12
Total			66	101	108	275
CZ	Age	20–30 years	4	5	7	16
		31–40 years	12	23	16	51
		41–50 years	18	31	22	71
		51–60 years	12	28	16	56
		61–70 years	0	1	2	3
Total			46	88	63	197
Total	Age	20–30 years	18	23	34	75
		31–40 years	39	53	51	143
		41–50 years	36	60	51	147
		51–60 years	16	46	30	92
		61–70 years	3	7	5	15
Total			112	189	171	472

2.2. Input Variables

The data are obtained using an online questionnaire. The questionnaire offers primary data on the violation of social legislation by truck drivers from the Czech and Slovak Republics. The questionnaire consists of more than 20 questions. These questions include binary/multiple options with a single answer choice. However, only some of the input variables are used, such as the driver type; the value of the highest fine; the reduction in daily or weekly rest time; the reasons for violating social legislation, i.e., complications in meeting the loading or unloading deadline, poor traffic planning, traffic accidents (traffic jams), driving home and a lack of free parking spaces or areas. All inputs are categorical variables (nominal or ordinal variables). This questionnaire was available online for Slovak truck drivers using Google Forms from 2 February 2021 to 12 March 2022, for a total of 429 days. On the other hand, Czech truck drivers completed the online questionnaire via Survio from 11 January 2022 to 17 February 2022, for a total of 37 days. The success rate in completing the questionnaire for Czech respondents was approximately 60%, because only 208 truck drivers out of 356 completed the questionnaire.

2.3. Methods

The profile of the Slovak and Czech truck drivers is determined using two-step cluster analysis. In detail, this tool generates homogeneous groups with similar driving behavior. Both continuous and categorical data are analyzed using the two-step cluster approach. It is possible to analyze quantitative variables simultaneously with multiple scale units and nominal scales. It is assumed throughout the procedure that categorical variables have a multinomial distribution, continuous variables have a normal distribution and all variables are independent. Additionally, the automatic calculation of the ideal number of clusters is included in the added benefits. Larger samples with more than 500 respondents are used with this technique [34]. Cluster analysis is quite often used in scientific research [35–37].

The procedure includes several parameters, such as the distance measure, optimal cluster number and cluster quality [38].

$$d_{(i)(j)} = \xi_i + \xi_j - \xi_{(i,j)} \quad (1)$$

$$\xi_s = -N_s \left(\left(\sum_{k=1}^{K^A} \frac{1}{2} \log \left(\hat{\sigma}_k^2 + \hat{\sigma}_{sk}^2 \right) \right) + \left(\sum_{k=1}^{K^B} \hat{E}_{sk} \right) \right) \quad (2)$$

$$\hat{E}_{sk} = - \sum_{l=1}^{L_k} \left(\frac{N_{skl}}{N_s} \times \log \left(\frac{N_{skl}}{N_s} \right) \right) \sum_{l=1}^{L_k} \left(\frac{N_{skl}}{N_s} \times \log \left(\frac{N_{skl}}{N_s} \right) \right) \quad (3)$$

where

K^A —total number of continuous variables;

K^B —total number of categorical variables;

L_k —number of categories for the k -th categorical variable;

N_s —total number of data records in cluster s ;

N_{skl} —number of records in cluster s whose categorical variable k takes l category;

$\hat{\sigma}_k^2$ —estimated variance of the continuous variable k ;

$\hat{\sigma}_{sk}^2$ —estimated variance of the continuous variable k in cluster j ;

$d_{(i)(j)}$ —distance between i and j ;

$(i;j)$ —index representing cluster formed by combining clusters i and j [39].

To determine market segmentation, product bundling, formal classification and medical diagnosis, two-step cluster analysis is frequently employed [40].

The ideal number of clusters. The cluster with the lowest BIC score is considered ideal. For each cluster within a given range, Schwarz's Bayesian Criterion (BIC) is calculated as

$$BIC_R = -2 \sum_{r=1}^R \xi_r + m_r \log(N) \quad (4)$$

with

$$m_r = R \left\{ 2K^A + \sum_{k=1}^{K^B} (L_k - 1) \right\} \quad (5)$$

where

BIC_R —Bayesian information criterion;

m_r —ratio in r -cluster developed during the hierarchical clustering stage;

L_k —number of groups in k categorical variables [41].

