Vision Zero in Lithuania

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Abstract

This chapter covers statistical data and initiatives related to the challenges and achievements of road safety in Lithuania. After providing an overview and an evaluation of previous programs to improve road safety in Lithuania, we discuss a selection of various improvements and assessment of safe traffic measures and their efficiency through relevant information from research and statistical data analysis. Priorities to achieve safer behavior of road users, safer streets and roads, safer vehicles, safer rail transport, and higher survival rates after accidents are discussed in more detail. The country-specific issues of pedestrian fatalities in

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dark hours, intensive land transportation due to geographical location, and accidents related to railway level crossings are also presented.

Keywords

Lithuanian roads · Vision zero · Safe roads · Safe behavior · Safe railways · Road accidents

Introduction

Lithuania, as a member of the European Union, aims for sustainable road transport and sets high goals in order to significantly reduce the road crash rate. Life experience in historical period of oppression left a mark on the mentality and social norms of society without excluding the road safety issues. Moreover, while high penetration of land transport in society provides undeniable benefits in everyday life, the fast evolution of machines also reveals the physical and psychological fragility of human beings. People naturally make mistakes, which comes out as injuries or fatalities; therefore, exceptional attention must be focused on this area.

The Vision Zero Declaration in transport in 2018–2030 is the Lithuanian road safety strategy aimed at preventing fatalities and severe injuries in the road transport sector. The guiding principle of this vision is the shared responsibility of transport sector managers and users, bearing in mind that the traffic environment and vehicles must be tailored to maximize the protection of the road user from potential errors and, if they occur, to ensuring effective technical and medical assistance to road users affected by the crash.

This declaration will be implemented through inter-institutional action plans that are coordinated by the Ministry of Transport and Communications. The authorities that are implementing the plans set out in the declaration must submit data on the results achieved to the Ministry of Transport and Communications within 60 days of the end of the year. This will reach the Commission on Traffic Safety for further consideration.

The Vision Zero Declaration in Transport 2018–2030 continues the efforts of previous traffic safety programs and is aligned with:

- United Nations 2030 Agenda for Sustainable Development (Target 3.6)
- Decade of Action for Road Safety 2011–2020
- for the purposes of the White Paper on Transport
- European Union Road Safety Program (2011–2020)
- National Progress Program for Lithuania for the period 2014–2020
- Verona Declaration
- Valletta Declaration

The programs and declarations emphasize common issues that are important for Europe, that is, social cohesion, greener economy, education, and innovation. These

objectives are taken into account ensuring safe and sustainable mobility of all citizens and exploiting the full potential of technological progress. The program of Decade of Action for Road Safety 2011–2020 is focused on national and local level actions highlighted as safer roads and its management, safer vehicles and road users, and post-crash response. The White Paper on Transport adopted by the European Commission on 28 March 2011 states that a high priority must be given to road traffic safety, as it is essential to minimize the number of road accidents and deaths in order to improve the overall efficiency of the transport system and meet the needs and expectations of the citizens and businesses. European Union Road Safety Program (2011–2020), in addition to the actions already mentioned, declares boost of smart technologies, strengthening education and training, better enforcement, focus on motorcyclists. Verona Declaration adds attention to importance of funding, enforcement, and the use of best practices.

Overview of Previous Programs to Improve Road Safety in Lithuania

There were three road safety programs-strategies in Lithuania from 1990 to 2017.

The first program was in force from 2002 to 2004. The main purpose of this program was "to ensure that fewer people comparing with 2011 are killed and affected in road crashes":

- To reduce the number of fatalities by 4% in 2002
- by 5% in 2003
- by 6% in 2004

The program target set for 2004 was not achieved as the number of fatalities on the roads started to increase rapidly between 2004 and 2006. This has been attributed to the high rate of cases of speeding, the consequences of intoxicated drivers, the low level of safety culture and discipline of all road users, etc. Equally important systemic issues include the inadequate national approach to road safety issues, including the legal framework, education and awareness, and the lack of an integrated road transport policy covering road transport development, road and street infrastructure, and road safety issues (Pikūnas and Pečeliūnas 2005). As the situation was changing, since 2007, the number of road fatalities has started to decline indicating the positive tendencies and better positioning in the context of the European Union (Tolón-Becerra et al. 2014). One of the reasons for the positive implementation of road safety was the adoption of road infrastructure management to safe design principle based engineering. Small roundabouts, speed cameras, and other engineering devices were integrated into urban and rural roads, but it is assigned to the second road safety program.

The second program was in force from 2005 to 2010. The main objective of this program has already been linked to that of the European Union – "to reduce the number of road fatalities in half by 2010 compared to 2004":

- to reduce road fatalities by 25% by 2008 (reached 33%)
- by 2008, reduce the number of road crash victims by 10% (reached 26%)
- by 2010, to reduce the number of road crash victims by 20% (achieved 45%)

The purpose of this program was to create conditions for the targeted and long-term improvement of safe traffic and to design and implement measures to reduce the number of road crashes. The program provided for raising the responsibility of road users, changing their behavior, improving road infrastructure, vehicle safety, and improving the legislative framework.

As part of the traffic safety program, funds were allocated for the reconstruction of high crash rate road sections, intersections, lighting, construction of pedestrian and bicycle lanes, automatic speed measuring equipment, road weather information system (KOSIS), and road safety audits for all road objects under construction and reconstruction. The program promoters were: the ministries of Transport and Communications, Health, Education and Science, Interior and Finance, Police Department, and other institutions. For example, in 2006 measures to improve road safety included the installation of 57.35 km of hiking and cycling trails and 46.6 km of protective metal barriers, elimination of 11.8 km of separate road sections, and reconstruction of 17 intersections.

The following provisions were legalized in the country in 2006:

- It is mandatory to drive with the dipped-beam headlamps on during daylight hours.
- Passenger cars are allowed to drive at 110 km/h on motorways, on the speeds up to 90 km/h on asphalt or concrete roads, and speeds up to 70 km/h on other roads (previously was 90 km/h).
- The Road Traffic Regulations (RTR) provide that if a vehicle decelerates before a pedestrian crossing, the driver of another vehicle travelling in the same direction must slow down or stop and restart only after verifying that there is no pedestrian at the crossing.
- Compulsory use of safety belts in all vehicles weighing less than 3.5 t and in buses.

To sum up the results (the number of road fatalities decreased by 33%, road injuries decreased by 45%), the program objectives for 2005–2010 were achieved with success.

The third program valid from 2011 to 2017. For the first time, this program mentions a long-term vision on road safety "*No deaths and no serious injuries of road users in Lithuania*" (Government of the Republic of Lithuania 2011).

The strategic objective of the program is ambitious, inspired by the success of the program of 2005–2010: "In improvement of the condition of road safety, to achieve Lithuania to be among the top 10 best performing countries in the European Union by the number of fatalities per 1 million road users (or no more than 60 per million population killed)."

Significant progress has been made in the area of road safety over the program implementation period, but the objectives set have not yet been met, and it is, therefore, necessary to find new effective solutions to reduce the number of fatalities and injuries.

High collision rates at level crossings were observed in the analysis of statistical data; therefore, in 2007, the railway safety strategy of the State Railway Inspectorate under the Ministry of Transport was approved. Based on Sweden's good example, a zero vision has been formulated: "A safe society and safe rail transport without fatalities and injuries." Based on this zero vision, measures to reduce fatalities, injuries, and the prevention of road crashes were included in safety strategy.

Our achievements: Lithuania in the local and in the European context. The number of road traffic fatalities and injuries in Lithuania has changed significantly over the last decade. From 2007 to 2011, the number of registered road crashes and injured persons decreased rapidly (Fig. 1). The rapid decrease in 2006–2008 is linked to the intensive implementation of engineering traffic safety measures on the roads and streets of the country, intensified traffic law enforcement of driver violations, tightening of sanctions for violations, and the changed focus on traffic safety education. Another indirect cause is the impact of the economic crisis, which has significantly slowed down the road freight transport in the country. In 2008 about 25% fewer incidents of road crashes were registered in Lithuania, and their volume was almost twice as low in 2011 compared to 2007.

Overall, the number of road crashes and injuries in Lithuania was reduced by more than half in 10 years, but worse periods with temporary increase of accident rate have not been avoided since 2011. The number of road fatalities has also been decreasing over the last decade. In 2008, compared to 2007, road fatalities had fallen by 33%, and they have already been reduced by half in 2009. In 2011, compared to

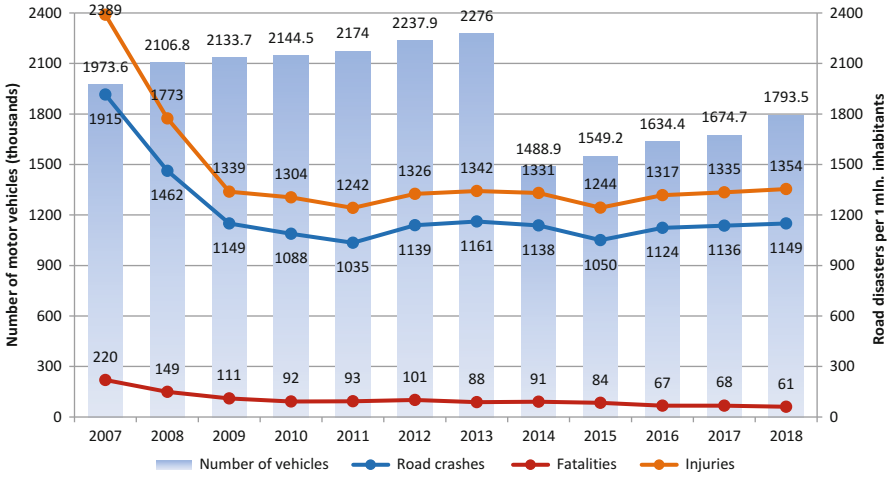

Fig. 1 Number of registered vehicles, road crashes, injuries, and fatalities in 2007–2018. (Source: Lithuanian Road Administration (LRA) 2019)

2007, 60% fewer fatalities were recorded. Since 2011 the number of road fatalities in Lithuania changed insignificantly and unevenly. The number of road fatalities in Lithuania decreased more than three times in 10 years period (Fig. 1). Nonetheless, these results are not encouraging, as they were achieved in the background of the extremely alarming previous period when the number of road fatalities used to exceed 600 per year (Pikūnas and Pečeliūnas 2005). Despite the results achieved, the started works must be continued and extended by new means.

At the beginning of July 2014, the country introduced changes to vehicle registration procedures, which are also reflected in the analysis of national statistics (Fig. 1). Under the new regime, vehicles without compulsory civil liability insurance and (or) roadworthiness tests have been de-registered, resulting in a reduction of the vehicle fleet by more than one-third. Now, these data are more in line with the actual number of vehicles on the country's roads, but the upward trend remains evident, reflecting the intensive road transport in Lithuania.

