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The impact of selected safety systems in trucks on preventing road accidents, according to the opinions of Polish truck drivers

Wpływ wybranych systemów bezpieczeństwa w samochodach ciężarowych na zapobieganie wypadkom drogowym w opinii polskich kierowców ciężarówek

Abstract. The study aimed to find out the opinions of professional drivers on the impact of selected active safety systems on minimizing the risk of road accidents. The data for the study were collected using a questionnaire. Kendall's tau correlation coefficient was used to analyze the data. The study showed that the vast majority of drivers rated the systems positively in terms of ensuring road safety. The only exception was traditional cruise control; in this case, most drivers felt it had no impact on safety. In the case of some assessments of individual active vehicle safety systems, correlations have been found with sociodemographic variables and the nature of the work performed. Thus, correlations exist between sociodemographic variables and between the EBS (p = 0.00, $\tau = -0.24$) and ACC (p = 0.00, $\tau = -0.25$) systems and age. In turn, in the case of the nature of the work performed, there are correlations between the type of vehicle driven by the driver and traditional cruise control (p = 0.00, $\tau = -0.38$) and the professional experience of drivers and the ASR system (p = 0.00, $\tau = -0.28$), EBD system (p = 0.00, $\tau = -0.28$) and EBS system (p = 0.00, $\tau = -0.22$). An important observation from the study is the drivers' opinions: despite pointing out the positive impact of active vehicle safety systems in most cases, they also identified several disadvantages. The study's results fill a research gap regarding users' assessments of active vehicle safety systems and may provide valuable insights into their effectiveness for truck manufacturers.

Keywords: road safety, truck drivers, behavior, vehicle safety systems, risk, lorries, active safety, passive safety

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Synopsis. Celem badania było poznanie opinii zawodowych kierowców na temat wpływu wybranych aktywnych systemów bezpieczeństwa w samochodach ciężarowych na minimalizację ryzyka wypadków drogowych. Dane do badania zebrano za pomocą kwestionariusza. Do analizy danych wykorzystano współczynnik korelacji tau Kendalla. Badanie wykazało, że zdecydowana większość kierowców pozytywnie oceniła stosowane w samochodach ciężarowych systemy pod względem zapewnienia bezpieczeństwa na drodze. Jedynym wyjątkiem był tradycyjny tempomat – większość kierowców uznała, że nie ma on wpływu na bezpieczeństwo. W przypadku niektórych ocen poszczególnych aktywnych systemów bezpieczeństwa pojazdów stwierdzono korelacje ze zmiennymi socjodemograficznymi i charakterem wykonywanej pracy. Istnieją zatem korelacje między zmiennymi socjodemograficznymi a systemami EBS ($p = 0{,}00$, $\tau = -0{,}24$) i ACC ($p = 0{,}00$, $\tau = -0{,}25$) oraz wiekiem. Z kolei w przypadku charakteru wykonywanej pracy istnieją korelacje między typem pojazdu prowadzonego przez kierowcę a tradycyjnym tempomatem ($p = 0{,}00$, $\tau = -0{,}38$) oraz doświadczeniem zawodowym kierowców a systemem ASR ($p = 0{,}00$, $\tau = -0{,}28$), systemem EBD ($p = 0{,}00$, $\tau = -0{,}28$) oraz systemem EBS ($p = 0{,}00$, $\tau = -0{,}22$). Ważną obserwacją wynikającą z badania są opinie kierowców, którzy pomimo wskazania w większości przypadków pozytywnego wpływu aktywnych systemów bezpieczeństwa pojazdów, zwrócili również uwagę na kilka ich wad. Wyniki badania wypełniają lukę badawczą dotyczącą oceny aktywnych systemów bezpieczeństwa pojazdów przez użytkowników i mogą dostarczyć cennych informacji na temat ich skuteczności producentom samochodów ciężarowych.

Słowa kluczowe: bezpieczeństwo ruchu drogowego, kierowcy zawodowi, zachowanie, systemy bezpieczeństwa pojazdów, ryzyko, samochody ciężarowe, bezpieczeństwo czynne, bezpieczeństwo bierne

JEL codes: R41, R42, I10

Introduction

Data from Eurostat's "Key figures on European transport. The 2023 edition" shows that the transport sector employed 6.1 million people across the European Union in 2022. The dominant mode of transport was road transport, employing almost 90% of all workers in the sector. In Poland, 747.000 people were employed in transportation at that time, which was the second-highest figure in the European Union [Eurostat 2024; Zając 2024]. Across the European Union, almost 6.5 million heavy goods vehicles were recorded in 2022, of which 1.3 million were registered in Poland, accounting for 20% of all such vehicles. Heavy goods vehicles registered in Poland accounted for 20.10% of all transport, measured in tonne-kilometers [Eurostat 2024].