The "optimal" number of clusters has the lowest BIC value, and a lower BIC value indicates the optimal number of clusters. Furthermore, the huge ratios of the distance measures and IBM SPSS 29, the ideal number of clusters is automatically determined [42] without the author's input group calibration. The silhouette value expresses how cohesively an object belongs to its cluster, as opposed to how separate it is from other clusters. The average distance between a sample and every other data point in the same cluster is known as the cluster cohesiveness. On the other hand, the average distance between a sample and every other data point in the closest cluster is denoted by the cluster separation [43]. The range of this metric is 1 to -1 .

The silhouette value identifies

- poor classification from -1.0 to 0.2 ;
- fair classification from 0.2 to 0.5 ;
- good classification from 0.5 to 1.0 .

$$s(i) = \frac{b(i) - a(i)}{\max(b(i), a(i))} \quad (6)$$

$$\bar{S} = \frac{1}{N} \sum_{i=1}^N S_i \quad (7)$$

where

S_i —silhouette coefficient for i -th object,

b_i —average of minimum distance between i -th object in different cluster (average inter-cluster distance);

a_i —average of minimum distance between i -th object in same cluster (average intra-cluster distance);

S —average value of silhouette coefficients;

N —total number of observations [44].

3. Results

The aim of this paper is to identify selected groups of Czech and Slovak truck drivers with the same tendency to observe/break the rules of social legislation and traffic regulations in domestic and international road freight transport in order to develop appropriate measures. The results show that truck drivers can be divided into four clusters based on nine input variables using two-step cluster analysis. This tool was used because all inputs are categorical variables. The silhouette measure of cohesion and separation demonstrates that the cluster analysis appropriately segments the truck drivers based on the input variables into clusters; this indicator reaches 0.3. Tkaczynski [34] claims that if the silhouette measure is higher than 0.2, it demonstrates an acceptable distance between clusters (fair zone).

Table 3 shows important statistical metrics determining the optimal number of clusters using two-step cluster analysis for 15 clusters. The optimal number of clusters is often determined based on the lowest BIC value or the largest ratio of distance measures. The statistical-analytical program uses an automatic solution based on a compromise between a reasonably large ratio of BIC changes and a large ratio of distance measures; the optimal number of clusters is four (ratio of BIC changes = 0.407, ratio of distance measures = 1.416). Generally speaking, a large number of clusters results in a complex model.

Table 3. Auto-clustering.

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change ^a	Ratio of BIC Changes ^b	Ratio of Distance Measures ^c
1	5642.162			
2	5163.329	−478.833	1.000	1.350
3	4833.969	−329.361	0.688	1.459
4	4639.009	−194.960	0.407	1.416
5	4530.111	−108.898	0.227	1.223
6	4458.978	−71.132	0.149	1.060
7	4397.483	−61.495	0.128	1.107
8	4351.461	−46.022	0.096	1.054
9	4312.812	−38.649	0.081	1.156
10	4292.555	−20.257	0.042	1.112
11	4284.162	−8.393	0.018	1.036
12	4279.504	−4.657	0.010	1.030
13	4277.818	−1.686	0.004	1.038
14	4279.822	2.004	−0.004	1.113
15	4291.600	11.778	−0.025	1.044

^a The changes are from the previous number of clusters in the table. ^b The ratios of changes are relative to the change for the two-cluster solution. ^c The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

Table 4 shows that the total sample consists of 483 truck drivers from the Czech and Slovak Republics. These truck drivers are divided into four clusters using two-step cluster

analysis. The 456 truck drivers form four clusters, as 27 observations are excluded due to missing data on the input variables. The results show that the fourth cluster consists of the largest group compared to the other clusters (more than 32% combined). On the other hand, the third (smallest) cluster includes 88 truck drivers (less than 20% combined).

Table 4. Four clusters.

