LEVEL CROSSING ACCIDENTS ANALYSIS IN ROMANIA

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Abstract: Level crossing accidents are one of the largest groups of fatal accidents and it is often useful to investigate them from a safety point of view in order to avoid their recurrence. Level crossings are a serious hazard for rail safety killing more than 200 people/year in the EU. Material damages are also substantial in terms of loss of assets and disruptions to traffic. Crossing a level crossing without following signs is a widespread problem. Even in the case of an obvious violation of safety rules, the causative factor may come from the railway system. Accidents at level crossings have an obvious impact on railway safety regulation or safety management, if the accident was a result of deficiencies in the railway system (e.g. technical failures of infrastructure devices or rolling stock, staff not following procedures, deficiencies in the safety management system, etc.). In this context, the analysis of road accidents at railway level crossings in Romania helps to understand the current situation and the measures needed to modernize them to increase road safety.

Keywords: Traffic safety, fatality index, railway, level crossing

1. INTRODUCTION

In accordance with the Government's Emergency Ordinance (GEO) no. 73/2019 on railway safety, level crossing accident means any level crossing accident involving at least one railway vehicle and one or more vehicles using the crossing, other users of the crossing such as pedestrians or objects temporarily on the railway or next to it, which have been lost by a vehicle or a user using the crossing [1].

Failure to comply with the rules of railway crossing is extremely risky, with often tragic consequences. However, against the background of haste and carelessness, such violations are committed more and more often, despite the fact that the road fatality index associated with this type of accidents is extremely high. [2]. According to statistics, the ratio between the number of people who died and the number of serious accidents in which these deaths occurred far exceeds the values recorded in the case of other accident situations [3]. Most of these road tragedies can, however, be prevented. There are several simple practices that can help you cross railroads safely, and it's

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important to be aware of that:

- it is our responsibility to avoid the accident because the train driver cannot do it;
- a train under emergency braking will stop with difficulty due to high inertia, but not in time to avoid a collision;
- unlike passenger trains, freight trains do not have a strict schedule and can surprise us at any time, we cannot rely on knowing the train schedule;
- in the case of double railways, there is not a single train running, coming from only one direction;
- stopping for insurance at a railway crossing can delay our journey by tens of seconds, while rushing can have tragic consequences;
- we can always be fooled by the optical illusion generated by the combination of the size of the train, the angle of view and the parallel lines of the tracks converging towards the horizon - often the train is moving faster and is much closer than it seems;
- thanks to modern technologies, trains are now much quieter and harder to hear from a distance.

2. SPECIAL CHARACTERISTICS OF THE ROAD

One of the criteria according to which traffic accidents are analysed is the special characteristics of the road (curve, tunnel, intersection, bridge, railroad crossing). More than two-thirds of the serious accidents in Romania took place on road segments that did not require the existence of a special characteristic of the road. Thus, although some of these special elements of the road remain significant factors in the configuration of road risk for almost a third of serious road accidents, the majority of serious road accidents occurred on road segments that did not raise special problems from the point of view of view of its configuration. Of the serious accidents that occur on road segments with special characteristics, most occur in curves and intersections (Table 1, Figure 1) [4]. Thus, the special characteristics of the road do not represent a major factor influencing the occurrence of serious road accidents. Analysing from the point of view of the road fatality index (the ratio between the number of dead and the number of serious accidents in which these deaths occurred × 100), its calculation for road events produced in circumstances related to the characteristic of the road demonstrates the particularly dangerous nature of the railway crossing, as well as the high degree of danger of the curve, when they become elements of the description of the road accident (Figure 2). At the same time, the calculation of the road mortality indices for each of these characteristics also revealed the particularly dangerous nature of the level crossing with the railway, with mortality indices of over 73%. Railroad crossing accidents left very little chance of survival following their occurrence.

The road mortality index in the period 2011-2021 demonstrates the importance of ensuring road and railway safety at railway level crossings (Figure 3).