At the same time, although the number of accidents involving truck drivers in Poland is decreasing, truck drivers remain the second-largest group of road accident causers (right after passenger car drivers). The number of accidents caused by this group of drivers between 2021 and 2025 is summarized in Table 1.

Table 1. Traffic accidents caused by truck drivers from 2021 to 2025
Tabela 1. Wypadki drogowe z winy kierowców samochodów ciężarowych w latach 2021–2025

Year	Number of accidents	Dead	Injured
2021	1,977	244	2,295
2022	1,691	221	1,974
2023	1,481	193	1,714
2024	1,464	186	1,741
2025	1,435	86	1,681

Source: own work based on [KGP 2022–2026]
Źródło: badania własne na podstawie [KGP 2022–2026]

As can be seen from the above, the number of accidents, fatalities, and injuries in 2025 decreased by more than 35% compared to 2021. At the same time, given the socioeconomic consequences of traffic accidents, it should be noted that this number remains significant.

Despite the enormous positive impact of road transport on a country's economy, attention should be paid to the social and economic costs associated with this mode of transport, as measured by the number of accidents, fatalities, and injuries in road accidents [Achtenberg 2007; Antov et al. 2011]. As the EC Report indicates, the total external costs of road accidents for the 28 EU countries (excluding the UK) amounted to €238.5 billion for passenger transport and €42.8 billion for road freight transport [European Commission 2019]. Therefore, knowing the causes and effects of hazards is essential. An analysis of the sources of hazards shows that there are many. However, those that appearing most frequently can be grouped into three categories [Badina 2022; Belanova et al. 2022; Kofalvi 2001]: artificial hazards, hazards; hazards caused by natural forces (i.e., heavy rainfall, snow blizzards, and fog); and hazards caused by construction defects, such as cavities in the road surface.

Human factors are the most influential cause of road accidents [Brożyna 2017; Eurostat 2024; Hryc & Godlewska 2026]. Researchers have indicated that inappropriate driving behavior is one of the most significant factors influencing accident risk [Pałęga 2017; Washburn et al. 2023; Rowe et al. 2015; Rashmi & Marisamynathan 2023]. According to Naderi et al. [2010], inappropriate driving behavior can be divided into three general categories: mistakes, errors and traffic violations. Mistakes behind the wheel are often due to memory problems, shortcomings, and negligence, for example, when a driver enters an intersection or a lane incorrectly. Driving errors usually result from poor judgment and limited visibility, for example, when a driver turns right and suddenly encounters a cyclist or motorcyclist, increasing the risk of a collision. Traffic violations include failure to comply with necessary rules, which are absolute requirements for safe driving.

Accidents involving HGV drivers primarily occur due to aggressive maneuvers or non-compliance with traffic rules, as well as poor weather conditions that affect visibility and make it difficult to control the vehicle [Bednarek 2024; Naderi et al. 2021; Trigell et al. 2017].

A significant factor contributing to road accidents among HGV drivers is fatigue. Brown [1994] presented a comprehensive review of the scientific literature on the nature of fatigue and its impact on driver behavior and road accidents. Estimates of the proportion of car accidents related to driver drowsiness vary depending on the study type and the quality of the data. A population-based study conducted in New Zealand found that factors significantly increasing the risk of a fatal or serious injury accident included driving during the time allocated for sleep, driving after less than five hours of sleep in the previous 24 hours, and driving between 2:00 and 5:00 a.m. The study found that minimizing all three of these behaviors could reduce the incidence of injury accidents by up to 19% [Connor et al. 2002].

The advent of mobile phones has also negatively affected the behavior of truck drivers [Dhibi & Alhajyaseen 2026; Alireza et al. 2025]. Research by Donkor et al. [2018] on truck drivers in Ghana revealed that most drivers (96.4%) were aware of the law prohibiting the use of phones while driving. However, 59.6% did not comply with this law on a daily basis. Among drivers who reported using their phones while driving, 44.6% reported using a hands-free kit. Drivers indicated that most phone use was for communicating with fellow drivers about road events, although this cannot be independently confirmed. More than a quarter of respondents did not believe that using a phone was distracting while driving. Among drivers who reported using a cell phone while driving, 2.5% were involved in an accident while using the phone, and 12.4% reported an incident that could have resulted in an accident had they not been using the phone. In 2023, 3,275 people died in the US due to distracted driving [NHTSA n.d.]. Various sources indicate that distracted driving causes between 7% and 50% of traffic accidents [Hanowski et al. 2005; Montuori 2021; Klauer 2017; Palat 2009]. According to Ferreira et al. [2019], among all categories of drivers, it is well known that truck drivers are particularly vulnerable to the risks associated with distraction due to extended driving hours and the solitary nature of their work.