		N	% of Combined	% of Total
Cluster	1	126	27.60	26.10
	2	95	20.80	19.70
	3	88	19.30	18.20
	4	147	32.20	30.40
	Combined	456	100.00	94.40
Excluded Cases		27		5.60
Total		483		100.00

The most important inputs are the lack of free parking spaces and parking areas (100%), presented in Table A6 in Appendix A; compliance with unloading or loading deadlines (more than 70%), presented in Table A3 in Appendix A; and traffic accidents or traffic jams (more than 50%), presented in the Table A4 in Appendix A, in contrast to other input variables (less than 20%), presented in Tables A5 and A7–A9 in Appendix A. Figure 2 shows the optimal number of clusters based on the input variables using two-step cluster analysis. The input variables are differentiated according to the significance scale (see legend).

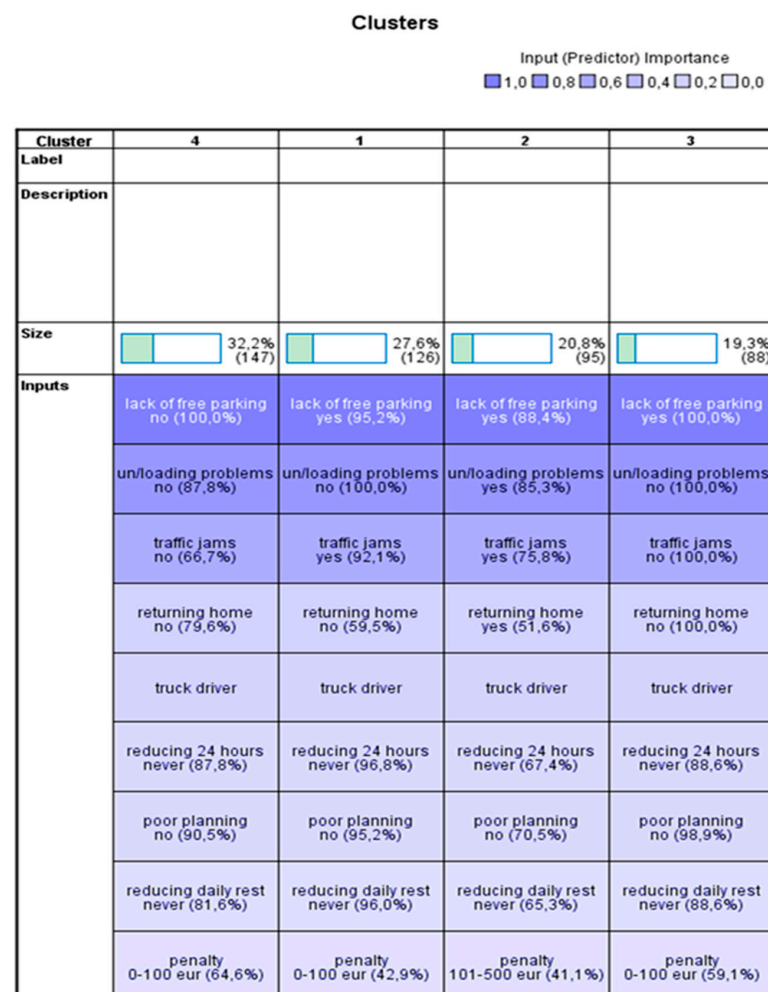


Figure 2. Clusters (inputs sorted by overall importance).

Figure 2 summarizes the outputs from the two-step cluster analysis. This figure shows that the fourth cluster includes 147 drivers; this group has the largest representation in the comparison, unlike the third group. The color scale demonstrates that the three most important factors in differentiating the drivers into the four groups are a lack of jobs, loading/unloading problems and traffic congestion. In addition, some boxes show which category of a given variable has the most frequent representation in a given cluster. In other words, we find that drivers in the third cluster do not violate social legislation when loading/unloading goods or due to traffic accidents or traffic jams, as well as when returning home. However, all these drivers experience problems due to the lack of free parking spaces.

