

Issue of the Impact of Traffic Signs on Observance of Safe Distance Between Vehicles in the Czech Republic

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Abstract

This technical article deals with the issue of influence of road sign on observance of the safe longitudinal distance between vehicles on 1st class road in Czech Republic. It contains an analysis of vehicle accidents on the roads in the Czech Republic, focusing on the accidents caused by non-observance of the safe distance. It also deals with the legislative requirements for the observance of the safe distance and at the conclusion, there is accomplished an analysis of influence of road sign on observance of the safe longitudinal distance between vehicles (classified by vehicle type) on the 1st class road in Czech Republic where is vertical and horizontal road sign to observe the safe distance between vehicles.

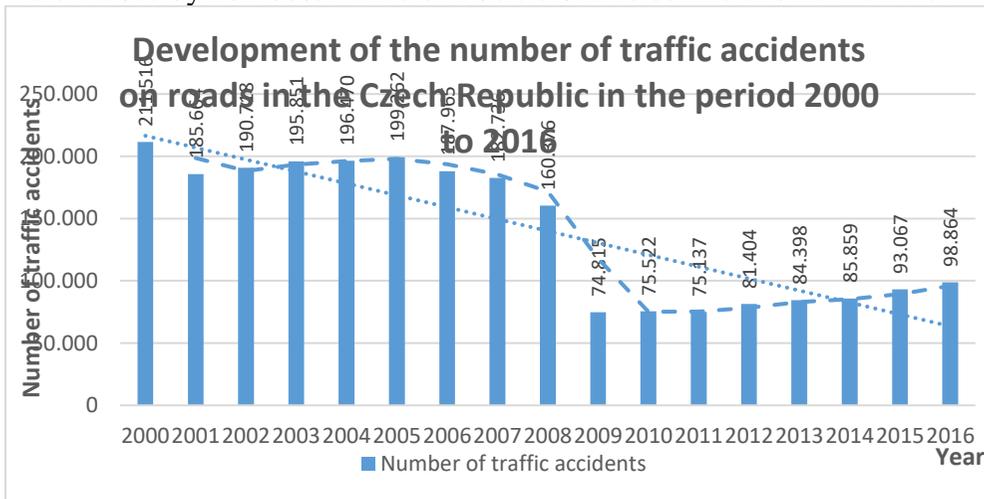
Keywords: Safe distance; vehicle; traffic accident

Introduction

The third most frequent cause of traffic accidents in the Czech Republic according to the statistics of the Czech Police is non-observance of a safe distance behind another vehicle. The distance of the second vehicle in a motorcade in these traffic accident cases was shorter than the distance in which the driver could respond adequately to avoid an accident upon the vehicle in front of him slowing down. Driving with an insufficient distance behind another vehicle is not only dangerous, but also aggressive. The problem is that the traffic regulations of the Czech Republic do not specify the safe distance to be kept behind another vehicle and drivers are usually fined for non-observance of a safe distance only at the moment when a traffic accident occurs. This professional article solves the issue of the impact of traffic signs on observance of a safe driving distance between vehicles.

The issue of road traffic accidents in the Czech Republic

In the period from 2000 to 2016, according to statistical data, a total of 2,379,624 traffic accidents occurred on roads in the Czech Republic which were investigated by the Police of the Czech Republic, which is an average of 139,978 traffic accidents per year. Since 2009, the number of traffic accidents recorded by the Czech Police has substantially declined, and this is clearly to a larger extent due to the amendment of Act No. 361/2000 Coll. under Act No. 274/2008 Coll., in force from 1 January 2009, where the damage incurred for reporting of traffic accidents to the Czech was increased to CZK 100,000 for any of the vehicles involved in the traffic accident, including transported items. A further influence was obviously, for instance, the implementation of the points evaluation system from 25 April 2006, including its subsequent amendments. In spite of the above-mentioned influences, the decline in the number of traffic accidents recorded by the Czech Police from 2009 was annually characterized by a slight increase up to 2016, when the Czech Police handled a total of 8,146 traffic accidents which were caused by non-observance of a safe distance behind another vehicle.