Due to numerous instances of improper behavior by drivers and others around them, it became necessary to introduce design solutions in vehicles to improve safety. Safety systems are designed to minimize negative driver and environmental behavior and improve road safety [Jermakian 2012; Puthan et al. 2018; Trigell et al. 2017]. That is why it is crucial to install devices that enhance both active and passive vehicle safety [Guvenc 2020].

In this regard, car manufacturers are introducing a number of new solutions that are also aligned with EU requirements. Since 2009, the European Union has been working on the General Safety Regulations package. This package is being implemented gradually. The main objective of the GSR is to improve road safety, and one of its outcomes is the introduction of new mandatory equipment for trucks and advanced safety systems that must be installed in newly registered vehicles [Regulation (EU) 2019/2144].

Active and passive safety systems used to minimize the risk of road accidents are listed in Table 2.

Active safety systems are designed to reduce the number of road accidents involving other road users. These systems provide drivers with the opportunity to react before an undesirable event occurs [Ljung Aust & Engström 2011; Guvenc 2020]. In turn, the function of passive safety systems is to protect road users when active safety systems prove insufficient [Niebuhr et al. 2015]. The primary consideration here is the health of passengers and other people involved in the incident [Krzyszkowska 2015;

Table 2. Selected active and passive vehicle safety systems
Tabela 2. Wybrane aktywne i pasywne systemy bezpieczeństwa pojazdów

System	Type of system	Characteristics
Active system	Anti-lock braking system (ABS)	Prevents the vehicle's wheels from locking during braking. It was designed to enable simultaneous braking (especially sudden braking) while still allowing the car to be steered.
	Acceleration slip regulation (ASR)	The traction control system is one of the systems that improves driving safety. Its primary role is to control wheel speed. As a result, ASR increases the traction of the drive wheels during various maneuvers.
	Electronic stability control (ESC)	Electronic stability program (ESP) and dynamic stability control (DSC). When cornering, this system takes control of the combined ABS and ASR systems. It activates automatically when the appropriate sensor detects the possibility of the vehicle skidding out of the corner. To prevent this, the electronic stability control system brakes one or more wheels.
	Electronic brake force distribution (EBD or EBFD)	This system is responsible for the electronic distribution of braking force, which is available in all modern European cars. This system significantly improves safety during braking in all situations.
	Traditional cruise control	A feature in a car that allows the driver to maintain a constant speed while driving.
	Adaptive cruise control (ACC)	It is an advanced driver assistance system that automatically adjusts the vehicle's speed to traffic conditions.
	Automated emergency braking (AEB)	The primary task is to detect potential collisions automatically and, if necessary, initiate braking independently to prevent an accident or mitigate its effects.
	Lane assist	A system that monitors whether the driver is keeping the car within the lane. It works by linking a camera, usually located behind the windshield at the height of the rearview mirror (sometimes assisted by cameras located in the side mirrors), which monitors the space in front of the car, with the steering system.
Passive system	Seat belt	They keep the passenger's body in place during sudden braking or a collision, preventing them from moving around uncontrollably and hitting parts of the cabin.
	Airbags and air curtains	Devices that fill with gas in a fraction of a second in the event of a collision. They create a soft barrier between the passenger's body and the complex elements of the car interior, significantly reducing the risk of injury to the head, chest, or limbs.
	Headrests	When properly positioned, they support the head and reduce the risk of cervical spine injuries.
	Crumple zones	These are specially designed areas of the bodywork that deform predictably during a collision. Their primary function is to absorb impact energy before it reaches the passenger compartment, thereby reducing the forces acting on occupants.
	Steering column with controlled deflection function	In the event of a substantial impact, the steering column collapses or deforms in a controlled manner, reducing the risk of serious injury to the driver's chest and head.

Source: own research
Źródło: badania własne

Sabarinath 2020]. When an unexpected event occurs, they limit its effects by, among other things, maintaining the correct position of the vehicle user and absorbing the force of impact with the obstacle [Sabarinath 2020].

One might be tempted to conclude that these systems are the most crucial elements of vehicle equipment [Krzyszkowska 2015]. Studies on the impact of safety systems on reducing road traffic risks indicate their great potential. According to eImpact (high-risk scenario from 2020), electronic stability control (ESC) prevents by far the highest number of fatalities and injuries: approximately 3,000 fatalities (−14%) and approximately 50,000 injuries (−6%) per year. Speed warning systems (with active accelerator pedal) (−5%), eCall (−4%) and lane departure warning systems (−3%) also have a significant impact on the number of fatalities. At the same time, these applications contribute to reducing traffic congestion, as approximately 15% of all traffic jams in Europe are caused by accidents [European Commission n.d.].