In 2010–2018 Lithuania's progress in reducing road crashes had been assessed in the context of the European Union. The second best crash reduction rate achieved (−43%) and the Road Safety Performance Index (PIN) rating are shown in Fig. 2. This PIN indicator is established by the European Transport Safety Council (ETSC), a Brussels-based, independent nonprofit organization dedicated to reducing the numbers of deaths and injuries in transport in Europe (ETSC 2019). Lithuania has

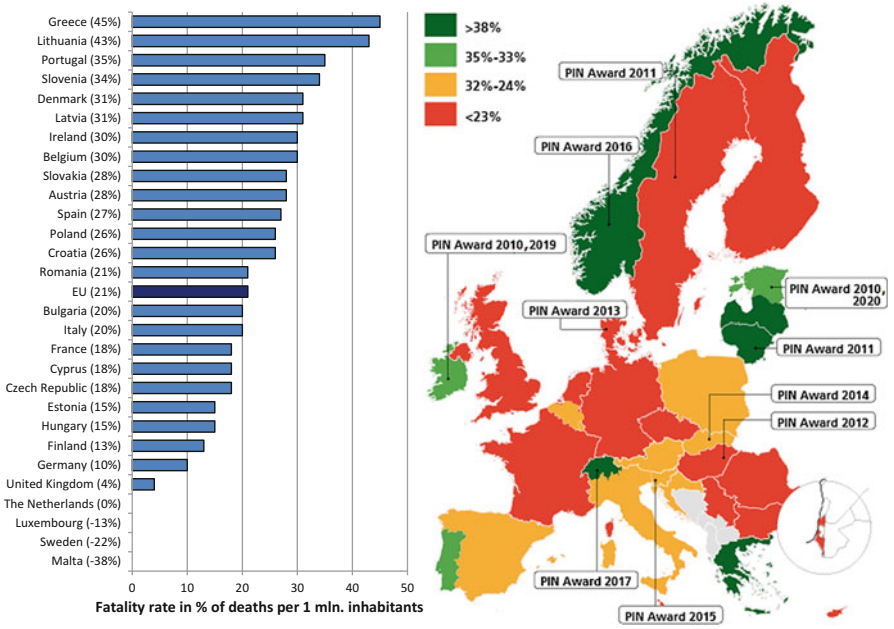

Fig. 2 Relative change in road deaths between the period 2010–2018 (left) and map of Road Safety Performance Index (right)

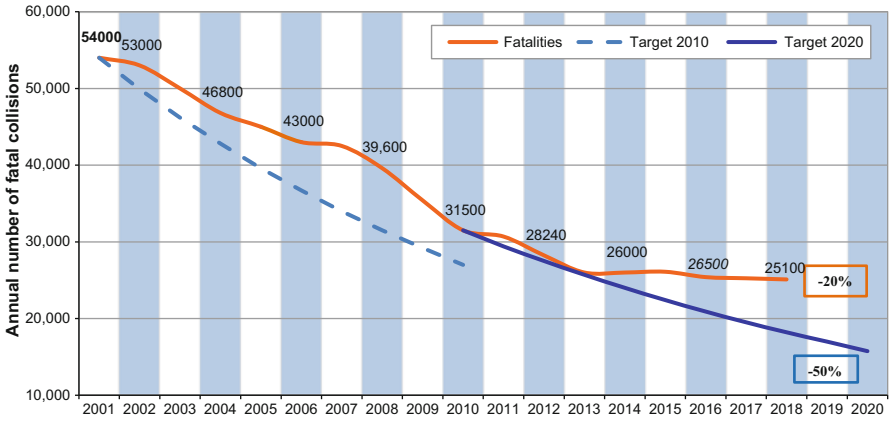

Fig. 3 EU fatalities in road accidents and targets 2010–2020. (Source: CARE – EU road accidents database)

taken a significant step toward the safer road transport but remains below the EU average (Fig. 2).

In 2016 there were 25,500 road fatalities in the European Union, 1.5 million of road users were injured. In 2016, a total of 67 people died in road crashes in Lithuania per 1 million of population, whereas the European Union has an average of 50 fatalities per 1 million of population. The trend of this period reflects a consistent move toward the European Union's goal of halving the number of road fatalities over the last decade. Nevertheless, the EU road accident statistics of recent years is not improving in accordance with the set scenario (Fig. 3). In 2018, the EU average was 49 fatalities per 1 million of population.

Despite the results already achieved, Lithuania remains a high road traffic risk country compared to other EU member states. In 2018, 60.5 people died in road crashes per 1 million of population. Even taking into account the shrinking population and investment in road infrastructure and public education and awareness, the number of road crashes in the country is significantly higher. Such statistic is characteristic to most East-Central European countries (Fig. 4).

Needs for Building Strategic Directions

For the second consecutive decade, international organizations such as the United Nations and the European Commission are formulating objectives on the road safety for the decades to come (UNECE 2019; European Commission 2019). Meanwhile, the main goal is to reduce the number of fatalities to zero by 2050. The current road safety objectives of these organizations are linked to the year 2020 and the prospects for 2030 are already planned. As Lithuania usually sets its goals in the field of road safety in accordance with the objectives of the European Commission, a new strategy (as a vision) is envisaged.

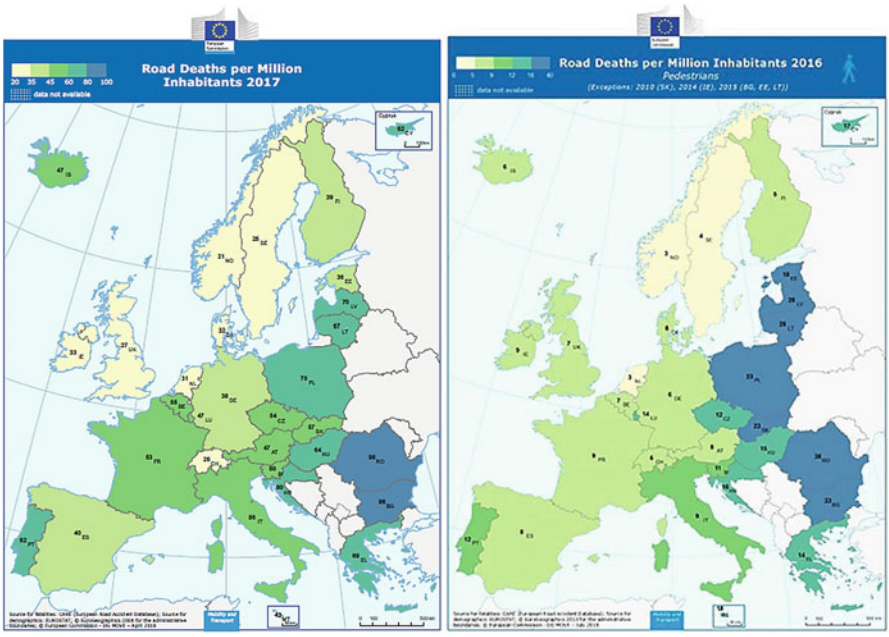

Fig. 4 Europe's map for road deaths per million inhabitants, 2016–2017. (Source: CARE)

VISION – ZERO IN TRANSPORT IN 2018-2050

The third Lithuanian Road Safety Program, valid for 2011–2017, formulated a long-term vision on road safety "No road user is killed or seriously injured in Lithuania." The importance of such a vision has not diminished; on the contrary, it is largely followed by the international community. As the current situation in the field of traffic safety remains intolerable, this vision is further pursued in Lithuania.

Essential measures to improve road safety:

- Improvement of infrastructure on state roads.
- Stricter sanctions for offenders.
- Zero promille of blood alcohol level (BAC) for certain driver group + the legitimation of Alcolock idea.
- The average speed enforcement has started.
- Close cooperation between institutions in organizing educational activities.

Unlike the previous one, the new program in addition to objectives defined and tasks formulated for each of them has measures already provided for and the specific institutions assigned to their implementation. Evaluation criteria, expressed in quantitative values, are provided for the implementation of the goals and objectives of the

program. For example, (i) the task to reconstruct dangerous intersections on main and national roads is intended for the Lithuanian Road Administration. It provides for the responsibility to reduce the number of accidents in 2025 by 90%, and in 2030 by 100% compared to 2018. (ii) The Lithuanian Transport Safety Administration and the Police Department have the task and responsibility to perform roadside inspections of the technical condition of vehicles in 2025 – 7% and in 2030 – 8% from the fleet. It is expected that more specific tasks and responsibilities will better achieve the stated objectives of the new program.

Selection of Specific Measures for Traffic Safety Improvement and Evaluation of Its Efficiency

The guiding principle of the program "Vision Zero" is based on shared responsibility of the road traffic managers, vehicle manufacturers, and companies representing the interests of the manufacturers for road safety, that is, the traffic environment and vehicles must be designed and maintained to help road users avoid errors, and in the event errors, to have the least possible consequences, and the road users must act the way that does not pose a risk to themselves or others (National Road Traffic Safety Programme "Vision Zero" 2020).

TARGET – zero fatalities and serious injuries in road transport

Significant attention is directed toward the prevention of deliberate violations of road traffic regulations, development of the safer road infrastructure, management of safer vehicle fleet, and mitigation of the consequences of road crashes. The following subsections are the description of the identified issues and selected measures addressed for safer behavior of road users, safer roads, safer vehicles, and more efficient rescue assistance.

First Priority: Safer Behavior of Road Users

Compliance with Permitted and Safe Speed

In accordance with the analysis of accident data of the country, it has been found that the most common factors of fatal crashes are related to noncompliance with safe driving, as defined in the traffic rules. It includes the human risk factors, among them, the unsafe speed of a vehicle in a bend of the road – 9%. In Lithuania, as many as two out of three drivers in the territories of settlements exceed the permitted speed. Observations show that 17.6% of motorists exceed the speed limit on motorways of more than 10 km/h, and same can be said about 31.6% of drivers on state roads and 19.2% of drivers on regional roads. This encourages the pursuit of compliance with **the speed limits as a habit for drivers**.

Exceeding the speed is the most common violation of traffic rules and safe driving principles both in Lithuania and in many other countries. Unfortunately, there is a prevailing perception among drivers that exceeding the speed up to 10 km/h is not a violation and does not interfere with road safety. However, even a slight over speeding will result in longer reaction time of the driver, more complex car handling in unexpected circumstances and adverse conditions. Unfortunately, drivers do not see the problem speeding above 10 km/h. This is due to a lack of awareness of how increases the risk of driving and the possible consequences of colliding with another vehicle or hitting a pedestrian even at low speeding. Long-term tolerance of low speeding, including the relatively high tolerance of speed cameras, has also contributed to this attitude and behavior of most drivers. Unfortunately, when individual drivers do not exceed the speed limit at all (often buses or trucks with speed limiters), they become objects of continuous overtaking. This further increases the risk of driving, so the control of unsafe and right-hand overtaking, as well as speeding without tolerance, must remain an active means of implementing safe driving.