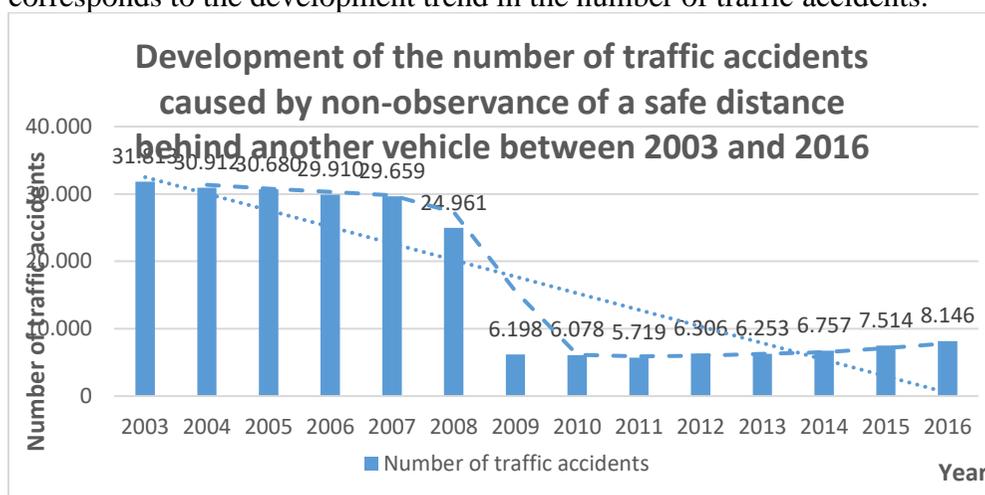
Graph 1 Development of the number of traffic accidents on roads in the Czech Republic

Causes of traffic accidents

According to the Police, among the 10 most frequent causes of traffic accidents on Czech roads caused by motor vehicle drivers in 2016 was failure to devote full attention to driving, incorrect turning or reversing, non-observance of safe distance behind another vehicle, other types of incorrect driving, driving at a speed inappropriate to the road conditions (ice, pot holes, mud, wet surface, and the like), failure to adapt the speed to the technical conditions of the roadway (bend, slope, gradient, road width and the like), losing control of the vehicle, failure to respect a “Give Way”

sign, turning without adequate side clearance and running into the path of oncoming traffic, while the most common cause of traffic accidents was that the driver did not pay full attention to driving, made incorrect turns or reversed, while the third most common cause was non-observance of a safe distance behind another vehicle, which applied to a total of 8,146 traffic accidents.

In the period between 2003 and 2016, according to the police, non-observance of a safe driving distance behind another vehicle resulted in a total of 230,906 traffic accidents in the territory of the Czech Republic (see next graph), which is an annual average of 16,493 traffic accidents. The development trend in the number of traffic accidents caused by non-observance of a safe driving distance behind another vehicle approximately corresponds to the development trend in the number of traffic accidents.



Graph 2 Development of the number of traffic accidents caused by non-observance of a safe distance

In 2016, the Czech Police recorded 67 % of traffic accidents which occurred within city limits, 29 % of traffic accidents which occurred outside city limits and 4 % of traffic accidents which occurred on the motorways of the Czech Republic.

According to the Czech Police, the road traffic accident death toll in 2016 was broken down as follows: 62 % died in traffic accidents outside city limits, 32 % died in traffic accidents within city limits and 7 % died in traffic accidents on the motorways in the territory of the Czech Republic.

Definition of safe distance behind another vehicle in the laws of the Czech Republic

In the laws of the Czech Republic, specifically Act No. 361/2000 Coll., on road traffic, as amended, under Section 19(1), among other things, the safe distance between vehicles is defined as follows:

“The driver of a vehicle that is travelling behind another vehicle must maintain an adequate safe distance to enable him to avoid a collision in the event of an abrupt speed reduction or sudden stop of the vehicle in front of him.”¹²⁴⁾

Generally, according to this Act, the driver is obliged to keep such a distance that allows him to stop safely in case of the occurrence of the above-mentioned traffic situation. This definition thus does not quantitatively determine the distance behind another vehicle, but the so-called “two seconds rule” exists, which recommends that drivers in good weather conditions should keep a distance of at least two seconds behind another vehicle, and keep a longer distance in deteriorated weather conditions.