One area of activity aimed at reducing the number of accidents and their negative consequences involving HGV drivers is the installation of safety systems in HGVs. At the same time, the introduction of new solutions or the improvement of existing ones involves, on the one hand, numerous tests by manufacturers and, on the other, an assessment of their suitability from the user's point of view. There are many studies on negative driver behavior [He et al. 2023; Mehdizadeh et al. 2018; Han et al. 2021; Rashmi & Marisamynathan 2023; Habybabady 2025] or on the evaluation of systems to improve driver safety [Chengula et al. 2023; Galal 2023], but there are no studies in this area referring to the experience of professional drivers.

Accordingly, the aim of the study was to examine the relationship between socio-demographic variables and drivers' professional experience, as well as their assessment of the impact of selected active safety systems in trucks on reducing the risk of traffic accidents.

Research method

The empirical analysis was conducted based on a questionnaire. The questionnaire was divided into four groups: (1) demographic variables, (2) work experience, (3) factors and situations threatening road safety, and (4) operation of safety systems in trucks. Additionally, the last question was an open-ended question, in which respondents expressed their views on the advantages and disadvantages of safety systems in trucks.

The research was conducted in the first half of 2024. The CAWI method was used in the data collection process. The online questionnaire was prepared using a Google form and distributed via social media channels, including Facebook and professional driver groups. One hundred and twelve respondents participated in the study. After analyzing the validity of the completed questionnaires, 107 questionnaires were used for further analysis. They were Polish drivers providing transport services both in Poland and across Europe. To answer the research questions, statistical analyses were conducted using Excel and Statistica 13.3 software. It was used to calculate basic descriptive statistics and Kendall's tau coefficient. The significance level in the article was set at $\alpha = 0.05$.

Characteristics of respondents

There were more men than women among the study participants, i.e., 98 men (91.59%) and 9 women (8.41%) (Table 3). The structure of the study participants reflects the prevailing trend in this sector. The profession of truck driver is still predominantly performed by men.

Table 3. Characteristics of survey respondents ($N = 107$)
Tabela 3. Charakterystyka respondentów ($N = 107$)

Variables	Frequency	Percentage [%]
Gender		
Women	9	8.40
Men	98	91.59
Age		
18–25	4	3.74
26–35	23	21.50
36–50	55	51.40
Above 50	24	23.36
Education		
Vocational education	42	39.25
Secondary education	49	45.80
Higher education	16	14.95
Residence		
Village	40	37.38
Town with up to 50,000 inhabitants	28	26.17
Town with 50,001 to 150,000 inhabitants	30	28.04
City with over 150,000 inhabitants	9	8.41
Type of transport performed		
Domestic	42	39.25
International	25	23.37
Domestic and international	40	37.38
Experience as a driver		
Up 5 years	13	12.15
6–10 years	24	22.43
11–20 years	43	40.19
More than 20 years	27	25.23
Type of truck driven		
Tractor unit with semi-trailer	90	84.11
Truck with van body	4	3.74
Truck for bodywork	10	9.35
Special truck	3	2.80
Work system		
Every day at home	32	29.91
Monday to Friday on the road, weekends at home	32	29.91
Two weeks on the road, one week at home	27	25.23
Three weeks on the road, one week at home	15	14.02
Every day at home	1	0.93

Source: own research

Źródło: badania własne

The largest group of drivers were people aged 36–50, who accounted for over half of all respondents. In terms of education, people with secondary and vocational education were the most prevalent (85.05%). Significantly fewer, only 14.95%, had higher education. In terms of residence, people living in rural areas and cities with a population of 50,001 to 150,000 were the most prevalent.

Nearly 40% of respondents are involved in domestic transport. The largest group were respondents with 11 to 20 years of work experience (40.19%), mainly aged 36–50. Over 33% of respondents reported having 1 to 10 years of work experience. In this case, they were primarily drivers aged 26 to 35 years old. Drivers with over 20 years of professional expertise accounted for over 25% of all respondents. The survey mainly involved drivers of tractor units with semi-trailers. Two work systems dominated the surveyed group. These systems involved either daily returns home or work from Monday to Friday, with weekend returns home.

Results

Main traffic hazards according to truck drivers

Several factors influence the frequency and severity of road accidents. These include both the behavior of road users and factors beyond their control. As shown in the data in Figure 1, inappropriate behavior by road users is the primary threat to road traffic, particularly from other drivers.