Table 1. The number of traffic accidents according to the characteristics of the road

Year / Road feature	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Without it	6241	6249	5678	5654	6050	5855	5811	5730	5711	4092	3332
Curve	1495	1458	1331	1340	1485	1355	1412	1342	1277	1037	744
Intersection	1450	1577	1443	1357	1746	1390	1337	1412	1575	1061	790
Tunnel	6	14	16	14	7	11	11	7	18	11	6
On the bridge	63	38	52	44	48	42	47	54	36	38	22
Under the bridge	11	2	4	2	3	3	3	3	4	4	3
Level crossing	24	28	31	36	40	30	25	21	21	30	18

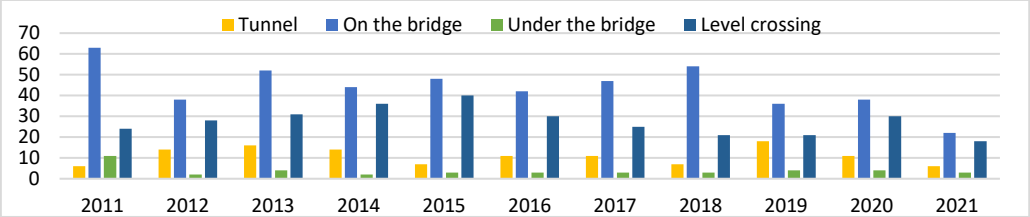

Fig. 1. Serious traffic accidents, depending on the characteristics of the road on which it occurred

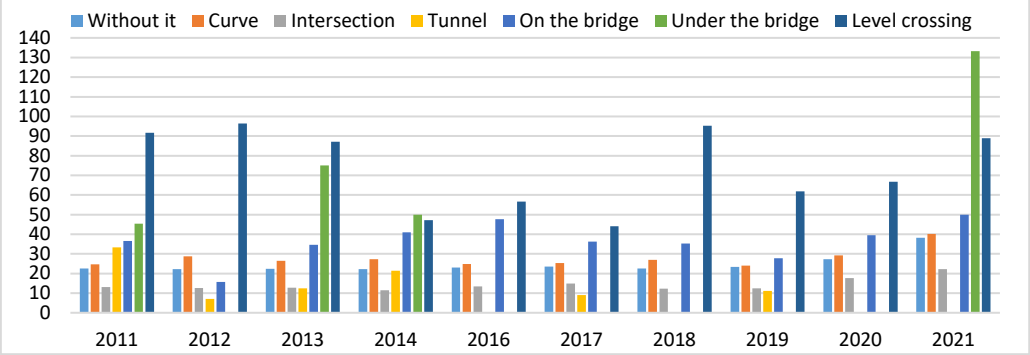

Fig. 2. Road fatality index of serious traffic accidents according to road characteristics

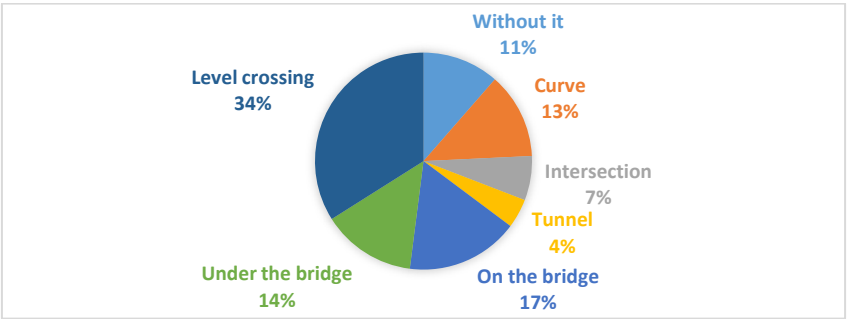

Fig. 3. The road mortality index in the period 2011-2021 in the case of serious traffic accidents

The fact that Romania does not have the safest railway level crossings can also be seen from the data of the European Railway Agency (ERA) [5]. Thus, in the period 2006-2022, 839 accidents were registered in Romania (Figure 4). In 2022, the accident rate at railway level crossings per million train-km is 0.284, above the EU average of 0.218. The top position is held by Estonia with 1.618 and the best situation is found in Ireland, where there are only 0.000 incidents (Figure 5).