Analysis of the impact of traffic signs on observance of the distance behind another vehicle in the Czech Republic

Measurements were taken outside city limits on Road E461 not far from the Municipality of Bořitov in the direction to Brno on 19 November 2015 from 14:20. The measurement was done on a section with vertical and horizontal traffic signs that warn drivers to keep a safe distance behind another vehicle. For the purposes of the analysis, the traffic situation was measured before the upright traffic sign that warned about observing a safe distance and at the same time after this traffic sign and at the end of the horizontal traffic sign on the roadway that warned about such observance.



Fig. 1, 2 Upright, respectively, horizontal traffic signs for observance of safe driving distance behind another vehicle in the measured section

¹²⁴⁾ Parliament of the Czech Republic. (n.d.). Act No. 361/2000 Coll. Retrieved March 12, 2017, from <https://portal.gov.cz/app/zakony/zakonPar.jsp?idBiblio=49756&nr=361~2F2000&rpp=15#local-content>.

The weather conditions were, among others, cloudy without precipitation, temperature of 15 °C and a slight breeze. During measurement, the vehicles were recorded from an adequate distance in the field at the beginning and end of the section in such a manner as not to influence the drivers' activities and thus avoid distortion of the measurement. For this reason, the recording equipment was located at an adequate distance so that the drivers would not see it. For the purposes of this measurement, video recordings were made using digital video cameras in a full HD resolution of 1920 x 1080 pixels at a frame rate of FPS 50.

Before making the video recording, the important distances for subsequent evaluation of the measurements were measured using a tape and marked with wooden pegs. These measured points were subsequently recorded by two cameras in a video recording for subsequent analysis.

During analysis of the individual frames, the following traffic situation data were recorded:

- categories of vehicles travelling in a motorcade,
- video recording imaging coefficient,
- time of vehicle front-end at beginning of section [s],
- time of vehicle rear-end at beginning of section [s],
- time of vehicle rear-end at end of section [s],
- length of measured section [m].

From these variables, the average vehicle speed and average distance between the vehicles in the measured section were calculated. Vehicles with a spacing of less than 100 metres were considered as vehicles travelling in a motorcade. The evaluation, apart from vehicles with a spacing of more than 100 m also excluded a tractor travelling at too low a speed with vehicles in a motorcade behind it, in order to avoid distortion of the sample data set.

Data analysis results obtained from the measurement and acquired knowledge

The traffic intensity in the measured section in the direction to Brno at the time of measurement was 530 vehicles per hour. From the primary set of 530 vehicles travelling through the given section, a sample of 312 measured vehicles travelling through the given section with a distance of 100 m behind another vehicle and also travelling at a speed above 50 km/h. The random variables included the already mentioned vehicle speed and distance behind another vehicle, whose values make up the data set.

Measurement of speed before and after the traffic sign warning the driver about observing a safe distance behind another vehicle

From the primary set, approx. 93 % of the drivers in the measured section before the upright "Keep a Safe Distance" traffic sign did not exceed

the maximum permitted speed. A total of 39 drivers out of 530, i.e., approx. 7 %, drove through the measured section at a higher speed than permitted. Absolutely, the highest measured speed recorded was 103 *km/h*.

For vehicles from the sample data set, the lowest measured speed was 61 *km/h*, and the highest 96 *km/h*. The average speed of the vehicles was 76 *km/h*, while 25 % of the vehicles travelled at a speed below 71 *km/h* and 25 % of the vehicles at a speed above 79 *km/h*. In the following graph, it can be seen that the majority of drivers drove at a speed between 72 and 75 *km/h*.