The fourth cluster consists of almost 50% of truck drivers from domestic road freight transport. This group does not violate the social legislation at all due to a lack of free parking spaces or parking areas. Moreover, the majority of truck drivers do not violate social legislation for several reasons, such as traffic accidents (almost 67%), complications in meeting the loading or unloading deadline (less than 88%), poorly planned transport routes (more than 90%) and driving home (almost 80%). These drivers do not reduce their daily or weekly rest times. Finally, less than 65% of the truck drivers paid the highest fine for the violation of traffic regulations or social legislation, which was up to EUR 100 (if at all).

The first cluster consists mainly of truck drivers from international road freight transport (more than 50%). These truck drivers violate social legislation for several reasons, such as traffic accidents or traffic jams (more than 92%) and a lack of free parking spaces or parking areas (more than 95%). On the other hand, these drivers mostly do not violate social legislation due to complications in meeting the loading or unloading deadline (100%), driving home (almost 60%) and the poor planning of traffic routes (more than 95%). Moreover, these drivers rarely cut their daily or weekly rest times. Finally, these drivers pay fines of up to EUR 100 (if at all) (54 respondents) or from EUR 101 to EUR 500 (49 respondents).

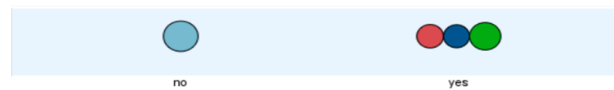
The second cluster consists mainly of truck drivers from domestic and international road freight transport. These drivers violate social legislation for several reasons, such as complications in meeting the loading or unloading deadline (more than 85%), driving home (almost 52%), a lack of free parking spaces or parking areas (more than 88%) and traffic accidents or traffic jams (almost 76%), compared to the poor planning of traffic routes. The results show that almost 71% of the drivers do not violate social legislation due to poor travel planning. As in the previous clusters, this cluster demonstrates that the drivers do not reduce their daily or weekly rest times. Finally, these drivers pay fines of mostly EUR 101 to EUR 500 (more than 41%). This group represents the most dangerous group of truck drivers.

The third cluster, as with the second, is mainly composed of international road haulage drivers (almost 47%). These drivers violate the social legislation for free parking spaces or parking areas (100%). On the other hand, the social legislation is not violated at all due to traffic accidents or traffic jams (100%), driving home (100%), complications in unloading or loading deadlines (100%) and the poor planning of traffic routes (almost 100%). Moreover, these drivers do not reduce their daily or weekly rest times. Almost 60% of these drivers paid the highest fines of up to EUR 100 (if at all). This group consists of considerate drivers with no tendency to violate the social legislation, except in the case of a lack of free parking spaces.

Figure 3 compares all four clusters. The results show that the fourth (light blue) cluster is mainly composed of domestic road freight truck drivers compared to the first (red) and third (green) clusters, and the second (dark blue) cluster consists mostly of drivers engaged in both types of road transport. In all clusters, most drivers do not reduce their daily or weekly rest times at all. In addition, most truckers do not violate the social legislation due to poor traffic planning. On the other hand, the reasons for the violation of the social legislation differ in the various clusters. First, the fourth cluster shows typical compliance with the social legislation, unlike the other clusters. Second, the second cluster violates the

social legislation for several reasons, such as a lack of free parking spaces in parking lots and parking areas, complications in meeting the loading or unloading deadline, traffic accidents and driving home, compared to others. However, the third and even the second cluster violate the social legislation due to traffic accidents, as compared to the other clusters. The majority of drivers paid the largest fines of up to EUR 100 (if at all), in contrast to the second group. This group pays mostly higher fines of EUR 101–500. All additional data are shown in Appendix A.

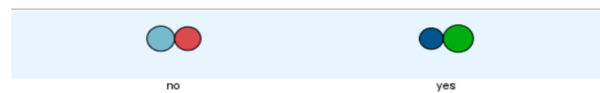
Lack of free parking



Un/loading problems



Traffic jams



Returning home



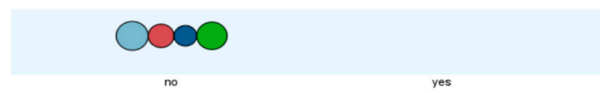
Truck driver



Reducing 24 hours



Poor planning



Reducing daily rest



Penalty



■ 4 ■ 1 ■ 2 ■ 3

Figure 3. Cluster comparison.