The National Police Department has started controlling the speed of cars on state roads using sectorial speed meters and the number of sections that record cases of average speed violations are expanding. In the coming years, a total of 130 average speed measuring sections will be installed in the country (Fig. 5). The network of

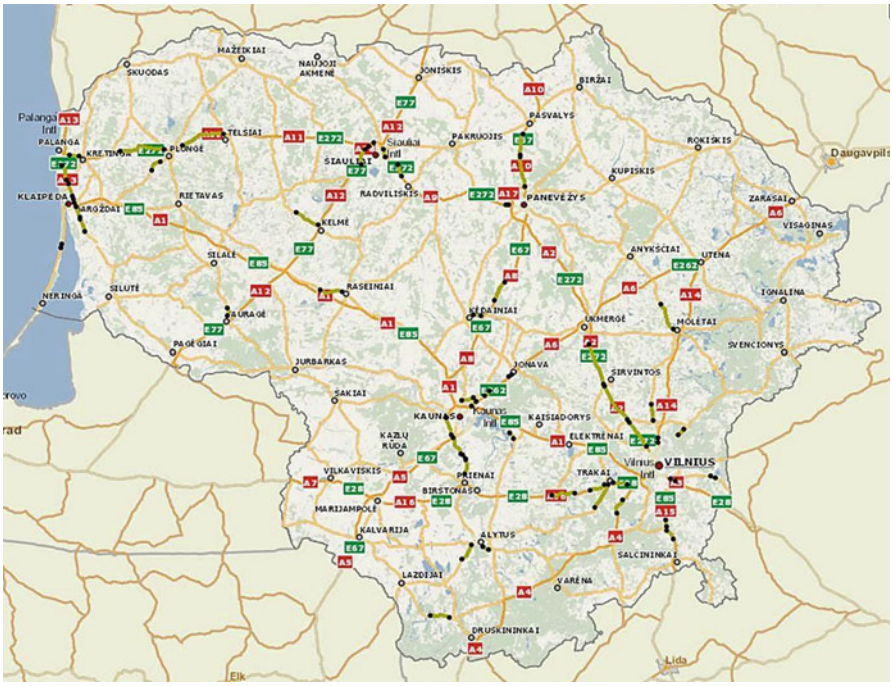

Fig. 5 Estimated average speed measurement sections on Lithuanian roads. (Source: LRA 2019)

Table 1 Implementation of permissible and safe speed compliance. (Adapted from National Road. . . 2020)

Measure	Expected effect	Assessment indicator
Change of the legal base		
Change the legal base by introducing a zero tolerance for speeding	The introduction of lower tolerance for speeding is intended to reduce the cases of speeding	30% reduction in the number of drivers exceeding the speed limit in settlements up to 10 km/h
Road users education		
Emphasizing the risks of speeding in a social advertising campaign	Modern and attractive forms of education will be used to explain the risks of speeding	At least 50% of respondents in the public poll report that social advertising has had a positive impact on their behavior in traffic, particularly in respect of speed limits
More efficient supervision		
Development of an automatic speed control system (including insurance, roadworthiness tests, etc.) on country roads	On the sections where an automatic speed control system will monitor the speed, the number of speeding and registered crashes will be reduced	A number of registered crashes on the road sections with automatic speed control reduction after the implementation of the control system on the section by at least 80%
The inevitability of penalties for severe violations of RTR (especially for speeding)	In case of detection of a severe RTR infringement by automatic means on a vehicle registered in another EU country, a report is sent to the owner of the vehicle	Contract on data exchange in accordance with Directive (EU) 2015/413 of the European Parliament and the Council has been signed with at least 20 member states

instant speed cameras is also expanding by installing 70 cameras (15min.lt 2019). These tools are directly focused on law enforcement on the permitted speed limit.

Table 1 shows the measures, the expected effects, and evaluation indicators to address the issue of compliance with admissible and safe speed. In the context of the various measures to implement road safety, it is important not only to define those instruments clearly but also to anticipate their effects. When applying measures at the level of national regulation, it is very important to provide an indicator of evaluation for each measure – the best-achieved result in terms of quantity. This format will continue to apply to other measures described.

After implementing measures to improve traffic safety in the long-term, the proportion of motor vehicles exceeding the speed limit in Lithuania in settlements is expected to reduce from 68% in 2014 to 60% in 2025 and up to 45% in 2030.

Public Intolerance of Drunk Driving

In 2019 alone, drunken road users (drivers, motorcyclists, cyclists, pedestrians) caused 265 road crashes, resulting in 351 injuries and 25 fatalities. The statistics for the last four years have not changed significantly, and that warns of the

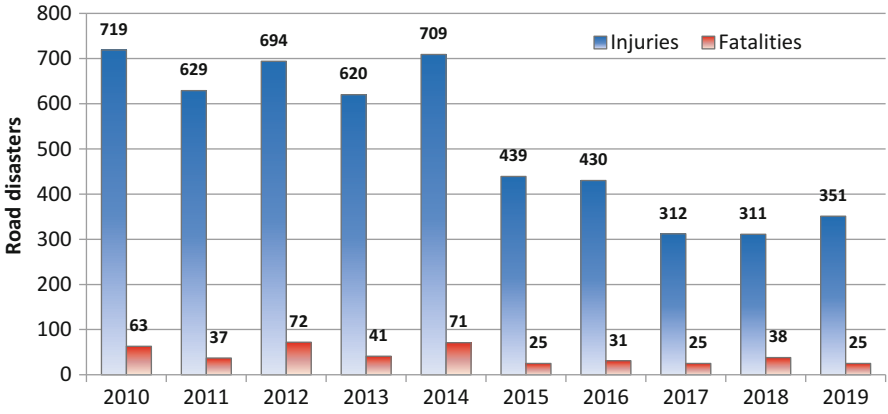

Fig. 6 Alcohol-impaired road traffic fatalities 2010–2019. (Source: Lithuanian Police)

ineffectiveness of the measures currently taken. The statistics for the period 2010–2019 due to road disasters caused by drunk road users is presented in Fig. 6.

Between 2013 and 2016, the highest numbers of fatal crashes (23% of all fatal crashes caused by road users) were due to the impact of alcohol: 14% for drunk drivers, 8% for drunk pedestrians, and 1% for drunk cyclists. **It is therefore planned to achieve that the public does not tolerate driving under the influence of alcohol or psychoactive substances**. The following are the main reasons identified as to why drivers are drunk while driving in the country:

- Drivers hope a police officer will not catch him on the road
- It is naively believed they succeed in making a "consensus" with a police officer on the road.
- They do not know the exact details of imminent sanctions and all the hassle in recovering a driving license.
- High availability of alcoholic beverages (ban on their trade-in petrol stations and limited time after trading in shops).
- Public indifference toward drunk drivers.

Successful measures to reduce the number of drunk drivers in foreign countries:

- The consequences of alcohol use for each individual and society as a whole are publicly and clearly identified (health, early mortality, increased injuries at home and work, long-term decline in the quality of life and satisfaction).
- Significant strengthening and publicizing the sanctions for unauthorized alcohol use.
- Thorough traffic law enforcement by officials (the inevitability of criminality).
- Ongoing intensive educational campaigns to explain the harm of alcohol and the improvement of people's lives without alcohol.

- Promotion of more sports, active recreation and leisure without the excessive alcohol or food consumption (development of cycle path infrastructure, public urban spaces, parks, restriction of access to alcohol and fast food).

In 2016 the country set a legal limit of zero promille of BAC for the following groups of drivers: novice drivers, drivers of a taxi, motor vehicles, mopeds, motorcycles, tricycles, light quadricycles, quadricycles, power quads, vehicles with a maximum permissible mass exceeding 3.5 tons or with more than nine seats or carrying dangerous goods. It has been agreed during the revision of the legal liability of road users that the installation of alcolocks in vehicles should be done on a voluntary basis. Choices are offered: disqualification from driving or a reduced term for driving disqualification, but compulsory participation in a rehabilitation program and the use of alcolock system in the vehicles. Drivers who install alcolocks on their vehicles and undergo the drunk driving rehabilitation programs could reduce their disqualification term by a factor of two. As of 2016, alcolocks are installed on all new school buses reaching the country's roads.

Educating road users through the involvement of alcoholic beverage manufacturers, more effective supervision through intensive police checks are also effective tools. A variety of road safety education activities are carried out by most public authorities or nongovernmental organizations in the EU (such as the European Transport Safety Council (ETSC), the International Traffic Safety Data and Analysis Group (IRTAD)), both in a combination of actions by police officers or stricter controls on certain groups of road users (e.g. educational activities against a drunk driver, at the same time the enhanced control of driver intoxication enforcement). See Table 2 for additional measures, expected effects, and assessment indicators for the problem of intoxicated driving.

After the implementation of measures to improve traffic safety in the long term, it is estimated that in Lithuania the number of road crashes caused by intoxicated road users would decrease from 307 in 2017 to 100 in 2025 and to 50 in 2030.

No Use of Mobile Devices

In Lithuania, about 45% of drivers talk on the phone without a headset while driving a vehicle and about 30% of drivers write messages. About 16% of drivers also browse their smart devices while driving, and this behavior is playing an increasingly important role in life and is rapidly growing. Using a phone negatively affects driving safety in two ways: it physically complicates the operation of the vehicle, especially in unexpected or sudden changes in driving conditions, and distracts the driver's attention and thoughts from monitoring and interpreting the traffic environment, thereby increasing his response time (Žuraulis et al. 2018).

It is intended **to prevent drivers from using a mobile device while driving a motor vehicle**. Measures, expected effects and evaluation indicators to address this problem are presented in Table 3.

After implementing measures to improve traffic safety in the long term, it is estimated that in Lithuania, the number of drivers using mobile communication

Table 2 Implementation of public intolerance to drink driving. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Change of the legal base		
To prepare a rehabilitation program for drivers who violated the RTR while driving when their blood alcohol levels exceeded the legal limits	Drivers opting for a rehabilitation program will be allowed to drive motor vehicles with integrated engine blocking equipment that responds to alcohol concentration in the driver's exhaled air	The program includes at least 50% of the drivers disqualified from driving under the influence of alcohol
To carry out an in-depth analysis and improvement of procedures and methods to determine whether or not road users are /were intoxicated with narcotics, psychotropic and other psychoactive substances	This measure aims to improve procedures and methods for determining whether road users are/were under the influence of narcotic substances	Police are using new procedures and methods to determine whether or not road users are intoxicated with narcotic substances
Road users education		
Social advertising emphasizes the dangers and risks of driving under the influence of alcohol or psychoactive substances	Modern and attractive forms of education are used to explain the risks of driving under the influence of alcohol or psychoactive substances	At least 50% of respondents of the public poll report that social advertising has had a positive impact on their behavior in traffic, in particular by discouraging them from driving under the influence of alcohol or psychoactive substances
More efficient supervision		
On a large scale, to perform the law enforcement of driving under the influence of alcohol or psychoactive substances	Frequent and continuous law enforcement campaigns of driving under the influence of alcohol or psychoactive substances in the whole of Lithuania for non-compliant drivers will mean the inevitability of sanctions.	A 5% annual reduction in offenders in road crash who ignore the prohibition of driving while under the influence of alcohol or psychoactive substances.

devices, in the way prohibited by the RTR, will reduce from 45% in 2016 to 10% in 2025 and to 5% in 2030.