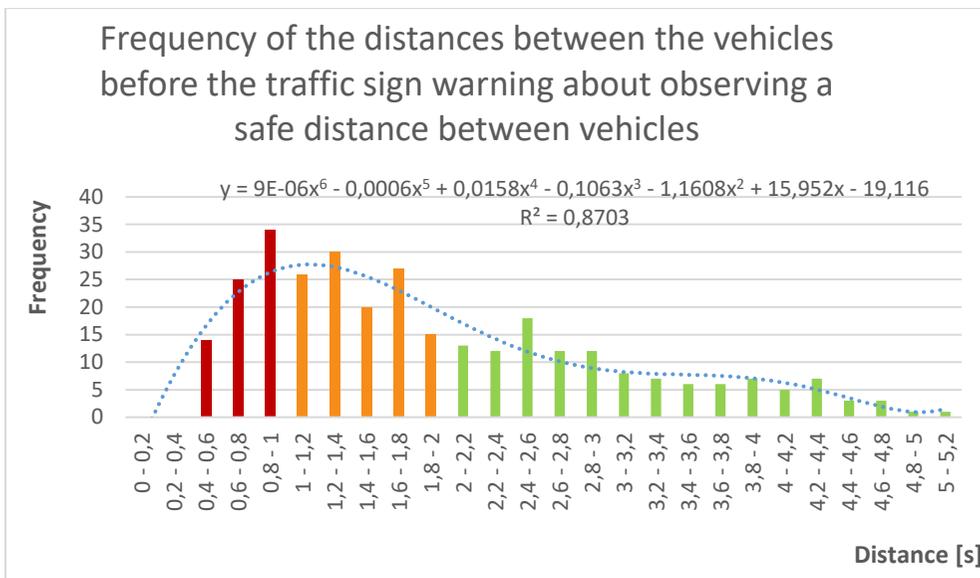
From the primary set, approx. 97 % of the drivers in the measured section after the upright “Keep a Safe Distance” traffic sign and also at the end of the V16 “Keep a Safe Distance” horizontal traffic sign did not exceed the maximum permitted speed. A total of 16 drivers out of 530, i.e., approx. 3 %, drove through the measured section at a higher speed than permitted. Absolutely, the highest measured speed recorded was 103 *km/h*.

For vehicles from the sample data set, the lowest measured speed was 58 *km/h*, and the highest 92 *km/h*. The average speed of the vehicles was 73 *km/h*, while 25 % of the vehicles travelled at a speed below 68 *km/h* and 25 % of the vehicles at a speed above 77 *km/h*. In the following graph, it can be seen that the majority of drivers drove at a speed between 70 and 73 *km/h*.

The difference between the speed of the vehicle before and after the safe distance traffic sign in the case of the sample set of 312 vehicles is on average approx. -3 *km/h*, i.e., The drivers on average reduced the vehicle speed after travelling past the upright traffic sign and over the horizontal traffic sign warning about observing a safe distance behind another vehicle.

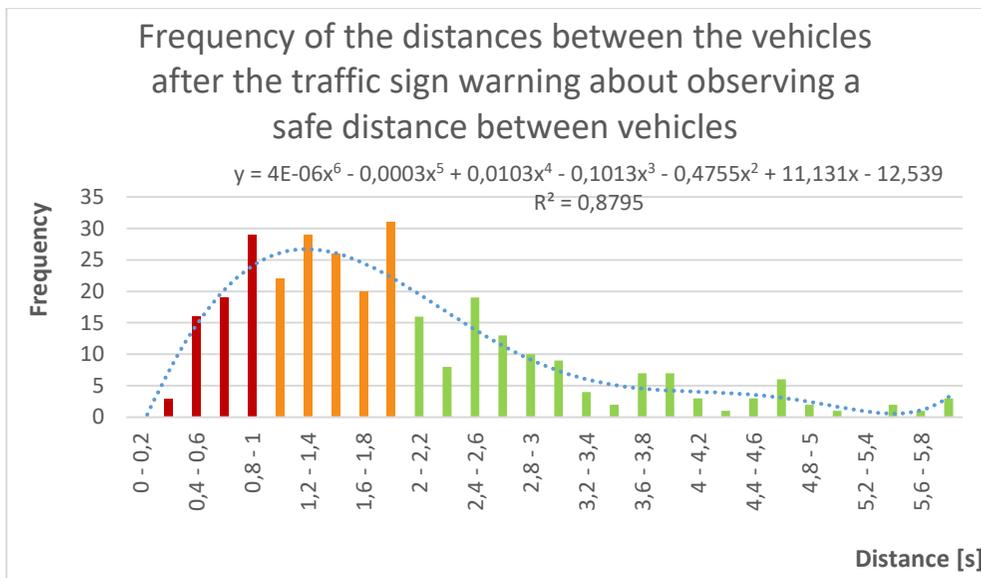
Measurement of distance between vehicles before and after the traffic sign warning the driver about observing a safe distance behind another vehicle