The results show that the second (dark blue) cluster mainly includes drivers of both types of transport, domestic and foreign truck transport; these drivers most often paid fines of EUR 101 to EUR 500, unlike the other groups. Moreover, this group mostly experiences loading or unloading problems, as more than 80% of the 99 truck drivers were included in this cluster. These drivers violate the social legislation due to traffic accidents and congestion, together with the first (red) cluster, because almost 80% of the drivers out of 237 are included in one of these two groups. The first (red) cluster consists mainly of drivers engaged in international road transport; this group does not experience problems with loading or unloading, similar to the third (green) cluster. Truck drivers from the third (green) cluster do not violate the social legislation at all, even due to traffic accidents and congestion, poor planning or driving home. On the other hand, this group experiences problems with parking; almost one third of all drivers who experience problems with parking are included in this cluster. Finally, the two-step cluster analysis shows that the first (red) cluster violates the social legislation primarily due to traffic accidents and congestion, but also a lack of parking spaces, unlike the other groups, because almost half of the drivers with this problem are included in this cluster. The first (red) cluster consists mainly of drivers engaged in international road transport, but drivers involved in domestic and international road transport are also significantly represented. These results can help to identify problem groups of drivers in order to design educational courses to eliminate violations of traffic regulations, especially in foreign road transport, and to improve traffic planning.

4. Discussion

Concerning the factors leading to truck/large truck accidents and/or risky behavior, most research on the dangers associated with their operations covers factors that include age [45,46], job experience [47,48], sleep quality [49,50], driving mileage [51,52] and the time of day [53,54]. There is a lack of literature, especially for heavy goods vehicle drivers, on the influence of nationality on violations of drivers' working rules or on the type of goods transported. In our research, we sought answers to these questions. This research addressed the main challenge of obtaining information about truck drivers from the Czech and Slovak Republics. On the other hand, a limitation of this study is that it was not able to assess the impact of the observed data on the occurrence of traffic accidents in road freight transport. Another problem is that, despite the anonymous nature of the survey shown in Appendix B, there was no guarantee that the drivers' answers were truthful. Many respondents were concerned that their answers would not be anonymous due to the sensitive questions regarding the use of magnets and other violations of traffic legislation. Future research can consider modeling the most frequent factors causing violations of traffic legislation using multinomial regression analysis, but the sample should be expanded to include new respondents, particularly truck drivers from domestic and international road transport. These results can help to identify problem groups of drivers in order to design educational courses to eliminate violations of traffic regulations, especially in foreign road transport, and to improve traffic planning. With the increasing demand for road freight transport and the rising demographic curve of drivers, it can be concluded that, soon, there will not be enough drivers to transport goods from A to B. The traditional logistics operation planning strategy is unable to meet the requirements that are currently associated with transportation [55]. The above statement is applicable throughout the EU and not only in the Slovak Republic. According to the latest report by the International Road Transport Union (IRU), there will be a shortage of up to 7 million drivers worldwide by 2028. In the current context of the driver shortage in the Slovak Republic and the EU, it is very important to determine the likelihood of drivers of different nationalities to violate the currently applicable social legislation. Comparing the different legal regulations on the work of drivers shown in the table in the Introduction, we found that the strictest laws were implemented in the EU. It follows from the above that one of the solutions to the current situation could be a change in the social legislation. Based on the analysis, one