It is important to note that using a mobile device for calls or surfing is dangerous not only from the drivers' part but also from other road users. Pedestrians pose a danger to themselves and others by focusing their attention on the phone screens at intersections, pedestrian crossings or their accesses. In order to draw the attention of such pedestrians, pedestrian footpaths are equipped with loudspeakers that signal the danger of entering the street under a red traffic light (Fig. 7). Also, warning signs are

Table 3 Implementation of non-use of the mobile device while driving. (Adapted from National Road. . . 2020)

Measure	Expected effect	Assessment indicator
Change of the legal base		
Changing the legal framework by introducing a zero speed tolerance for unauthorized use of mobile devices while driving	The legislative changes are intended to reduce the number of unauthorized use of mobile devices while driving	A reduction of at least 20% in the number of unauthorized use of mobile devices while driving
Road users education		
The emphasis during social advertising of the risks arising from driving and using mobile devices in an unauthorized manner	Modern and attractive educational forms will be used to explain the risks of unauthorized use of mobile devices while driving	At least 50% of respondents in the public poll report that social advertising has had a positive impact on their traffic behavior, namely, avoidance of the unauthorized use of mobile devices while driving
More efficient supervision		
To carry out the law enforcement campaigns and their publicity on the avoidance of the use of mobile devices by hands while driving	Talking on a cell phone without using a headset, texting or surfing the Internet while driving is one of the causes of serious road crashes and therefore this tool is intended to alert drivers to the risks and consequences and to raise driver awareness	More than 70% of drivers are not using the phone without a handset while driving More than 80% do not write short messages while driving More than 90% of them do not surf the Internet while driving

Fig. 7 Audible and visual means to draw the attention of pedestrians using phones at pedestrian crossings

painted on the pavement just in front of a pedestrian crossing in the hope that it will draw the attention of pedestrians who are with their heads in the phone (browsing).

The LED strips on pavement crossings in front of the pedestrian crossings in the sidewalk in several cities of the country have drawn the particular attention of the public (Fig. 8). Along with the traffic lights, these strips are illuminated red or green and are very noticeable and ensure a good warning at dusk or when it is completely

Fig. 8 Pavement LED stoplight strips are mounted to duplicate traffic lights and draw the attention of pedestrians using phones

dark. Such a means is also focused on the attention of pedestrians who constantly divert their gaze to the phone screen.

Listening to music through headphones in heavy traffic areas, which limits the perception of pedestrians and cyclists, is also dangerous. In some cases, this may prevent the traffic participant from hearing special vehicles with acoustic signals. Understandably, it is not possible and reasonable to apply the tightening of liability for all cases. Therefore the long-term public education and awareness-raising of the public must remain a priority strategy in the improvement of road safety. In the case of use of mobile phones education of road users by involving mobile operators, insurance companies or nongovernmental organizations popular in the public domain is also considered a useful tool.

Use of Reflective Elements

In 2018 the most significant number of pedestrians were killed on Lithuanian roads and streets – as much as 40% of all road users (Fig. 9). There were 1021 hits of pedestrians by cars, with 1024 pedestrians injured and 69 killed. Of these, 327 persons were injured, and as many as 52 were killed at night. The distribution of road fatalities and injuries in Lithuania in 2018 is shown in Fig. 9.

Autumn and winter are characterized by long dark hours and unfavorable traffic conditions, which worsen road safety for the most vulnerable road users – pedestrians. Autumn and winter account for about 70% of all pedestrian hits. The majority of pedestrian fatalities are older citizens (>64 years), which is related with their lax

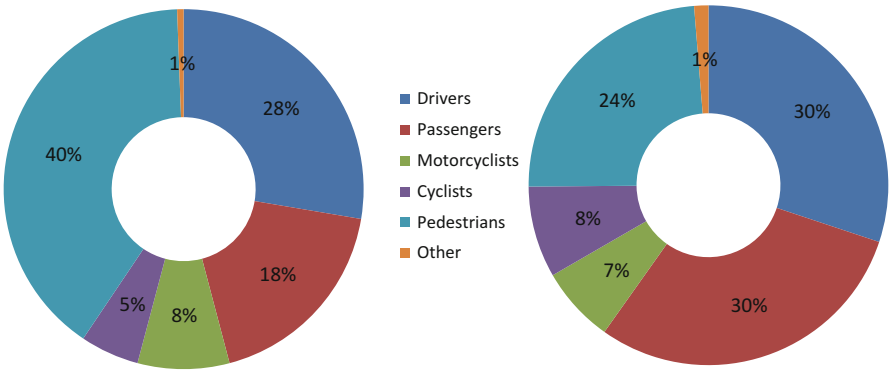

Fig. 9 Deaths (on the left) and injuries (on the right) by road user category in 2018. (Source: LRA 2019)

approach to safety measures (reflective vests, reflectors) and their proper use or human recklessness. Meanwhile, young people (aged 15–34) make up the majority of injured pedestrians. Risk in this age group is explained by a lack of focus and a characteristic hasty behavior. Nevertheless, due to the high number of pedestrian fatalities, the state authorities responsible for the design, renewal, and periodic maintenance of road infrastructure also have a significant role to play. A significant number of pedestrian-hazardous road sections can be predetermined and adapted to safe pedestrian traffic – paved paths with barriers from the carriageway, maintained roadsides, controlled speeding, necessary road signs built, and other engineering measures to improve traffic safety equipped.

The Road Transport Research Institute, which is currently expanding its activities to include air transport and licensing, is now operating as an Agency for Transport Competencies, contributing significantly to the monitoring and prevention of road crashes in the country. In 2014 and 2016, the Institute conducted a study on the use of reflectors during the dark hours (KTTI 2016a), monitoring pedestrians and cyclists on 30 state roads at public transport stops, shops, and other places near resident attraction points. The study showed that about 22% of all pedestrians and cyclists do not use reflectors, and about 21% are misusing them in the dark hours. The use of reflectors by different groups of vulnerable road users is presented in Fig. 10. The same study was conducted by the Institute in 2014. Comparing the results, in 2016, the number of road users using reflectors during the daytime increased by 14%, the number of them misusing them increased by 16%, and the number of road users not using them during the dark hours declined by 30%. This demonstrates the need to continue educational campaigns on reflector distribution and awareness of their use.

The importance of reflectors is evident, as a pedestrian wearing a reflector, a vest or other clothing with reflective elements is visible from a distance of 300 m, and without reflectors only from a distance of 100 m from a vehicle with high beam headlamps on. When the vehicle is passing with the dipped-beam headlamps on, a

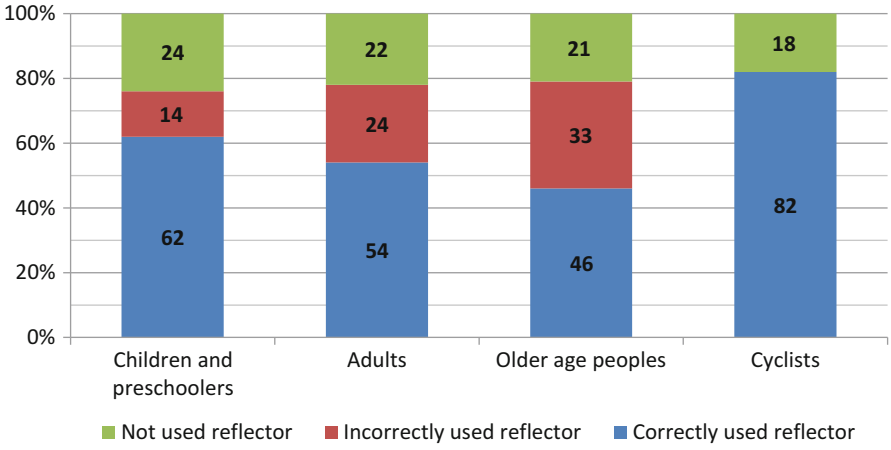

Fig. 10 Use of reflectors in accordance with the monitoring carried out in 2016 on the roads of national importance. (Source: KTTI 2016a)

pedestrian with reflective elements is noticeable from a distance of 150 m and only from 50 m without them. In these circumstances, even at a speed limit of 50 km/h, the driver will be able to stop the vehicle from a distance of at least 35–40 m on wet surfaces, taking into account his reaction time in the dark (1.2–1.5 s). It is therefore important to seek that **vulnerable road users (pedestrians, cyclists) make appropriate use of reflective elements during the dark hours**. This involves the education of road users through the active involvement of municipalities and supervisory enforcement activities (Table 4).

In the long term, after implementing measures to improve traffic safety, the proportion of road users who do not use reflectors or similar devices at all and misuse in Lithuania is expected to decrease from 43% in 2016 to 30% in 2025 and 15% in 2030.

Use of Seat Belts in Rear Seats and Child Seats

The consequences of road crashes are heavily influenced by whether the occupants of the vehicle are wearing seat belts or not. Over the period of 2013–2016, it has been recorded that almost one-fifth of road users were not wearing seat belts. Seat belts in the front of the vehicle in Lithuania are used by 97% of vehicle occupants, while only 30% wear them when sitting in the back (including child seats) (KTTI 2016b); therefore, **correct use of seat belts in child car seats and the rear seats of the vehicle must be encouraged**. Measures, expected effects, and evaluation indicators to address this problem are presented in Table 5.

Following the implementation of measures to improve traffic safety in the long term, it is estimated that in Lithuania, the proportion of vehicle occupants in the rear seat wearing seat belts (including child seats) will grow from 30% in 2016 to 60% in 2025 and to 95% in 2030.

Table 4 Implementation for use of reflective elements by road users. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Road users education		
Emphasize the risks of not using or misusing reflectors or other visibility enhancers during the dark hours should be made in social advertising	Modern and attractive forms of education will explain the risks of not using or misusing reflectors or other visibility enhancers at night	At least 50% of respondents in the public poll report that social advertising positively influenced their behavior in traffic, namely, in promoting the use of reflectors or similar visibility enhancers at night and explaining the risks of their misuse
More efficient supervision		
To conduct the traffic law enforcement campaigns and publicize the use of reflectors	One-fifth of all pedestrians, cyclists, and riders misuse the reflectors. Significant reductions in pedestrian fatalities are expected. Autumn and winter are characterized by long dark hours and unfavorable traffic conditions, which reduce road safety for unprotected road users, pedestrians. About 70% of all pedestrian hits occur in winter and autumn	More than 90% of all pedestrians, cyclists, and riders of state roads use reflectors in the dark. The reflectors are used by more than 90% of pre-school age youth, more than 85% of middle-aged people and more than 80% of elderly people Reflectors in the dark I used by more than 90% cyclists Among all reflector users, more than 90% pedestrians, cyclists, and riders use reflectors correctly.