For vehicles in the sample set, the shortest distance before the upright “Keep a Safe Distance” traffic sign was approx. 0.4 *s*, the longest approx. 5 *s*. The average distance behind another vehicle was approx. 1.88 *s*, while 25 % of the vehicles travelled at a distance behind another vehicle of less than approx. 1 *s* and 25 % of the vehicles at a distance behind another vehicle of more than 2.5 *s*. In the following graph, it can be seen that the majority of drivers drove at a distance behind another vehicle of between 0.8 and 1 *s*. From the sample set, i.e., 312 vehicles, a total of 193 drivers, i.e., approx. 62 %, when driving behind another vehicle kept a distance of less than 2 *s*, a total of 78 drivers, i.e., approx. 25 % kept a distance of less than 1 *s* and a total of 9 drivers, i.e., approx. 3 % kept a distance of less than 0.5 *s*.



Graph 3 Frequency of the distances between the vehicles before the traffic sign warning about observing a safe distance

For vehicles in the sample set, the shortest distance after the upright “Keep a Safe Distance” traffic sign and also at the end of the V16 “Keep a Safe Distance” horizontal traffic sign was approx. 0.2 s, the longest approx. 5.9 s. The average distance behind another vehicle was approx. 1.92 s, while 25 % of the vehicles travelled at a distance behind another vehicle of less than 1.1 s and 25 % of the vehicles at a distance behind another vehicle of more than 2.5 s. In the following graph, it can be seen that the majority of drivers drove at a distance behind another vehicle of between 1.8 and 2 s. From the sample set, i.e., 312 vehicles, a total of 199 drivers, i.e., approx. 64 %, when driving behind another vehicle kept a distance of less than 2 s, a total of 70 drivers, i.e., approx. 22 % kept a distance of less than 1 s and a total of 11 drivers, i.e., approx. 4 % kept a distance of less than 0.5 s.



Graph 4 Frequency of the distances between the vehicles after the traffic sign warning about observing a safe distance

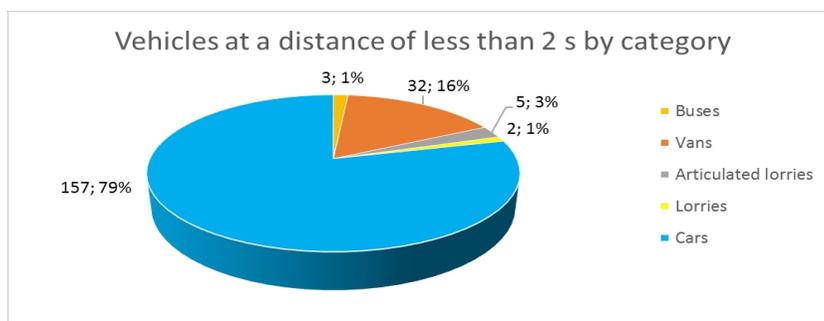
The difference between the distances behind other vehicles before and after the safe distance traffic sign in the case of the sample set of 312 vehicles is on average approx. +0.04 s, i.e., the drivers on average slightly increased their distance behind another vehicle after travelling past the upright traffic sign and over the horizontal traffic sign warning about observing a safe distance behind another vehicle.