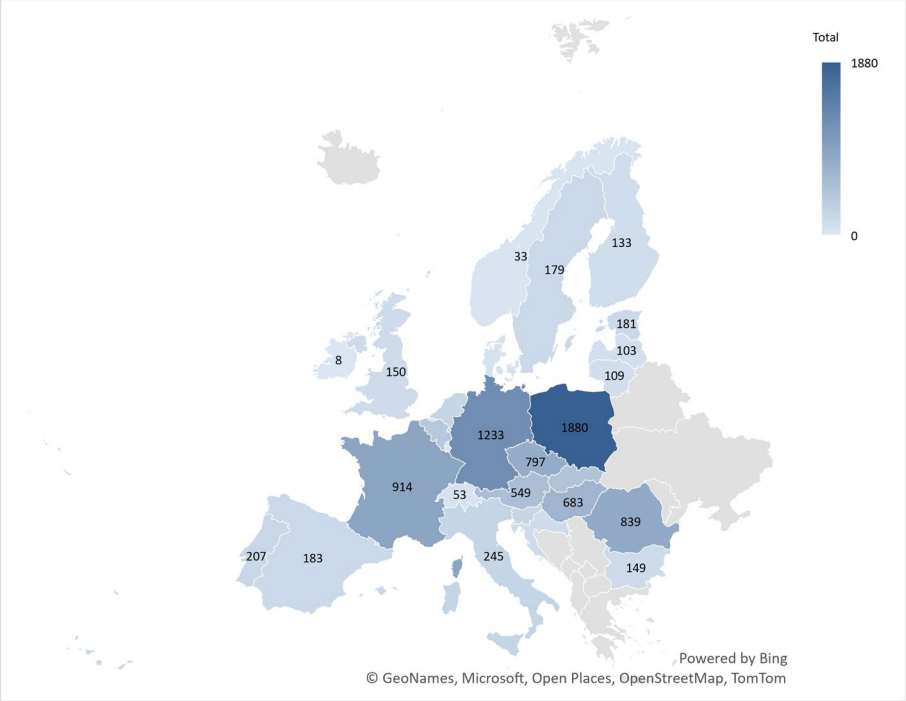

Fig. 4. Level-crossing accidents in ERA countries in the period 2006-2022

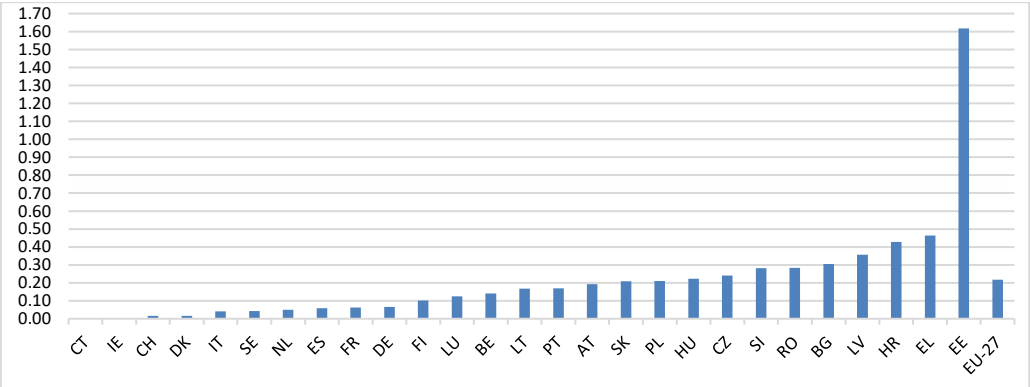

Fig. 5. Level-crossing accidents relative to train km in ERA countries in 2022

3. LEVEL CROSSING

According to GEO 195/2002 republished on traffic on public roads, the level crossing is the level crossing between a public road and a railway or tram line, which has an independent platform [6]. In accordance with GEO no. 73/2019 on railway safety, level crossing is any level crossing between a road or a passage and a railway, authorized by the infrastructure manager and open to the public or private users [1]. From the point of view of railway safety, the following indicators refer to the technical safety of the infrastructure and its implementation:

- *passive level crossing* - a level crossing without any warning or protection system activated when the crossing cannot be safely used by users;
- *active level crossing* - a level crossing whose users are protected or warned of the approach of the train by activating devices when the crossing cannot be safely used by them.

Protection through the use of physical devices includes: barriers or semi-barriers; doors.

The warning is done by using fixed equipment installed at the level crossing:

- visual signals: lights;
- sound warning devices: bells, sirens, horns, etc.

Active level transitions are classified into:

- *manual* - a level crossing where user protection or warning devices are manually activated by an employee of the railway company;
- *automatic with user warning* - a level crossing where the user warning device is activated when the train approaches;
- *automatic with user protection* - a level crossing where the user protection device is activated when the train approaches. This category includes a level crossing that has both protection devices and user warning devices;
- *with protection on the side of the railway* - a level crossing where a signal or other system of protection of the train allows it to proceed only when the level crossing is fully protected on the side of the users and their entry is no longer possible.

On the railway network managed by CFR SA there are 5,025 level crossings with the railway, of which, 252 are provided with automatic barriers, 888 are provided with acoustic and light signals, 436 are provided with mechanical barriers and 3449 are signalled with road signs (Saint Andrew's Cross) (Figure 6) [5,7].