The data presented in Figure 1 confirm that human error is the primary source of road traffic hazards, followed by weather conditions. According to the respondents, the primary source of danger is the irresponsible behavior of other drivers, with almost 87% of respondents indicating this answer. Next, drivers most often identified hazards such as weather conditions (70%), other road users (63.5%), fatigue (58%), and the technical condition of the vehicle (49.5%). In the opinion of truck drivers, driving under the influence of alcohol and drugs is the least significant factor. The nature of their work and the legal prohibition against working under the influence of alcohol may influence this response pattern. The dangerous behavior of professional drivers does not differ from that of passenger car drivers. Most often, truck drivers do not adjust their speed to the speed limits (Figure 2).

The data obtained show that drivers most often exceed the speed limit (84.11%) and talk on their phones while driving (73.83%). The responses indicate that they also frequently exceed their working time (36.45%) and fail to yield the right of way (25.23%).

Assessment of the impact of selected active safety systems in heavy goods vehicles – sociodemographic variables and professional experience

This chapter presents the results of a study examining the impact of sociodemographic variables on the assessment of the effects of selected active safety systems in trucks on road safety. Kendall's tau coefficient was used to estimate the strength and direction of the relationship between sociodemographic variables and selected active vehicle safety systems. Thanks to this approach, it was possible to determine which systems have the

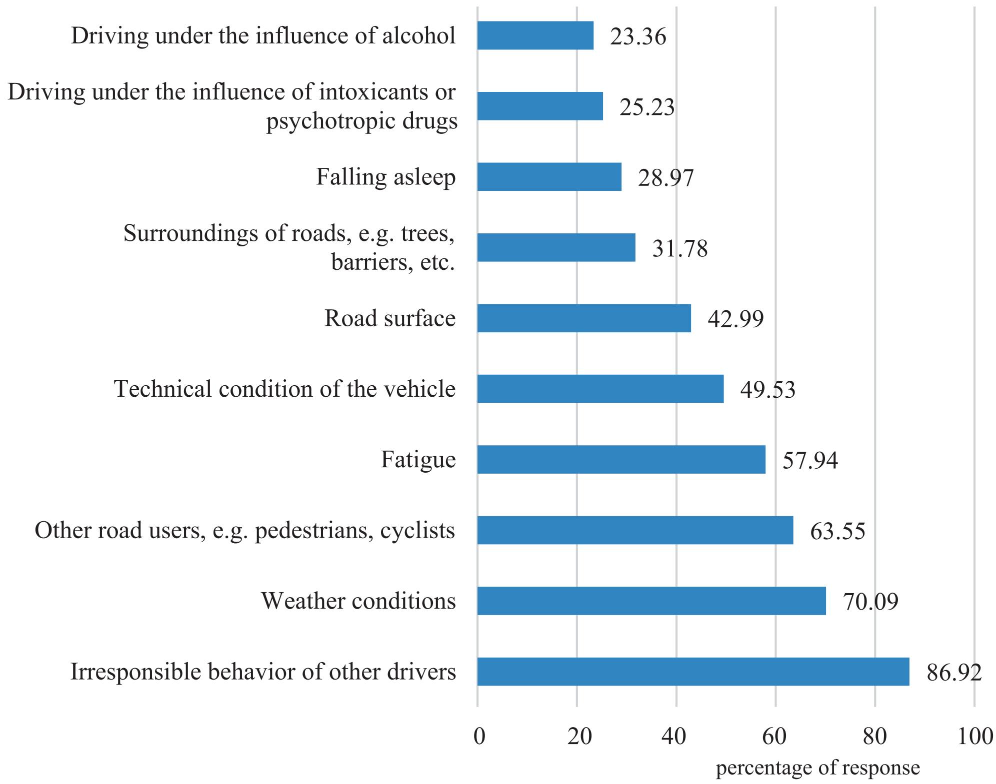

Figure 1. Primary sources of danger in road traffic according to professional drivers (multiple choice)
Rysunek 1. Główne źródła zagrożeń w ruchu drogowym w opinii zawodowych kierowców (wybór wielokrotny)