The following table shows that the lowest measured speed behind another vehicle after the upright “Keep a Safe Distance” traffic sign and also at the end of the V16 “Keep a Safe Distance” horizontal traffic sign on average was observed by bus drivers, i.e., 1.3 s, followed by car drivers, i.e., 1.8 s, followed by van drivers, i.e., 1.9 s, and a distance greater than 3 s on average was maintained by drivers of articulated lorries and lorries. On average, a mildly positive effect on the observance of safe driving distance behind another vehicle in the measured section between the part after the “Keep a Safe Distance” traffic sign as compared with the traffic situation before the “Keep a Safe Distance” traffic sign, was registered for the articulated lorries category, approx. +0.2 s. On the contrary, the distance behind another vehicle was shortened in the case of the bus category, by approx. 0.5 s.

Vehicle type	Distance before traffic sign [s]	Distance after traffic sign [s]	Difference [s]	Number of vehicles
Cars	1.8	1.8	0	228
Vans	1.9	1.9	0	54
Articulated lorries	2.9	3.1	+ 0.2	16
Lorries	3.0	3.0	0	11
Buses	1.8	1.3	- 0.5	3
Total average / number	1.9	1.9	0	312

Table 1 Comparison of average distance between vehicles according to vehicle category before and after the traffic sign

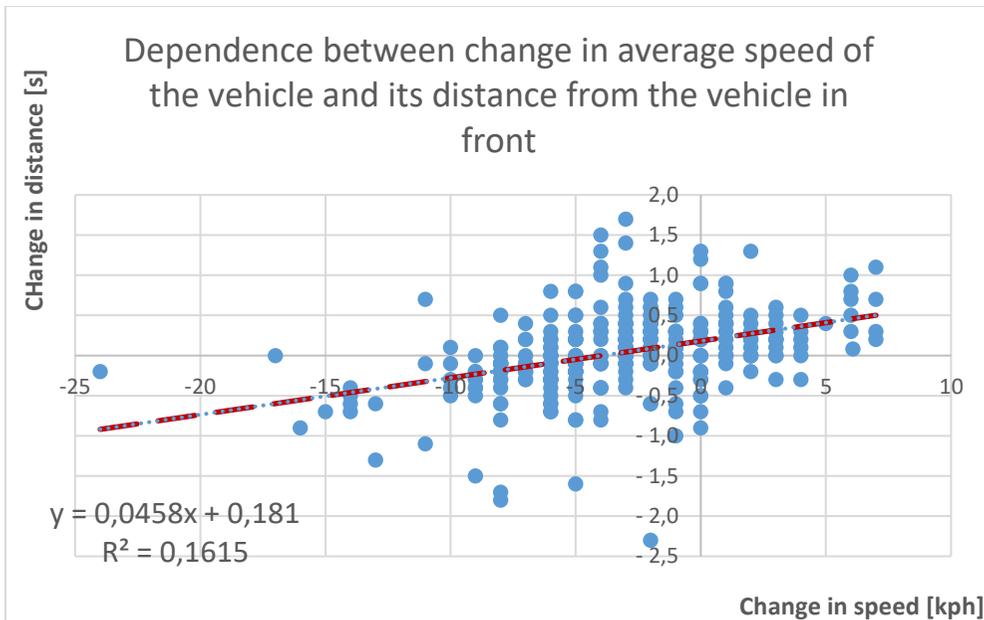
The following graph shows that the largest ratio of drivers who drove through the measured section during the measurement with a distance of less than 2 s after the Keep a Safe Distance traffic sign are drivers of cars and vans.