Higher Driving Culture and More Responsible Pedestrian Behavior

Road users cause about 90% of road accidents, and this is a common issue in Lithuania and other countries on average. Most road crashes are the result of deliberate violations of road traffic regulations or safe driving principles (e.g. safe speed selection) by road users. The behavior of road users on the road is heavily influenced by the monitoring of compliance with traffic regulations and the application of impact measures on road traffic offences. Involving more intensive traffic law enforcement as automated speed control, frequent and fast intoxication tests, seat belts and child seats (especially sitting in the back), as well as unauthorized use of mobile devices control will lead to more responsible drivers' behavior and less violation of RTR. Public intolerance occurring as announcements about obvious violations of RTR, and of course, education of the public about RTR violations is also crucial. The basic principles of road safety must be built during special activities at school. They should familiarize the young road users with the basic rules of the road and why they must be obeyed. It is also important, in the initial phase of driver training, not only to train young drivers of the rules of the road traffic and to provide them with the necessary skills but also to ensure their responsibility and mutual respect. Drivers training and examination system and the interrelations between the

Table 5 Implementation of seat belt fastening. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Road users education		
Emphasizing the dangers of driving with seat belts off, emphasizing the use of seat belts in rear vehicle seats and city buses and the safe transport of children in social advertising	Modern and attractive forms of education will be used to explain the dangers of driving with seat belts off	At least 50% of respondents in the public poll report that social advertising has had a positive impact on their behavior in traffic, namely, through the promotion of using seatbelts in rear seats and coaches and the safe transport of children
More efficient supervision		
Carry out and publicize the campaigns of wearing seat belts for front and rear-seat passengers and seat belt fastening for passengers in buses and country buses	Due to the failure to use seat belts, many people are still injured or killed in road crashes. The measure would encourage the use of seat belts, including seat belts in rear vehicle seats and country buses	98% of front passengers wear seat belts 50% of passengers in the rear wear seat belts (including child seats) In coaches equipped with seat belts, they are used by 50% of passengers
Carrying out and publicize the traffic law enforcement of children's transport in seats (seats, seating systems) adapted to their height and weight	Carriage of children in places not adapted for this purpose may result in injuries or loss of life during road crashes. The measure would encourage the transport of children in seating positions (seats, seating systems) adapted to height and weight	The proportion of children carried in seating positions (seats, seating systems) adapted to their height and weight, to be at least 80% of all children carried

institutions involved in this process play an important role here (Valiūnas et al. 2011). To reduce the road crash rate, Lithuania should pay greater attention to development of a road safety based training system, including practical and safe traffic skills in drivers, special training of professional drivers, and improvement of their qualification. The system should ensure improving the qualification of drivers, continuous training of drivers, and examination of their knowledge as well as the development of traffic safety knowledge and skills in road users of all age groups.

In order to achieve **a higher driving culture and more cautious and responsible pedestrian behavior**, the challenge is to reduce the number of abusive driving situations dangerous to others, as well as to reduce the behavior of non-cautious pedestrians (especially children and seniors). Here the role of system designer is envisaged for special attention to the development of safe pedestrian and cycling infrastructure. For this reason, it is necessary to separate the pedestrian and bicycle traffic from the motor vehicle traffic, expand quiet traffic areas with speed limited to 30 km/h – near schools, children's playgrounds, healthcare institutions, shopping centers, parks. Other measures, expected effects, and evaluation indicators to address to a higher driving culture and more responsible pedestrian behavior are presented in Table 6.

Table 6 Implementing a higher driving culture. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Change of the legal base		
Encourage candidate drivers to acquire as many driving skills as possible before passing the practical driving test	The aim is to encourage to acquire as many practical driving experience as possible before taking the practical driving test. Studies have shown that the learning of practical driving skills for about 120 h (including training with a family driving instructor), after getting a license, the chances for a beginner driver of being involved in a road crash are reduced by 40%	50% of applicants seeking to acquire the right to drive category B motor vehicles, before passing the practical driving test, acquire practical driving skills while driving for at least 50 h
Road users education		
Examining road crashes, their causes and selected measures, sharing them with driving schools and publicizing	The aim is to provide road users with information that will help them avoid errors in their behavior on the road	Thematic plans for driver training have been supplemented with new, relevant topics that would contribute to increasing traffic safety
More efficient supervision		
Encourage road users to report cases of reckless driving or other violations	The aim is to raise public intolerance for the abusive driving that endangers the lives and health of other road users	Surveys show that driving culture is improving

Government of the country back in 2016 has endorsed the Code of Administrative Offenses, which provides for stricter liability for violations of the rules on vehicle overtaking, dangerous and reckless driving, therefore currently the sanction for violation of overtaking rules includes a fine and the withdrawal of the right to drive from 3 to 6 months. In the event of loss of a driving license, additional medical examinations have to be passed (if the right of driving has been Substandard because of being intoxicated with alcohol or other substances), to receive a certificate of health knowledge certification and to attend additional driver training courses. The content of the latter courses includes a lecture on the accident levels and prevention of road crashes, a conversation with the psychologist of at least 55 min about the offense committed, the driving culture and responsibility on the road, and practical driving session with a driving instructor. If the right to drive has been withdrawn for a year or more, the driver has to retake both the theoretical and the practical driving test. Additional driver training may also be provided to novice drivers (not having two years of experience) who violate the RTR rules, as young drivers are more prone to errors or unsafe behavior on the road (Šeibokaitė et al. 2020). If these courses are not attended, a 10-year valid driving license is not issued to them.

A number of studies have been carried out in the country to monitor the behavior of road users, as road users specifically are the main perpetrators of road crashes. The irresponsible behavior of drivers, pedestrians, and cyclists, apart from carelessness and negligence, leads to disasters where they are most often affected, but it is too late for many citizens to become aware of the principles of good road behavior. The behavior of 1896 drivers was observed while they were waiting for the green light at signal-controlled intersections in various cities of Lithuania (Bogačionok and Rimkus, 2020). The most commonly encountered extraneous non-driving related activities are talking on and surfing on the phone (16.2% of observed drivers), communication with passengers (11.3%), and smoking (4.9%). In addition, other kinds of extraneous activities have been observed, that is, eating/drinking, checking one's appearance in the mirror, searching for fallen objects, cleaning the cabin, dozing off, throwing of rubbish through the window, using a computer, etc.

Another study observed pedestrian behavior and found that 18.6% of them crossings behave irresponsibly or violate rules at pedestrian (KTTI 2014). The study included a total of 23 h of surveillance of pedestrian crossings in the two largest cities in the country. In unregulated pedestrian crossings, pedestrians usually do not look around properly, are distracted from the traffic or simply cross the street, not at the crossing. The regulated pedestrian crossings are dominated by non-observance of traffic lights as well as inattentiveness and off-crossing.

Special attention needs to be paid to professional drivers as they spend their day on the road while carrying freight or large groups of passengers. Understandably, their responsibilities, in this case, are higher, so the requirements for the selection of such drivers are also stricter. A study of psycho-physiological characteristics of drivers (reaction time, attention concentration) and the influence of fatigue of these drivers on road crashes was carried out in a public transport company of the capital city of Lithuania, engaged in passenger transport within the city and suburbs (Zaranka et al. 2012). The study found that drivers are most likely to be involved in a road crash on the first day after a day off and that the likelihood of crash increases during the first hour of work and in the middle of the shift when the first signs of fatigue occur. Taking into account the results of the study, the company has applied a special method of selection of drivers based on driving experience, skills and attention keeping ability in accordance with the age group of the driver.

Second Priority: Safer Roads

The total network of Lithuanian roads reaches 84.5 thousand km. Roads are divided into national (21.2 thousand km) and local roads (63.1 thousand km), depending on the traffic permeability of vehicles and their socioeconomic importance. The network of roads assigned to the streets is 7.2 thousand km (LRA 2019).

Lithuania is a transit country in terms of its geographical location and share of gross domestic product. Back in 1994, the European transport ministers at a conference in Crete identified two Trans European Network corridors crossing Lithuania's territory (Fig. 11a). In addition, there are six highways of European significance in

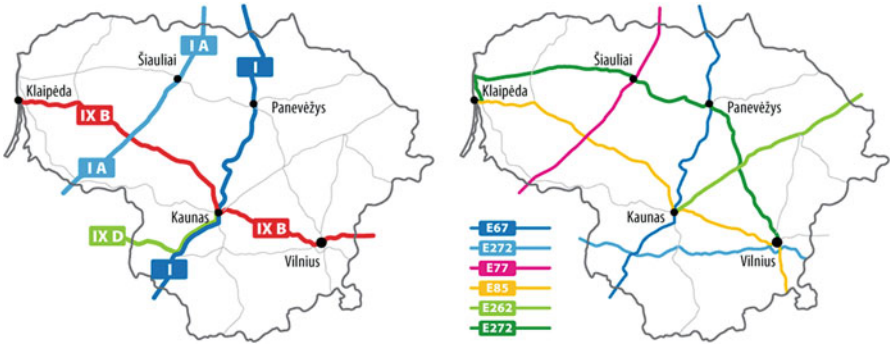

Fig. 11 Interstate road network crossing Lithuania: branches of the *Trans European Network* corridor (left); highways of European significance (right)

the country (Fig. 11b). Such interstate road infrastructure, the geographical location of the country, and the state policy implemented make land transport a significant contribution to the national economy. In accordance with the Lithuanian Department of Statistics, the state receives about 13–17% of the gross domestic product of the country due to cargo transportation. Therefore, Lithuania can rightly be called a transit state. In Lithuania, in the area of export services, road transport accounts for the largest proportion, 28.7% of services, compared to other modes of transport (railways, air and sea). The majority of cargo, 62.3%, is also carried by Lithuanian motorways (LRA 2015).

Despite the apparent benefits of the transport business, heavy traffic of vehicles carrying goods is causing a significant part of total crashes, which requires more attention and additional investment in ensuring the safety of the road infrastructure. Heavy vehicle drivers are responsible for about 25 road fatalities of road users each year in the country, which corresponds to about 14% all fatalities in the country's roads.

From the point of view of road safety, it is important that professional drivers working in the field of transport comply with the requirements in terms of road safety that apply to them. For this purpose, the country provides for automatic preliminary law enforcement of driving and rest regime and heavy and large-sized vehicles. The integration of vehicle number plates and data validation system in the road infrastructure requires automatic traffic law enforcement of the driving and resting mode. Thus, drivers will try not to violate the prescribed driving and resting regime, and it has a direct connection with driving and traffic safety. An automated traffic law enforcement system would also allow heavy and large-sized vehicles to be controlled, so drivers and logistics companies will try to stay within the maximum weight and size limits.