of the solutions could be to change the legislation to reflect that of the United States of America or Canada. Extending the weekly driving time or two-week time would help to increase the number of kilometers traveled by one vehicle. This would help to reduce the number of drivers currently needed to carry out individual transport tasks. Based on the above, it is therefore necessary to identify the most frequent reasons for violations of social legislation by drivers. In our research, we identified the influence of the driver's nationality on the most frequent violations of the regulations. In the future, it is necessary to carry out a better survey that determines the influence of the nationality of drivers from additional countries on the most frequent reasons for violating the legislation. Such a survey could be useful when considering changes to the current legislation. The type of road freight transport plays an important role in the violation of the regulations. Our research focused mainly on the reasons for violating the current legislation, which frequently leads to traffic accidents. There is evidence in the literature concerning vehicle operation that suggests that the level of education is also associated with speeding behavior and traffic safety [56]. The majority of drivers from Slovakia and the Czech Republic involved in the research worked in national road freight transport. Different factors motivate traffic-violating behavior among drivers. The most important reasons for violating the current legislation were given by most drivers as a lack of free parking spaces and parking areas, compliance with unloading or loading deadlines and traffic accidents or congestion that forced drivers to exceed the permitted performance or driving times. Drivers working in international road freight transport do not usually exhibit violations of social legislation due to complications in meeting loading or unloading deadlines, implementing a return home or simply poor planning of the transport route. Human error due to inattention, violations and drowsiness is a major factor that is responsible for more than 90% of road traffic injuries worldwide (NHTSA, 2011; The Royal Society for the Prevention of Accidents (RoSPA), 2017). In addition, these drivers rarely reduce their daily or weekly rest times. The results show that the second (dark blue) cluster mainly includes drivers of domestic and foreign truck transport; these drivers most often pay fines of EUR 101 to EUR 500, unlike the other groups. Moreover, this group mostly experiences loading or unloading problems, as more than 80% of the 99 drivers are included in this cluster. Finally, these drivers violate the social legislation due to traffic accidents and congestion, together with the first cluster, because almost 80% of the drivers out of 237 were included in one of these two groups. The first (red) cluster consists mainly of drivers in international road transport; this group does not experience loading or unloading problems, similar to the third cluster. Truck drivers from the third cluster do not violate the social legislation at all, even due to traffic accidents and congestion, poor planning or driving home. On the other hand, this group experiences problems with parking; almost one third of the drivers with parking problems are included in this cluster. When comparing the results of drivers from Slovakia and the Czech Republic, we found no significant differences in the propensity to violate the applicable regulations. In the near future, it is advisable to carry out a similar survey with drivers of different nationalities, who are now increasingly working for Slovak and Czech companies. This would help to better understand the drivers' view of the current legislation and its breaches. These results could help to identify problem groups of drivers in order to design educational courses to eliminate violations of traffic regulations, especially in foreign road transport, and to improve traffic planning.

5. Conclusions

In the EU, the legislation on driving conditions has recently been tightened, which is placing pressure not only on more drivers but also on the parking spaces required for breaks and rest periods. For a variety of reasons, including traffic accidents (nearly 67%), difficulties in meeting the loading or unloading deadline (less than 88%), poorly planned transport routes (more than 90%) and driving home (almost 80%), the majority of truck drivers do not find it problematic to break social laws. The tightening of the conditions for drivers to take rest breaks is certainly important in improving road safety.

Understandably, the tightening of these conditions creates a demand for more drivers, of which there is a huge shortage in the EU, even at present. One can point, for example, to the collapse of freight transport in the UK as a result of the shortage of drivers in autumn 2021. The main challenge facing the EU is to adapt the rules on driver work so that road safety is not reduced but that the number of drivers on the road freight market increases. With the recruitment of overseas drivers in the EU, we can expect a decrease in the understanding of the driver work regulations by these drivers and more frequent violations of the social regulations, which could lead to a greater number of traffic accidents caused by truck drivers. It is also essential to establish a transparent and harmonized EU system to recognize the qualifications and skills of professional drivers from additional countries, as long as they meet the EU standards for road safety and driver training. This will guarantee that their rights and skills are recognized in every member state [57]. The main limitation of this study was the inability to evaluate how the observed data affected the frequency of traffic accidents in the context of road freight transportation. Another issue is that the drivers' responses may not always be accurate, even with the anonymous nature of the poll. This issue might lead to bias in the acquired data. Drivers from additional countries, who are beginning to work in the EU, should be the subject of future studies. Such drivers are arriving from the east, including Ukraine, Serbia, Turkey, India and others. The results of this study may enable us to determine which country's drivers are the least likely to violate workplace regulations. Such research could help to ensure safety in road freight transport and compliance with regulations on the work of drivers.