Graph 5 Vehicles at a distance of less than 2 s by category

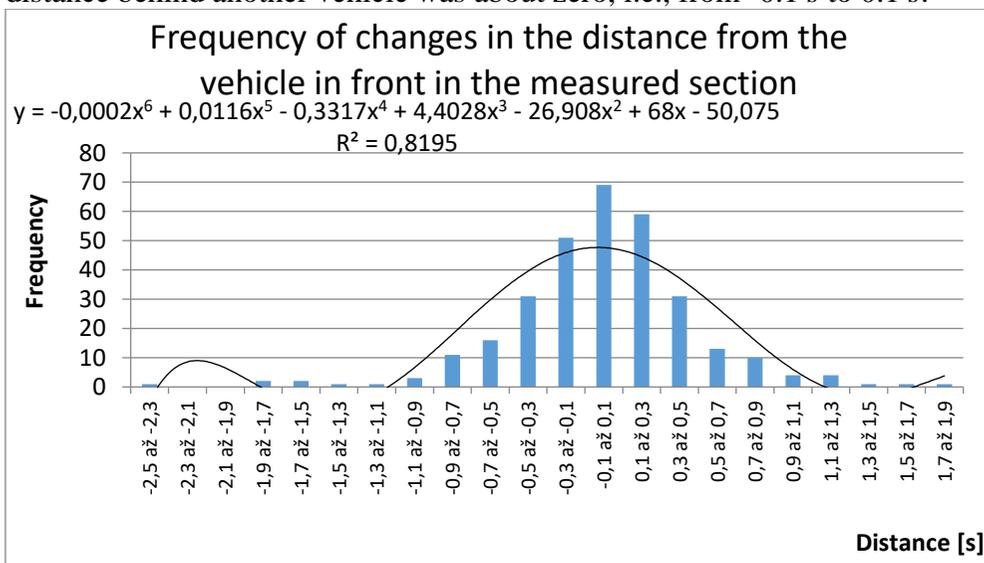
The coefficient of the correlation between the vehicle speed and its distance behind another vehicle for the sample set of 312 vehicles is close to zero in the case of both measured points, thus from the statistical viewpoint there is no direct or indirect linear dependence between speed and distance behind another vehicle before and after the “Keep a Safe Distance” traffic sign.

The coefficient of the correlation between change of speed and distance behind another vehicle after travelling through the measured section is equal to approx. 0.40, which indicates partial linear dependence between change in speed and change in distance behind another vehicle, or if the driver changed the speed of the vehicle after passing the “Keep a Safe Distance” traffic sign, then the distance behind another vehicle also changed to a certain degree.



Graph 6 Dependence between change in average speed of the vehicle and its distance from the vehicle in front

The following graph shows the frequency of individual changes in distance behind another vehicle in the measured section. The largest number of drivers, i.e., 69, did not change their distance behind another vehicle after driving through the measured section, or the difference in their distance behind another vehicle was about zero, i.e., from -0.1 s to 0.1 s.



Graph 7 *Frequency of changes in the distance from the vehicle in front in the measured section*

Conclusion

According to Czech Police statistics, the highest risk factor of the traffic system, which has a substantial impact on the frequency of traffic accidents, is the human factor, or road traffic participant, who drives a motor or other vehicle. Reducing the accident rate is being facilitated by the development of assistant systems in motor vehicles, development of the safety of the transport infrastructure, sanctions and many others although in spite of this, according to the Czech Police the number of traffic accidents has been rising since 2009. On the contrary, at least the number of deaths within 24 hours after a traffic accident in the territory of the Czech Republic is declining. According to road traffic accident statistics in the Czech Republic, it is becoming clear that “non-observance of safe distance” is one of the most frequent causes of traffic accidents. According to the Czech Police, it was the third most frequent cause of road traffic accidents in 2016.

From the given measurement, it follows that a significant proportion of drivers do not observe the “two seconds” safe distance rule, and in many cases not even such a distance behind another vehicle that could correspond to the usual response time of a driver, and they are not aware of the risks of such behaviour.

From the analysis of the measurements done in the given section, it also follows that the traffic signs that warn about observing a safe distance behind another vehicle on average have a negligible impact (+0.04 s) on observing a safe distance behind another vehicle. This behaviour on the part of drivers is probably influenced mainly by the fact that a safe distance is not specified in Act No. 361/2000 Coll., as amended, and at the same time, the relevant legal regulations do not define sanctions for non-observance of a safe distance behind another vehicle.

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