In its strategy, Lithuania has set a target that the share of driving and rest violations classified as very serious and severe of the number of drivers checked should be reduced from 10% in 2016 to 5% in 2025 and up to 1% in 2030. The

reduction of the share of noncompliant vehicles in terms of securing goods and carriage of dangerous goods by 2030 is expected to be 10 and 5 times, respectively.

The ratio of serious and very serious violations detected and rectified, to road vehicles when the allowed dimensions, gross mass and axle loads are exceeded without authorization, should increase from 10% to all recorded violations of this type (2016) to 50% (2025) and up to 80% in 2030. The objective of this indicator is to limit and eventually fully stop the participation in general traffic of vehicles which, when exceeding the maximum permissible parameters, pose a severe traffic safety hazard and have a significant negative impact on the environment or serious property damage.

Once the state road crash trends are identified, apart from the measures aimed at the education, traffic law enforcement and responsibility of road users, separate measures should be applied in parallel to other priority areas: streets and roads, vehicles, efficient post-crash assistance, sustainable interaction with other modes of transport.

The streets and roads we travel on every day also make a significant contribution to our security. Every year, over 250 high crash risk sections are reconstructed on state roads with various measures to improve the traffic safety (roundabouts, barriers, city gates, safety islands, directional lighting, speed controls, etc.). Due to consistent activities, the number of high risks sites on state roads has been reduced from 280 to 37 in 7 years (Fig. 12).

One of the causes of road fatalities is the poor condition of some roads as well as the lack of modern road safety and traffic control measures (Government of the Republic of Lithuania 2013). Thirty-two percent of Lithuanian roads are in poor or very poor condition, and the existing road pavement reconstruction volume (1.6% of the total road length in 2009) is five times lower than optimal. EU Directive 2008/96/EC provides that measures to improve road safety shall be implemented throughout the road infrastructure network.

Despite the decreasing number of high crash risk sections on the country's roads, it is imperative that **the road infrastructure is managed using advanced**

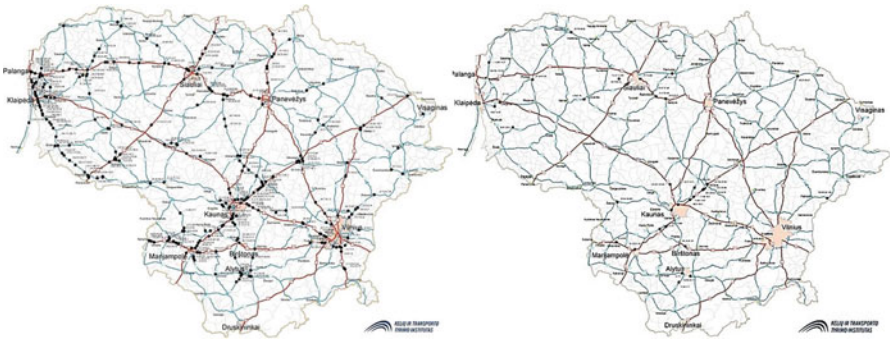

Fig. 12 Maps of high risks sites on national trunk roads and state roads 2007 (left) and 2015 (right). (Source: Transport Competence Agency)

technology and interstate road safety standards and provides the reliable information needed to improve road safety. The main tasks applied for this are:

- Continuous road maintenance and implementation of engineering safety improvement measures and evaluation of their effectiveness
- Advanced traffic safety management
- Collection and analysis of advanced crash information using advanced techniques

Lack of information about the circumstances is noticed during the analysis of road crashes in Lithuania. The specific information covers incorrectly specified exact location of an accident, insufficient information about specifics of local infrastructure, insufficient information about seat belts, child seats or helmets usage and airbags deployment, poor information on human injuries, inaccurate information on the type of the crash. Thorough data about road crash collection will help to identify the root causes and select, as well as implement specific measures for avoidance of fatal crashes.

The detailed measures, anticipated effects, and evaluation indicators to address the problems related to the management of road infrastructure are presented in Table 7.

The Valletta Declaration (No 9994/17 TRANS 252), approved by the Council of the European Union on 8 June 2017, states that Member States undertake, in their efforts to achieve the objective of reducing the number of fatalities up to 2020, to continue work together toward: (i) reduction of the number of serious injuries in road crashes; and (ii) by 2018 at the latest start providing reliable and comparable data using a common definition based on the MAIS 3+ injury classification (Maximum Abbreviated Injury Scale of three or more (MAIS3 +)).

In order to reduce the number of fatalities among pedestrians and cyclists and to reduce the number of crashes caused by overtaking, it is necessary **to develop the road infrastructure that improves road safety and mobility by**:

- Reconstruction of unsafe crossings so that they meet their requirements, extension of pedestrian and cycle paths (including cycle lanes), an adaptation of road infrastructure to persons with disabilities, development of road infrastructure ensuring the safer movement of animals when crossing the road network, reconstruction of dangerous intersections, removal of unprotected left turns on the highways
- Installing and developing intelligent transport systems (ITS) on the roads of national importance for ensuring traffic safety (prevention of unauthorized overtaking, etc.)

Table 8 shows the exhaustive measures, expected effects, and evaluation indicators to address the problems related to the development of road infrastructure to improve road safety and mobility.

After implementing measures to improve the management of road infrastructure in the long term it is expected that in Lithuania from 2018 to 2030:

Table 7 Implementation of advanced technology in road infrastructure management. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Advanced road safety management		
Implementing a road infrastructure management system	The created road infrastructure system will allow more efficient planning of investments, need and use of funds for improving road safety, prioritization of repairs and other work	The road infrastructure of national importance is managed using a unified information system
To carry out the road safety impact assessments and road safety audits for street construction, reconstruction, and major repair projects	All new street construction, reconstruction, and major repair projects will be evaluated in accordance with a set methodology for safe traffic. The objective is to make them safer for all road users when constructing or redesigning objects	Road safety impact assessment and traffic safety audits are carried out for street construction, reconstruction, and major repair projects, 100% in 10 largest cities in Lithuania
Establish the procedures for training and certification of road safety auditors	More specialists able to carry out road infrastructure safety audits will be trained to ensure that road and street construction, reconstruction, and major repair projects meet the road safety requirements	Traffic safety auditors shall be trained and certified in accordance with the procedure established by the competent authority of Lithuania
To set requirements for adaptation of roads and their elements to people with special needs	The newly constructed or reconstructed road and street infrastructure will be adapted to people with special needs and will ensure their safe participation in traffic	Road reconstruction or significant repair projects are carried out in accordance with the requirements for the adaptation of motorways and their elements to people with special needs
Perform street safety inspections	Regular inspections are a necessary tool to prevent intrinsic hazards, and therefore safety inspections would be carried out on the operating streets to identify aspects related to street safety and to prevent crashes.	A safety inspection of the streets of the ten largest cities of the country was carried out for 100%
Prepare maps of high risks road sites in the cities	The safety of existing streets must be increased by directing investments to the most crash-prone sections and those with the highest crash reduction potential. Drivers must be made aware of high-traffic road sections in	Maps of high risks road sites have been prepared for the ten largest cities of the country, and plans for elimination of high risks sites have been approved

(continued)

Table 7 (continued)

Measure	Expected effect	Assessment indicator
	order to change their behavior and to enforce road traffic rules, in particular as regards speed limits	
Collecting and investigating detailed information of road crashes		
As research is an essential tool for improving road safety, it is provided to carry out an in-depth analysis of serious collisions involving road users	The development and demonstration of components, tools, and methods and the dissemination of research results play an essential role in improving the safety of road infrastructure. The specific crash causes involving road users will be investigated, and remedies identified to remove these causes	A new classification of crash causes affecting road users has been prepared
To update the methodology of crash data collection using advanced solutions	The update of the methodology will allow collecting more information on the number of road users who have been injured, allowing for more accurate modeling of the management of the risks involved	A new methodology has been adopted
To establish an information system for the analysis of data on road crashes and for monitoring the implementation of road safety measures, which can be accessed by all interested authorities	More accurate crash information will be collected, which will enable for more precise identification of the circumstances of the crash and will allow this data to be used in selecting measures to prevent other potential accidents Responsible authorities would have access to primary crash data and could analyze their causes. The use of IS would result in the preparation of maps of high risks sites and monitoring the results of implemented traffic safety measures	A computer-based traffic data filling application is used to collect crash data, 80% of all crashes affecting road users Competent authorities have access to the updated database of accidents affecting road users
Categorize injuries sustained in road crashes as minor and severe in accordance with the MAIS3+ method	Uniform monitoring of statistics on traffic-injured persons to allow for a more efficient selection of traffic safety measures, is in place	A new methodology for classifying injuries sustained in road crashes as mild and severe in accordance with MAIS3+

Table 8 Development of road infrastructure to improve road safety and mobility. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
Increasing road and street safety		
Increase the length of fences against wildlife, the number of wildlife crossings and other roadside protection measures	The aim is to reduce the number of encounters with large and small species of wildlife	Road sections with the introduction of these changes shall 80% less of road crashes involving injuries or fatalities due to collision with wild animals
To reconstruct trunk roads with the most intensive (transit) traffic	Significant reduction in the number of road crashes is expected due to the reconstruction of highways with the highest traffic density	After the reconstruction of trunk roads, the number of road crashes in which injured or killed road users are reduced by 50%
To increase the overall length of roads with dividing strip, pedestrian and bicycle trails, illuminated roads, reconstruct unsafe intersections, increase the length of safe sidewalks	These measures are aimed at improving road safety and providing the right conditions for safe cycling	50% less of road crashes involving injuries or fatalities occur on the road sections where these changes are implemented
To develop the installation of the bike and ride stops and bike-sharing systems in the cities	These measures are intended to encourage and facilitate cycling	Equipped system of bike and ride stops and bike-sharing in six cities
To remove or modify any existing pedestrian crossings that do not comply with the rules for the organization of pedestrian crossing through roads and streets	Potentially dangerous pedestrian crossings will be eliminated or converted into safe areas	80% of crossings comply with the requirements of the rules for the organization of pedestrian crossing through roads and streets. In such crossings, 50% less of pedestrians are killed or injured compared to the situation before the conversion of crossings
To carry out the maintenance of roads of national importance at a higher level	Road safety conditions will be insured, and roads will meet the security requirements in response to the changing climatic conditions or obstacles on the road	To decrease the number of crashes involving road users on slippery roads on state roads by 20%
To develop a road and weather information system	Road users will be provided with more accurate information on road traffic conditions. Getting more information about metrological conditions will make road maintenance more efficient	Development of a network of metrological stops by 15% annually