As a result of the signals sent by public opinion following the accident of June 1, 2017, resulting in 5 deaths at the railway level crossing in Viișoara, Bistrița-Năsăud County, GEO no. 43 of August 28, 1997 regarding the road regime was updated [8]. According to it in article 31 it is mentioned:

- the signalling indicators of crossings at the same level as the railway are made by the road administrator, with the approval of the railway administrator and the traffic police;
- the signalling and pre-marking installations of the crossing at the same level as

the railway are carried out by the railway administrator, depending on the road category, road traffic, frequency and speed of train movement;

- the level crossings of all international "E" roads, as well as national roads that present a high degree of risk of road accidents will be provided with barriers or semi-barriers made by the railway administrator, with the approval of the road administrator and the traffic police;
- the railway administrator is obliged to ensure the visibility of crossings at the same level as the railway by clearing the vegetation within a radius of 150 meters measured from the intersection.

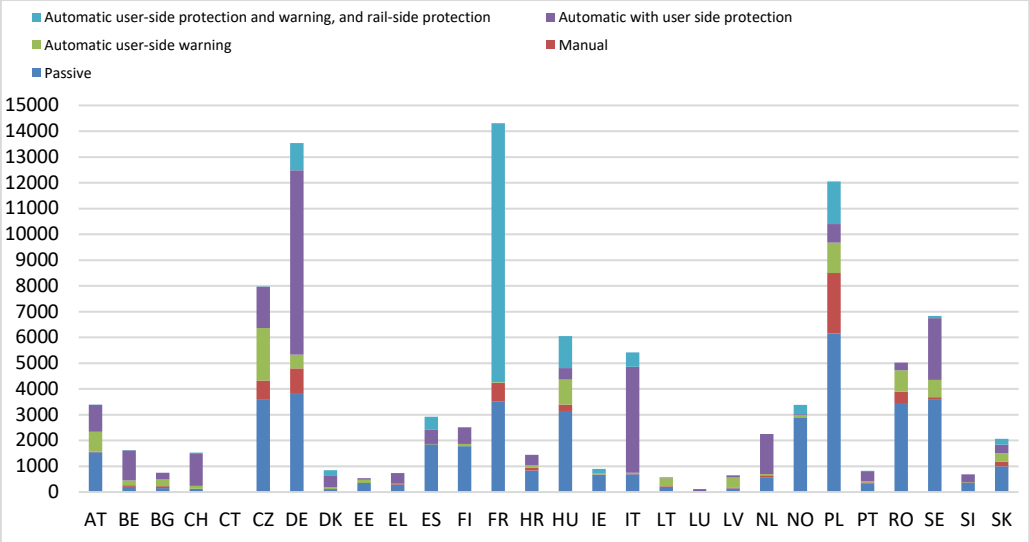

Fig. 6. Level crossings per type of protection per country in 2022

On 08.02.2022 the National Railway Company CFR SA launched a tender worth 160 million euros for the modernization of railway level crossings throughout the country over the next four years. The framework agreement will be concluded at the central level of CFR SA, and the subsequent contracts at the regional railway level [9]. Through the execution of these works, the component elements of the level crossing with the railway and the superstructure of the track are replaced, resulting in the elimination of speed restrictions, by bringing the line into the designed operating parameters and implicitly ensuring increased comfort and road traffic safety.

In the App2022_TN application for viewing data on the modernization of level crossings with the railway, you can find their modernization stage (Figure 7 - 21.12.2023), according to the data provided by NRC CFR SA [10].

4. TRAFFIC SAFETY

According to the republished GEO 195/2002 regarding traffic on public roads,

the following must be observed when at level crossing [6]:

- road users must show increased caution when approaching and crossing current or industrial railway lines, as the case may be;
- at the level crossing with a current railway, provided with barriers or semi-barriers, vehicle drivers are obliged to stop next to the stop sign, if they are descending or in a horizontal position and/or the sound and light signals that announce the approach of the train are in operation;
- when crossing a level with an industrial railway, properly signalled, drivers of vehicles are obliged to comply with the meaning of the railway agent's signals.