Source: own research

Źródło: badania własne

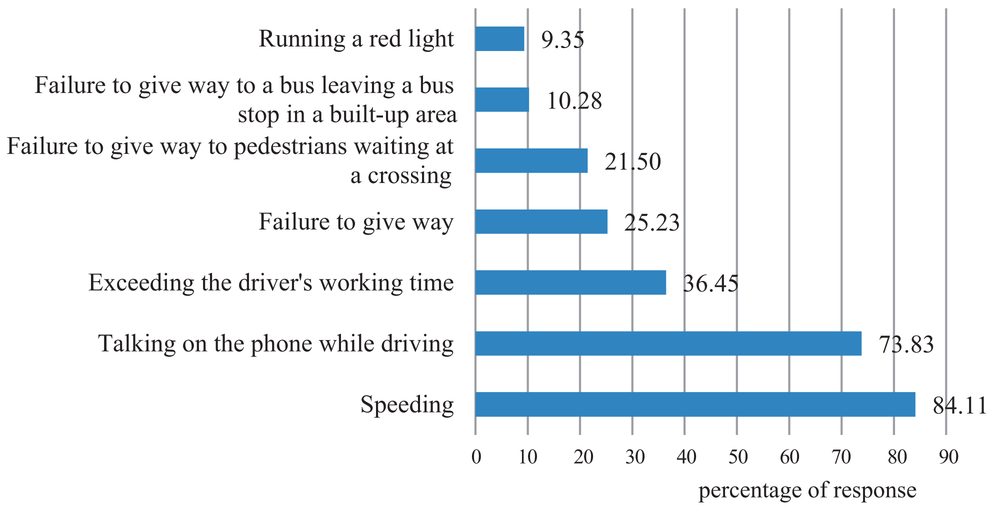

Figure 2. The most common traffic violations committed by professional drivers (multiple choice)
Rysunek 2. Najczęstsze wykroczenia drogowe popełniane przez kierowców zawodowych (wybór wielokrotny)

Source: own research

Źródło: badania własne

most significant impact on road safety, taking into account factors such as gender, age, and place of residence (Table 4).

Table 4. Kendall's correlation coefficients between sociodemographic variables and the assessment of the impact of vehicle safety systems on road safety ($N = 107$)
Tabela 4. Współczynniki korelacji Kendalla między zmiennymi socjodemograficznymi a oceną wpływu systemów bezpieczeństwa pojazdów na bezpieczeństwo ruchu drogowego ($N = 107$)

Factors	**Tau (Kendall)**	***p***	Factors	**Tau (Kendall)**	***p***
Gender			Age		
ABS	0.09	0.17	ABS	0.01	0.90
EBS	0.04	0.57	EBS	−0.24	0.00
ASR	−0.02	0.75	ASR	−0.17	0.01
EBD	−0.06	0.34	EBD	−0.17	0.01
Traditional cruise control	0.05	0.45	Traditional cruise control	0.01	0.92
ACC	0.10	0.14	ACC	−0.25	0.00
AEB	0.06	0.36	AEB	−0.06	0.37
Lane assist	0.08	0.22	Lane assist	−0.19	0.00
Education			Residence		
ABS	−0.07	0.25	ABS	−0.08	0.21
EBS	−0.13	0.04	EBS	0.02	0.79
ASR	0.06	0.34	ASR	0.13	0.05
EBD	0.09	0.15	EBD	0.15	0.02
Traditional cruise control	−0.13	0.06	Traditional cruise control	−0.03	0.60
ACC	0.00	0.99	ACC	0.25	0.00
AEB	0.19	0.00	AEB	−0.11	0.09
Lane assist	0.13	0.03	Lane assist	−0.05	0.43

Source: own research
Źródło: badania własne

When analyzing the data obtained, a weak correlation was found between age and the impact of the EBS system on road safety. The answer "yes" was most often selected by people over 51 years of age (92.00%), while people in the 26–35 age group (8.70%) indicated that the EBS system had no impact on safety. These people were also most often unable to determine the effect of this system on road safety (34.78%). A similar distribution of responses was observed in the assessment of the impact of the ACC system on road safety across age groups. With age, an increasing number of drivers answered "yes." The highest number of "yes" answers was given by drivers over 51 (80.00%). In the case of drivers aged 18–25, as many as 50.00% said that this system had no impact on road safety.

On the other hand, the effect of lane assist on road safety was highly rated by all driver groups, but among those aged 26–35, the "no" responses (8.7%) were the most common. Considering the location of residence and the impact of the ACC system on road safety, the "yes" answers were most frequently given by individuals living in rural areas (75.00%) and towns with fewer than 50,000 inhabitants (53.57%). In comparison, the "no" response was most common among drivers living in towns with 50,001 to 150,000 inhabitants (40.00%).

Other meaningful relationships that were examined included the assessment of the impact of active vehicle safety systems and the professional experience of drivers. The results of the relationships between individual variables are summarized in Table 5.