(continued)

Table 8 (continued)

Measure	Expected effect	Assessment indicator
To increase the efficiency of lighting on roads of national importance	Road sections will be better lit	Reduction of accidents affecting road users in the road sections where road lighting has been replaced by more efficient lighting, by 10%
Deployment and development of road safety improving the its		
Implementing a multifunctional violation control system on state roads	This system will allow controlling the weight, dimensions, speed of passing vehicles or their combinations, checking whether the vehicles have valid roadworthiness tests, compulsory motor third-party liability insurance, and registration data. In addition, the information obtained is required for traffic management on motorways	For road sections with a multifunctional violation control system implemented, no violations of RTR are detected in the passing 90% of vehicles
To implement an average speed control system on state roads	The introduction of an average speed control system aims to keep vehicles within the set speed limits Sanctions will be applied to drivers who exceed the established speed limit on the road section	On-road sections fitted with an average speed control system, the percentage of motor vehicles exceeding the speed limit above 20 km/h does not exceed 2% of the total number of passing motor vehicles
To develop a network of stationary speed meters on state roads by expanding their functionality	By increasing the number of fixed speed meters on the roads by more than three times and supplementing their functions, to record the leaving vehicles exceeding the set permitted speed, it is expected to significantly reduce the number of speeding vehicles on dangerous road sections	On-road sections with fixed speedometers, the percentage of motor vehicles exceeding the speed limit above 20 km/h shall not exceed 2% of the total number of passing motor vehicles
To deploy a dynamic safety speed management system on state roads (road signs with variable information)	The introduction of a dynamic safe speed management system will allow for rapid response to metrological conditions or obstacles on the road	50% fewer accidents due to failures to select safe speed occur on the road sections with a dynamic safe speed management system installed

- The number of pedestrian fatalities should drop to 34 (−50%)
- The number of cyclists killed will decrease to 8 (−50%).
- The number of road crashes involving animals on state roads will drop to 5 (−83%).
- The number of collisions when driving to the opposite lane should reduce to 80 (−66%).
- The number of road crashes affecting road users when the motor vehicle is driven off the road will fall to 394 (−30%).
- The length of the pedestrian and (or) bicycle trail network on state roads will increase to 1418 km (+ 18%).

The majority of measures to improve street and road infrastructure need to be adapted to the specific safety concerns and needs and habits of different groups of road users. A holistic assessment of the situation leads to a long-term and sustainable positive outcome. One example of this was the permission for cyclists to drive on pedestrian sidewalks, given the needs and specific habits of road users, where there is no bicycle lane or bike lane nearby and without endangering pedestrians, introduced in 2014. Nonetheless, often, if the interests of some road users are considered, then the interests of other users are undermined. Improving pedestrian safety by the reduction of the speed of movement of motorists, flow capacity or driving comfort, is a typical example. A change to the RTR has been introduced in the country, obliging drivers to park a vehicle at least 5 m behind a pedestrian crossing if there is one lane in each direction on the street, this way, not obstructing the visibility of pedestrian crossing to other drivers.

Given that the number of road crashes involving pedestrians in their crossings has increased over several years (2014–2016), the rules for the organization of pedestrian crossings on roads and streets were adopted in 2017. These rules prescribe the conditions, requirements, and restrictions for the installation of pedestrian crossings in the territory of the Republic of Lithuania. It is intended that the provisions of these rules should apply to the construction or reconstruction of roads and streets and major or ordinary repairs to roads and streets. The rules will also encourage municipalities to improve the safety of existing pedestrian crossings in the coming years. The approved rules set requirements for pedestrian crossings equipped on state roads can also be applied to local roads and streets maintained by municipalities. The rules establish the general conditions for the installation of pedestrian crossings and the requirements for engineering measures to ensure safe traffic. They are obligatory for newly constructed or reconstructed pedestrian crossings on state roads, recommended for previously installed pedestrian crossings on all roads (streets) of local importance. Municipalities reconstruct dangerous pedestrian crossings in accordance with the terms and conditions of the rules in order to improve the level of safe traffic for hazardous pedestrian crossings and to ensure pedestrian safety (Fig. 13). The rules for the installation of pedestrian crossings have been developed, taking into account the acceptable practices of foreign countries. The rules are characterized by the fact that, depending on the traffic intensity of pedestrians and cars, they clearly indicate when:

Fig. 13 Examples of reconstructed pedestrian crossings in Lithuanian cities

- Engineered traffic safety measures are installed for the safe crossing of the road (street)
- pedestrian crossings are installed
- Traffic light-controlled pedestrian crossings are installed
- Underground pedestrian crossings or pedestrian crossings above the road (street) are installed

The rules are designed to maximize pedestrian safety on the roads (streets). As an example, no pedestrian crossings can be on the roads (streets) where driving speed is above 50 km/h. Road design in those sections should be changed or pedestrian crossing removed. The rules also set visibility requirements for pedestrian crossings to be installed so that both pedestrians and drivers can notice each other in due time. The indicated engineering traffic safety measures are applied together with pedestrian crossings.

In 2018, the Lithuanian Road Administration (LRA) under the Ministry of Transport and Communications conducted a study that found that as many as 1,721 pedestrian crossings from 1,949 on national state roads were unsafe (LRA 2018). It is estimated that almost 95% of pedestrian crossings are not illuminated by

directional lighting, 29% crossings have no raised islands or dividing sections, thereby requiring pedestrians to cross a driveway wider than 8.5 m. Almost 20% crossings have no sidewalks, pedestrian and (or) bicycle paths, 18% of the crossings have no lighting at all, and adequate visibility is not ensured in them. More than 10% of crossings have no raised islands or dividing sections, although pedestrians have to cross more than two traffic lanes. The majority of such pedestrian crossings are being reconstructed, while the remaining part, where the speed limit is higher than 50 km/h and in other urban areas, will be eliminated.

Several priorities are set to attain ambitious road crashes reduction tasks in Lithuania, and one of them is modern information technologies. The objective of the priorities is to improve the process of collecting and presenting traffic data and implementing and developing Intelligent Transport Systems (ITS) in road infrastructure and vehicles (Jarašūnienė and Batarlienė 2020). After the deployment of the intelligent transport systems, Lithuania moved closer to the Western European countries in terms of the level of information traffic systems. Now road users, when planning their trips (and on the road), can quickly obtain traffic information or information on weather conditions and road surface conditions (Fig. 14), road repairs, their duration and detours, natural traffic restrictions, dangerous obstacles, and traffic disruptions (LRA 2015).

Despite the country's progress, there are also difficulties or delays in the work. The existing trans-European transport network infrastructure in Lithuania does not meet some of the requirements: lack of efficient interconnections, unresolved some of the bottlenecks, incomplete adaptation of intelligent transport systems ITS, the

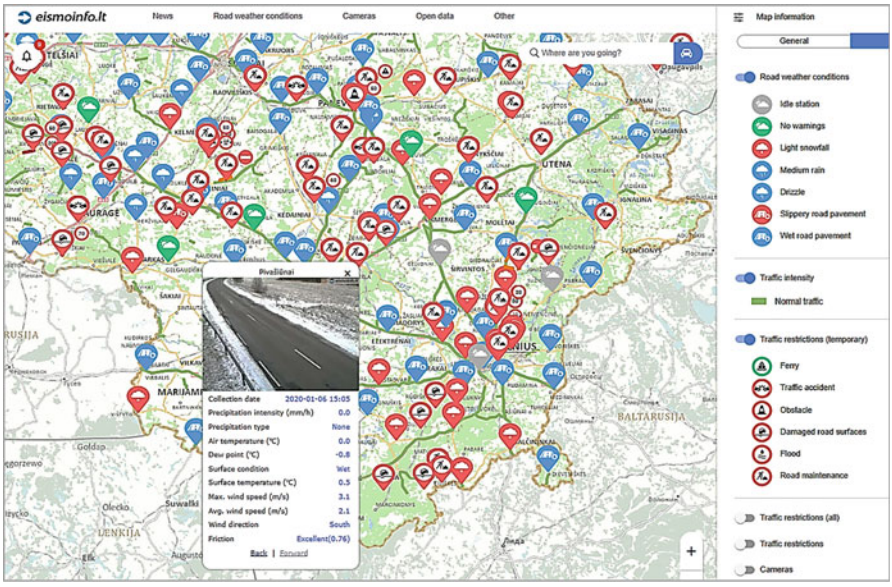

Fig. 14 Image from the website, providing drivers with instant information on the state of the country's roads, meteorological conditions, repairs, etc. (http://eismoinfo.lt)

current state of infrastructure is unable to meet the increasing road safety, and environmental requirements (Government of the Republic of Lithuania 2013). These shortcomings hinder the smooth and safe mobility of passengers and freight. Inefficient interconnection between different modes of transport and between the main and general transport network elements does not ensure sufficient interoperability between different transport modes. This reduces the cost of passenger and freight transport and increases the flexibility of transport services, but also contributes to reducing the negative environmental impact of the transport system.

Third Priority: Safer Vehicles

The average age of the country's passenger vehicle fleet in 2018 was as high as 14.4 years, while new cars registered for the first time made up only 16%, although this rate started to increase in 2019 (Source: VĮ Regitra). The big age of the vehicle fleet means that only every second passenger vehicle passes the mandatory roadworthiness test from the first attempt (Source: Lithuanian Association of Technical Inspection Companies Transeksta). Most of the deficiencies include unadjusted dipped-beam headlamps (13.3%) and malfunctioning suspension elements (11.9%). It is found that vehicle defects relating to lighting and signaling equipment have a weaker correlation with accident rates (coefficient of correlation 0.23) than brake failure (0.49) or tire failure (0.38) (Bureika et al. 2012). However, taking into account the natural conditions of Lithuania when the dark time predominates in October to March, the importance of vehicle lighting equipment for road safety is much higher. The target is that the assurance of good technical condition of the vehicle must be the responsibility of each driver.

Given the age of the country's fleet of vehicles and the prevailing technical shortcomings, it is crucial **to ensure that only safe means of transport are used on the roads of the country and to reduce the number of crashes caused by technically unsound vehicles**.

The detailed measures for achieving these objectives, the expected effects and evaluation indicators are presented in Table 9.