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Appendix A

Table A1. Do you work as a driver?

		Domestic Road Freight Transport		International Road Freight Transport		Domestic and International Road Freight Transport	
		Frequency	%	Frequency	%	Frequency	%
Cluster	1	13	11.60	64	35.20	49	30.20
	2	11	9.80	36	19.80	48	29.60
	3	15	13.40	41	22.50	32	19.80
	4	73	65.20	41	22.50	33	20.40
	Combined	112	100.00	182	100.00	162	100.00

Table A2. Have you ever been fined? (If you have received several fines, only state the value of the highest fine).

		0–100 Euros		101–500 Euros		501–1000 Euros		1001 or More Euros	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Cluster	1	54	23.00	49	31.20	12	30.80	11	44.00
	2	34	14.50	39	24.80	14	35.90	8	32.00
	3	52	22.10	24	15.30	9	23.10	3	12.00
	4	95	40.40	45	28.70	4	10.30	3	12.00
	Combined	235	100.00	157	100.00	39	100.00	25	100.00

Table A3. Compliance with the unloading/loading deadline as a factor in the violation of social legislation.

		No		Yes	
		Frequency	%	Frequency	%
Cluster	1	126	35.30	0	0.00
	2	14	3.90	81	81.80
	3	88	24.60	0	0.00
	4	129	36.10	18	18.20
	Combined	357	100.00	99	100.00

Table A4. Traffic accidents or traffic jams as a factor in the violation of social legislation.

		No		Yes	
		Frequency	%	Frequency	%
Cluster	1	10	4.60	116	48.90
	2	23	10.50	72	30.40
	3	88	40.20	0	0.00
	4	98	44.70	49	20.70
	Combined	219	100.00	237	100.00

Table A5. Poor transport route planning as a factor in the violation of social legislation.

		No		Yes	
		Frequency	%	Frequency	%
Cluster	1	120	29.50	6	12.20
	2	67	16.50	28	57.10
	3	87	21.40	1	2.00
	4	133	32.70	14	28.60
	Combined	407	100.00	49	100.00

Table A6. Lack of free parking spaces in parking lots and parking areas as a factor in the violation of social legislation.

		No		Yes	
		Frequency	%	Frequency	%
Cluster	1	6	3.70	120	41.10
	2	11	6.70	84	28.80
	3	0	0.00	88	30.10
	4	147	89.60	0	0.00
	Combined	164	100.00	292	100.00

Table A7. Driving home (carrier's seat or place of residence) as a factor in the violation of social legislation.

		No		Yes	
		Frequency	%	Frequency	%
Cluster	1	75	23.00	51	39.20
	2	46	14.10	49	37.70
	3	88	27.00	0	0.00
	4	117	35.90	30	23.10
	Combined	326	100.00	130	100.00

Table A8. Have you ever shortened the reduced weekly rest period of 24 h or the regular weekly rest period of 45 h?

		0–2 h		2–4 h		4 h and More		Never	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Cluster	1	0	0.00	0	0.00	4	23.50	122	31.00
	2	23	62.20	0	0.00	8	47.10	64	16.30
	3	6	16.20	2	22.20	2	11.80	78	19.80
	4	8	21.60	7	77.80	3	17.60	129	32.80
	Combined	37	100.00	9	100.00	17	100.00	393	100.00

Table A9. Have you ever shortened the daily rest period to 9 h (at most 3 times) or the daily rest period of 11 h?

		0–1 h		1–2 h		2 h and More		Never	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Cluster	1	4	7.70	1	11.10	0	0.00	121	31.80
	2	20	38.50	5	55.60	8	57.10	62	16.30
	3	9	17.30	0	0.00	1	7.10	78	20.50
	4	19	36.50	3	33.30	5	35.70	120	31.50
	Combined	52	100.00	9	100.00	14	100.00	381	100.00

Appendix B

Anonymous questionnaire for road freight transport drivers

An anonymous questionnaire for professional drivers in road freight transport with a focus on social legislation. All your answers are anonymous and will not be published. The results of the questionnaire will be used purely for research and to improve the working and business environment for all drivers and haulers.