Table 5. Kendall's correlation coefficients between the nature of work performed by drivers and the assessment of the impact of vehicle safety systems on road safety ($N = 107$)

Tabela 5. Współczynniki korelacji Kendalla między charakterem pracy wykonywanej przez kierowców a oceną wpływu systemów bezpieczeństwa pojazdów na bezpieczeństwo ruchu drogowego ($N = 107$)

Factors	Tau (Kendall)	*p*	Factors	Tau (Kendall)	*p*
Type of transport provided			Work experience		
ABS	0.01	0.90	ABS	−0.04	0.51
EBS	−0.04	0.59	EBS	−0.22	0.00
ASR	−0.02	0.74	ASR	−0.28	0.00
EBD	−0.04	0.52	EBD	−0.28	0.00
Traditional cruise control	0.09	0.19	Traditional cruise control	0.17	0.01
ACC	−0.05	0.44	ACC	−0.15	0.02
AEB	0.06	0.36	AEB	−0.02	0.73
Lane assist	0.05	0.44	Lane assist	−0.10	0.12
Vehicle type			Work system		
ABS	0.13	0.05	ABS	−0.05	0.37
EBS	−0.14	0.03	EBS	0.01	0.83
ASR	−0.09	0.17	ASR	0.19	0.00
EBD	−0.10	0.13	EBD	0.24	0.00
Traditional cruise control	−0.38	0.00	Traditional cruise control	−0.01	0.96
ACC	−0.15	0.02	ACC	0.07	0.28
AEB	−0.08	0.20	AEB	−0.04	0.57
Lane assist	−0.11	0.09	Lane assist	0.02	0.75

Source: own research

Źródło: badania własne

Work experience influences the assessment of vehicle safety systems. Considering the ASR system, it can be noted that drivers with the longest work experience unanimously indicated that this system affects road safety, followed by drivers with 11–20 years of work experience (76.74%). In contrast, in the group of people with less than 6 years of experience, as many as 30.77% of respondents answered that they "have no opinion." This response may suggest that such a system is not installed in the vehicle. A difference in responses based on length of service can also be seen in the case of the EBD system. As the length of service increased, drivers were more likely to answer "yes." Those with up to 6 years of work experience were least likely to answer "yes" (69.23%) and most likely to answer "no opinion" (30.77%). Those with 6–10 years of work experience also often answered "no opinion" (20.83%), while as many as 75.00% of this group of drivers answered "yes," meaning that EBD has an impact on road safety. An interesting correlation can be observed between the type of vehicle driven and the use of traditional cruise control. Only 18.89% of tractor-trailer drivers answered "yes," while as many as 62.22% answered "no." This means that, in their opinion, traditional cruise control has little impact on road safety. Drivers of other types of vehicles were much more likely to answer "yes." Another finding from the study is the difference in assessing the impact of EBD and work systems on safety. Drivers who return home every day, as well as those who spend 10 days on the road and 3 days at home, all indicated that this system impacts affects road safety. In contrast, among groups of drivers whose work system involved two weeks on the road followed by one week at home, and three weeks on the road followed by one week at home, the most common answer was "no," indicating that these systems had no impact on safety.

Dangerous situations and the operation of vehicle active safety systems

In addition to rating individual vehicle safety systems, respondents were asked whether they had ever experienced a situation in which any active vehicle safety system was activated and a road accident was prevented. The responses are summarized in Figure 3.

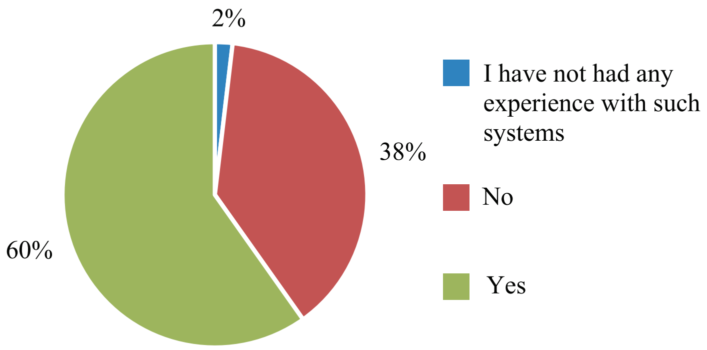

Figure 3. Active safety systems in vehicles and the prevention of road accidents

Rysunek 3. Aktywne systemy bezpieczeństwa w pojazdach a zapobieganie wypadkom drogowym

Source: own research

Źródło: badania własne

Sixty per cent of respondents reported that such situations had occurred, which may indicate that the safety systems were functioning correctly. On the other hand, over 38% of drivers reported never having experienced such a situation. In this case, it may be because they had never been in a situation that required the activation of the vehicle's modern systems. Respondents were then asked whether, despite having safety systems in their vehicles, they had ever experienced a situation in which one of these systems had not worked properly, resulting in an accident. Almost 87% of respondents denied that such a situation had ever occurred. This question also confirmed that safety systems work correctly in most cases. The survey also included Figure 4 drivers who had experienced one or more instances of system malfunction.