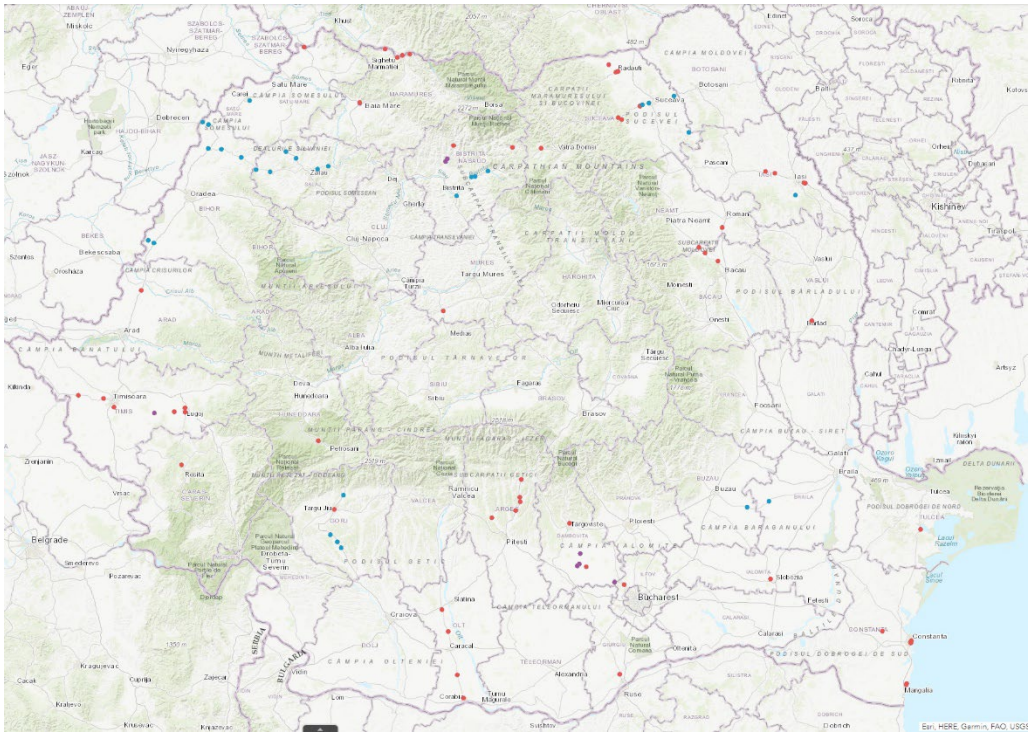

Fig. 7. Modernization of railway level crossings:
● - in progress; ● - in preparation; ● - completed

Traffic participants must show increased caution when approaching and crossing current or industrial railway lines, as appropriate, observing warning signs, light signals and additional panels (Figure 8) [6,11]. At the level crossing with a current railway, equipped with barriers or semi-barriers, vehicle drivers are obliged to stop next to the stop sign, if they are descending or in a horizontal position and/or the sound and light signals that announce the approach of the train are in operation. When crossing a level with an industrial railway, properly signalled, drivers of vehicles are obliged to comply with the meaning of the railway agent's signals.

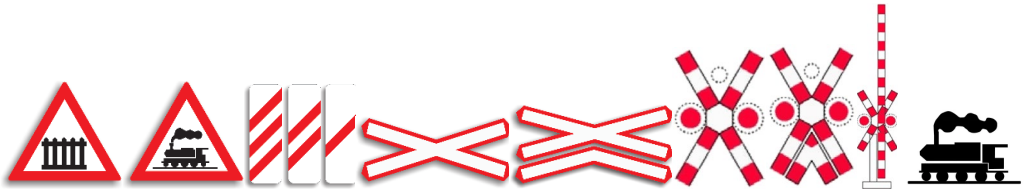

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Fig. 8. Warning signs, illuminated and additional at level crossings with a railway: a - Level crossing with a railway with barriers or semi-barriers; b - Level crossing with a railway without barriers; c - Additional panels for the level crossing with a railway; d - Level crossing with a simple railway, without barriers; e - Level crossing with a double railway, without barriers; f - Level crossing with a simple railway, without barriers, equipped with light signals to warn of the approach of the train; g - Level crossing with a double railway, without barriers, provided with light signals to warn of the approach of the train; h - Level crossing with a simple railway with a semi-barrier, equipped with light signals to warn of the approach of the train; i - Level crossing with industrial railway completing the meaning of the "Other dangers" indicator

A very important aspect is the identification and implementation of the most effective measures and methods to prevent the victimization of the population through traffic accidents. Thus, to prevent negative road events at the level crossing, it is recommended [3]:

- crossing the railway only at crossings designated and signalled as such;
- always slowing down when approaching a railway level crossing with barriers;
- mandatory stopping before railway level crossings where there are no barriers;
- thorough reassurance every time, listening and looking carefully, twice both ways;
- not to force passage if barriers or half-barriers are lowered, in the process of being lowered, or when red light and/or sound signals are in operation;
- not engaging in crossing the railway if there is not enough room to cross completely (stopping on the tracks is prohibited);
- that while crossing a railway level crossing never change gears (the shift to a lower gear should be done before reaching the level crossing with the railway; the movement should be constant; the shift to a top step to be done only after crossing the railway);
- waiting patiently for the half-barriers to be fully raised and the red light and/or beep signals to cease (in the case of double track there may be another train approaching);
- not engaging in overtaking other vehicles on level crossings with the railway and less than 50 m from them.