Thank you in advance for your sincere and honest answers.

How old are you?

- ☐ 20–30 years
- ☐ 31–40 years
- ☐ 40–50 years
- ☐ 51–60 years
- ☐ 61–70 years old

You work as a driver:

- ☐ national road freight transport
- ☐ international road freight transport
- ☐ national road freight transport and international road freight transport
- ☐ Other

You hold a road haulage license:

- ☐ Less than 9 years
- ☐ 10–20 years
- ☐ 21–30 years
- ☐ more than 31 years
- ☐ Other

Does your employer provide you with training on social legislation in road transport (Regulation (EC) No 561/2006; AETR Agreement; national rules, ...)

- ☐ no, we do not have such training
- ☐ yes, every year
- ☐ yes, every 2 years

- ☐ yes, every 5 years
- ☐ I don't know (I'm not sure)
- ☐ Other

How often (on average) do you get stopped by the Labour Inspectorate, a police patrol, or other inspection body?

- ☐ Annually
- ☐ more times a year
- ☐ once in more than 1 year
- ☐ never
- ☐ Other

If you have ever been stopped, what was the result of the check?

- ☐ everything was fine
- ☐ violation of social legislation (continuous driving time, rest periods, breaks,...)
- ☐ violation of road traffic rules
- ☐ other infringement
- ☐ Other

Have you ever been fined? (if you have received more than one fine, please indicate only the value of the highest fine)

- ☐ less than EUR 100
- ☐ 100 to 500 EUR
- ☐ 501 to 1000 EUR
- ☐ more than EUR 1000
- ☐ I have never received any fine
- ☐ Other

How often do you return home (your place of residence or company headquarters)?

- ☐ every day
- ☐ a couple of times a week
- ☐ every weekend
- ☐ once every two weeks
- ☐ once a month
- ☐ Other

Have you ever exceeded the continuous driving time (max. 4.5 h)?

- ☐ maximum 30 min
- ☐ 30 min to 1.5 h
- ☐ more than 1.5 h
- ☐ I have never exceeded
- ☐ Other

Have you ever cut your 45-min break at work short?

- ☐ max. by 5 min
- ☐ more than 5 min
- ☐ I have never shortened
- ☐ Other

Have you ever exceeded the daily driving time of 9 h, or extended it twice to 10 h in one week?

- ☐ max. by 1 h
- ☐ by 1 to 2 h
- ☐ more than 2 h
- ☐ I have never exceeded
- ☐ Other

Have you ever exceeded the 56-h weekly driving time or the 90 h bi-weekly driving time?

- ☐ max. 4 h
- ☐ 4 to 10 h
- ☐ I have never exceeded
- ☐ Other

Have you ever shortened the daily rest period of 9 h (maximum 3 times...) or the daily rest period of 11 h?

- ☐ max. by 1 h
- ☐ by 1 to 2 h
- ☐ more than 2 h
- ☐ I have never shortened
- ☐ Other

Have you ever reduced the 24 h of weekly rest or the regular 45 h of weekly rest?

- ☐ max. 2 h
- ☐ 2 to 4 h
- ☐ more than 4 h
- ☐ I have never shortened
- ☐ Other

The regular weekly rest period of 45 h you take?

- ☐ always at home
- ☐ if I'm away from home, in the car
- ☐ if I'm away from home, I'm in a vehicle or sometimes in accommodation
- ☐ if I'm away from home, I'm always in accommodation
- ☐ Other

What are your most common reasons for breaching social legislation? (you can tick more than one answer):

- ☐ driver's inattention
- ☐ compliance with loading/unloading deadlines
- ☐ poor planning of the transport route
- ☐ traffic accidents, congestion-congestion on the roads
- ☐ lack of free parking spaces in car parks and parking areas
- ☐ commute home (location of the carrier's headquarters or place of residence)
- ☐ forcing the employer to drive over the permitted time limits or orders not to observe prescribed rest periods, breaks
- ☐ you have ever used a magnet or other device to disable the tachograph
- ☐ Other

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