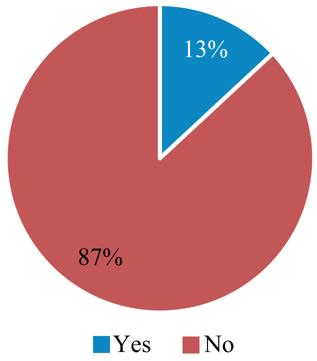

Figure 4. Active vehicle safety systems and the occurrence of road accidents
Rysunek 4. Aktywne systemy bezpieczeństwa pojazdów a występowanie wypadków drogowych

Source: own research
Źródło: badania własne

To supplement the survey results, drivers were asked to comment on the advantages and disadvantages of active vehicle safety systems (Table 6).

Table 6. Advantages and disadvantages of active safety systems – drivers' opinions
Tabela 6. Zalety i wady aktywnych systemów bezpieczeństwa – opinie kierowców

Advantages
"In my opinion, they have a significant impact on improving safety"
"Excellent rating. Safety systems are essential and improve the drivers' work and our safety on the roads"
"Very necessary, even essential in a situation of constantly increasing traffic intensity"
"They should be standard equipment in all trucks"
"Most of them are very useful"
"I think these are beneficial systems that improve traffic safety"
"They help me in my daily work, which is why I consider them useful and necessary"
"They facilitate and improve safety"
"I believe that these systems are critical in the work of every driver. In many situations, they have protected me and other road users from danger"
"They improve safety and make work easier. I feel safe"
Disadvantages
"Average rating. The sensors often see things that are not there or are afraid of road signs or overpasses. In addition, they turn off in bad conditions (rain/snow)"
"The emergency braking system activates when it should not. It also depends on the make of the vehicle"
"The current ACC and emergency braking systems need refinement"
"Some systems need improvement because they still do not work properly (they activate at inappropriate moments)"

Source: own research
Źródło: badania własne

As can be seen from the opinions presented in the table, active safety systems are not only positively evaluated for their impact on improving safety, but also for improving working conditions.

Conclusions

Based on the research conducted, several conclusions can be drawn:

1. The number of accidents caused by truck drivers has decreased by more than 35% over the past five years. The number and nature of traffic accidents are influenced by both external factors, such as weather and the condition of infrastructure, and internal factors, such as driver behavior (use of cell phones, fatigue, working late at night).
2. Actions by truck manufacturers and EU regulations have led to the implementation of numerous systems designed to improve truck safety.
3. According to truck drivers, the leading cause of road accidents is the inappropriate behavior of other road users, mainly other drivers. At the same time, the study reveals that hazardous behaviors among this group of road users include speeding, using cell phones, and failing to observe drivers' working hours.
4. To prevent road accidents involving truck drivers, their vehicles are equipped with increasingly advanced solutions. Research shows that most systems are rated positively by professional drivers. Nevertheless, specific correlations between sociodemographic variables and professional experience indicate a different assessment of their impact on road safety. The difference between the assessments of the EBC and ACC systems across age groups is particularly noticeable. Older individuals are more likely to attribute a positive impact of these systems on safety than younger people. Differences in assessing the effects of active vehicle safety systems on road safety and sociodemographic variables were observed in the responses for the ACC system.
5. Residents of rural areas and small towns believed that the ACC system had a significant impact on road safety, while city dwellers marginalized the effect of this system on safety. This distribution of responses may be influenced by the fact that rural residents can use this system more frequently due to their place of residence and the possibility of using it while driving.
6. Interesting conclusions could also be drawn from analyzing the impact of active vehicle safety systems, considering drivers' professional experience. In this case, too, the difference in assessment was most often found in the case of the EBD system. The positive impact of this system on road safety was primarily highlighted by drivers with longer work experience, as well as those whose work system involved returning home daily and those who spent 10 days on the road followed by 3 days at home. Another system for which differences in assessment were found is the ASR system, which was also more often positively assessed by drivers with longer professional experience. A notable observation from the study is the number of "no opinion" responses. Such responses do not necessarily indicate a lack of opinion on individual systems, but may result from a lack of familiarity with them. The active safety systems can prevent road accidents. However, some of the responses, including descriptive ones, indicate that these systems can sometimes be unreliable and may contribute to road accidents.

This study examined truck drivers' perceptions of active vehicle safety systems in relation to road safety. This study has certain limitations. First, the number of participants in the survey limits the conclusions that can be drawn for the study group. Second, the specific systems involved in preventing road accidents were not specified, particularly with regard to the role of active safety systems and the causes of accidents resulting from system failure. Indeed, further research should be conducted to examine the opinions of truck drivers in this area. The results of this study suggest that active vehicle safety systems improve road safety; however, like any system, they are not foolproof.

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