Voluntary stopping of vehicles is prohibited at level crossings with railways and at a distance of less than 50 m before and after them.

Many infrastructure managers and governments succeeded in eliminating level crossings. Until all level crossings are eliminated, level crossings need to be fully

protected road/rail side and connected to ETCS, GSM R or other TP systems (Figure 9) [12].

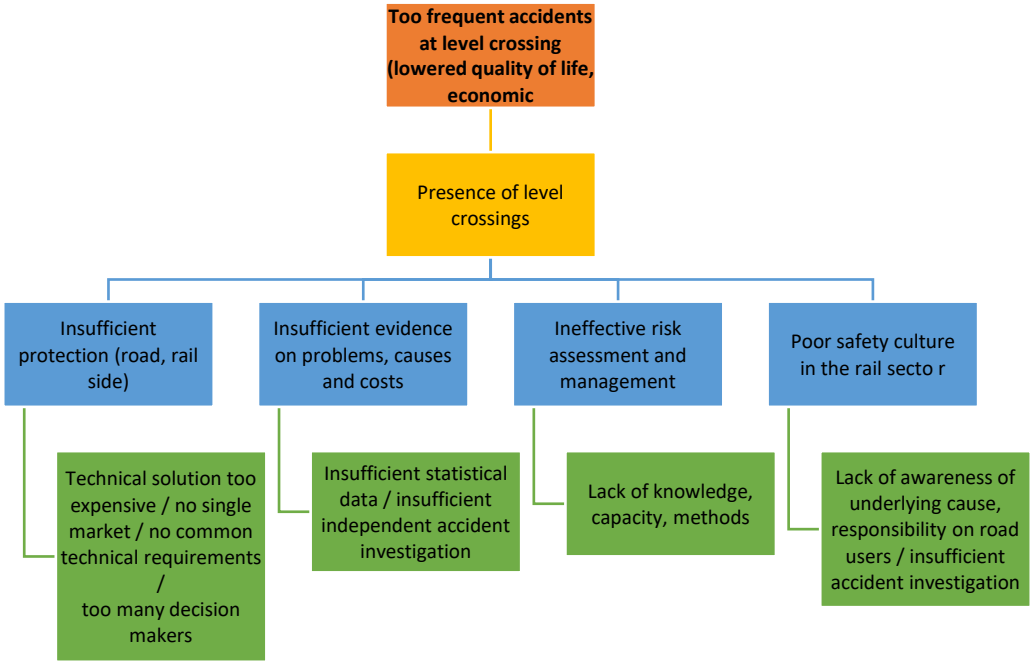

Fig. 9. Actions on root causes:
● - problem; ● - mediator; ● - drivers; ● - sub-drivers

5. CONCLUSIONS

The level crossing is not the most important characteristic of the road in terms of the number of serious accidents, but in terms of the mortality index, which has a value of 73.6% and a weight of 34% in the period 2011-2021 in case of serious traffic accidents. Romania is also above the European average in terms of incidents at railway level crossings within a thousand kilometres of the railway [13].

In order to reduce the number of serious accidents at railway level crossings, in addition to educational campaigns and actions to guide, supervise and control compliance with traffic rules on public roads, measures must be taken regarding their signalling. Thus, there is a need to update the legislation on road safety and railway safety, which requires the modernization of railway level crossings by installing automatic barriers and sound and light signals.

However, indiscipline in traffic can only be reduced through concerted actions of the Transport Police Directorate and the Road Directorate within the General Police Inspectorate. And here I remind you that in order to prevent accidents occurring in the area of railway level crossings, in just one day the police applied 2,612 contravention

sanctions, of which 320 were for non-compliance with railway level crossing rules, 2,017 for other violations stipulated by traffic law and 275 for other facts. Following the irregularities in the road regime, the police detected 16 crimes and detained 238 driving licenses, of which 81 were detained for non-compliance with the rules of level crossing with the railway, 18 for irregular overtaking in the area of level crossings with the railway and 139 for other offenses [14].

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