After the implementation of safe vehicles for road traffic in the long term it is expected that in Lithuania by 2030:

- The proportion of noncompliant vehicles banned from operating will be reduced to 1% (from 5% in 2016)
- The average age of passenger cars registered in Lithuania will decrease to 10 years (from 15 in 2016)

Newer cars on the country's roads mean not only their better technical condition, which correlates with the rates of accidents caused by vehicles state, but they also have more active safety systems (wheel-antilock braking, stability, automatic emergency braking, lane-keeping, blind zone monitoring, driver attention tracking) (Jarašūnienė and Batarlienė 2020). Newer vehicles also have advanced passive

Table 9 Implementation of safe vehicles on the roads. (Adapted from National Road... 2020)

Measure	Expected effect	Assessment indicator
More efficient law enforcement of the conformity of road vehicles with the specified technical requirements		
A more thorough inspection of requirements of vehicles should be applied during roadworthiness tests where the deficiencies of vehicles pose an immediate and imminent danger to road safety or which have a negative impact on the environment during a roadworthiness test	As vehicle requirements change, deficiencies that pose a direct threat to road safety are more clearly identified; therefore, targeted inspections can more accurately identify deficiencies, and the equipment used will allow for a more reliable system performance checks	Vehicle requirements are tested using equipment and the latest technology
Aim to Reduce the average age of the passenger car fleet		
To prepare a study on cost-effective ways to promote the purchase of safer and greener cars	Measures will be selected to encourage the purchase of safer and greener vehicles	An implementation plan for the measures has been approved
State support for residents to purchase a newer vehicle and disposal of the old vehicle	Newer vehicles will be purchased and old unsafe and polluting vehicles will be discarded	Reduction of the age of the fleet of passenger cars to 10 years
Renewal of local (urban and suburban) public transport fleet with green vehicles	Local public transport will be safer and greener	Increase in the share of public transport travel compared to 2016, by 5%
Ensure that only safe vehicles are returned to traffic after road crashes		
Establishing precise requirements for safe vehicle operation and the restriction of the use of unsafe vehicles	The participation of unsafe vehicles in public traffic will be severely restricted	Reduced number of unsafe vehicles in public traffic

safety, reducing the impact of a road crash on the driver, passengers, and vulnerable road users. Although under normal driving conditions, active safety systems often do not give drivers too much confidence or the expected effect, their increasing use in the long term contributes to the overall improvement of safety and the positive assessment by drivers (Broughton and Baughan 2002; Reagan et al. 2018). From the current advanced driver assistance systems (ADAS), automotive manufacturers distinguish the automatic emergency braking system as most contributing to the reduction of accident rates. However, the reliability of these systems still depends to a large extent on the technology used (obstacle detection by radars or cameras), environmental conditions (road surface adhesion, foreign objects), and driving circumstances (driving speed and nature of the obstacle movement). Taking this into account, in Lithuania in 2018–2019, the research team of Vilnius Gediminas Technical University (VTGU) conducted research of new cars with the emergency braking system. Of the 51 vehicles tested (23 vehicles from different manufacturers), 24 vehicles driving at 30 km/h stopped on time before the stationary obstacle, 8 cars

stopped incompletely, and the remaining 19 did not significantly reduce their speed. This result indicates that electronic braking assistants are still merely auxiliary steering systems and that drivers need to rely entirely on their driving skills and leave the operation of ADAS systems only for emergencies. A similar performance of the system, not exceeding 59% for the front-to-rear crash, was shown in a study carried out by the Insurance Institute for Highway Safety (Cicchino 2017).

Fourth Priority: More Efficient Rescue Assistance After a Road Crash

One has to admit that human errors cannot be avoided both by the road users or by specialists who are responsible for ensuring their safety. Therefore, even in the event of a road crash, it is imperative **to seek effective assistance from rescue teams**. Depending on the event, post-crash rescue teams in Lithuania consist of police, fire and rescue services, medical, and road maintenance personnel. Thanks to the Emergency Response Centre, which already operates in the country, the responsible call reaches rescue teams smoothly, and they can respond quickly and promptly to the call. Nonetheless, there are cases where emergency services have to perform extra tasks that are outside their scope of operation. For example, at night or in remote areas, police officers or rescuers have to clean the scene of the crash, and police officers are delayed by the owner of the vehicle or cargo that is not arriving or arriving late to the scene (KTTI 2017). Rescue services also require improved financial provision for rescue measures and materials. The detailed measures, expected effects, and evaluation indicators for achieving this objective are presented in Table 10.

Rail Transport and Road Traffic Safety

The European Union Railway Safety Report, published by the European Railway Agency in 2014 and presented to the European Commission, provides a significant threat to society posed by the railway system of the Republic of Lithuania as the highest among 28 Member States of the European Union. In the period 2010–2016, there were 180 major rail traffic crashes, with 129 persons killed and 61 seriously injured. The highest number of victims of rail crashes is bystanders (persons not entitled to be in a dangerous railway area), level crossing users (persons crossing the railway line by any means of transport or by foot on the railway crossing), and crossing users (persons crossing the railway line by foot at the level crossing). A minority of the victims are employees of railway companies (Fig. 15).

The main types of violations which result in fatalities or injuries in road crashes are:

- Users of level crossings enter the level crossing under the prohibiting traffic lights when the barrier is lowered or starts to fall
- Bypass other vehicles that have stopped before the level crossing to pass the train

Table 10 Implementation of efficient rescue assistance. (Adapted from National Road. . . 2020)

Measure	Expected effect	Assessment indicator
Enhanced collaboration between rescue teams		
Number of joint exercises for rescue services	Following the implementation of the measure, the actions of the rescue services involved in the removal of crashes will be better coordinated	Different scenarios for the joint exercises of the fire brigade, ambulance, emergency response center, police every year
Improving the qualifications of rescue team specialists		
Additional practical driving training for rescue team drivers	After implementing this measure, rescue team drivers will continually improve the practical driving skills needed to perform their functions safely	Mandatory training of rescue crew drivers on reduced adhesion surfaces has been introduced
Interoperability of information systems used by emergency services, general assistance centre, police, and traffic management centre		
Accept e-call system calls	In the event of an accident, a signal will be sent immediately to the General Assistance Centre	The crash is reported to the medical personnel within 2 min after receiving a call through the e-call system
Improving the issue of driver health certificates, the authority issuing the driving licenses shall receive data electronically on the fitness to drive	There will be no possibility of acquiring a driving license without complying with the health requirements for drivers (health condition and psycho-physiological abilities must be appropriate for driving in the relevant category (s) of vehicles)	Information on the fitness of a person in terms of health and psycho-physiological abilities to drive a vehicle of the appropriate category (s) shall be transmitted electronically to the licensing authority, 100%
Transmission of electronic data to the licensing authority in the event of a change in the health condition and the person is unable to drive a motor vehicle	Failure of the driver to meet the prescribed medical requirements (i.e., health condition and psycho-physiological abilities to drive the relevant category (-ies) of vehicles) shall result in immediate restriction of the ability to drive, etc.	When a medical institution determines that a person's health condition and psycho-physiological abilities are unfit to drive a vehicle of the relevant category (s), the information shall be transferred to the the authority managing the driving license register electronically, 100%

- Arbitrarily raise or circumvent a barrier
- Enter the crossing area if there is an obstacle behind it
- Deliberately transports unprepared agricultural, road, construction, and other machinery through the crossing

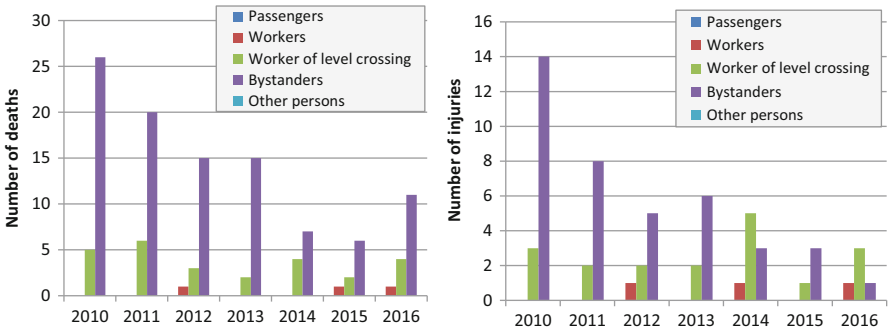

Fig. 15 Railway crashes in 2010–2016. (Source: Lithuanian Ministry of Transport and Communications)

These violations are due to the following reasons:

- Vehicle breakdowns
- Poor visibility due to poor weather conditions and (or) poorly designed road infrastructure
- No sense of responsibility for one's actions (no perception of the level of danger, a habit of breaking traffic rules at level crossings, not being expected to be punished)
- Lack of education and effective information campaign on safe behavior at a level crossing
- Drivers rush/late
- Users of level crossings can physically violate the road traffic regulations (lack of proper railway infrastructure or inconvenience to use it)
- Drivers are tired of waiting at the crossing
- Persons crossing the railway are intoxicated with alcohol or other psychoactive substances
- Because of convenience and time-saving, and due to poor road infrastructure, pedestrians cross the railway at unsuitable locations

The crossing of motorways with the infrastructure of other land vehicles raises **an important need for safer level crossings and safer rail infrastructure**. In some cases, a level crossing is not possible without direct interaction with road vehicles or pedestrians (one level) and a huge difference in mass and speed often lead to the tragic consequences of accidents. As some part of rail accidents is related to roads, the causes and suggested measures are analyzed in the context of road traffic safety. Therefore the main measures to increase safety are: automatic level crossing violation control, reconstruction of level crossings and railway stations, an update of rules for installation and use of level crossings with basic safety standards, implementation of means of information, education on safe behavior in the dangerous railway area for different social groups, in-depth analysis of rail crashes involving road users.

After the implementation of railway transport safety measures in the long term, Lithuania is expected to have zero fatalities in the collisions at level crossings in Lithuania by 2030.

Some pedestrians (especially children) are not sufficiently familiar with the basic rules and regulations applicable to road and rail traffic – do not recognize road signs, ignore traffic lights, believing that they are intended for cars. Others are aware of wrongdoing but are not aware of the potential consequences of their behavior that endanger the health and well-being of themselves and others. Other persons (railway employees or suicides) injured or killed in rail crashes are not related to a road safety system.

Conclusions

Three road safety programs before current Vision Zero have been carried out in Lithuania since the country's independence in 1990. While all road safety programs were aimed at reducing road crashes, only the period of 2007–2011 registered significant achievements in the reduction (more than twice) of fatalities and injuries. Nevertheless, long-term problems of violation of traffic rules and safe driving principles, faulty road safety systems design and ignorant road user behavior remained. A new road safety strategy with the vision to achieve zero fatalities was introduced emphasizing the improvement of road infrastructure, stricter sanctions for offenders of traffic rules, responsibilities and cooperation between institutions and organizations in activities, law enforcement, and education. Specific measures are detailed and targeted at speeding, intoxicated road users, unauthorized use of mobile devices while driving, inappropriate use of reflective elements, seat belt and child seat use, as well as the development of road infrastructure including advanced technologies and its management, implementation of safe vehicles, more efficient rescue assistance after a road crash, and safer level crossings and rail infrastructure. It is expected that purposeful and consistent work will lead to a reduction of 50% in road transport fatalities by 2030 compared to 2018.

The Lithuanian government, civil society and other public, private, academic, and social institutions are committed toward Vision Zero by doing as much as possible in the effort of improving the safety situation in our roads as soon as possible.

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