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IMPROVING ROAD SAFETY ON THE NATIONAL ROAD NETWORK IN ROMANIA THROUGH PILOT SOLUTIONS

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Abstract. In recognition of outstanding work in the field of road safety, especially for the implementation of road safety pilot projects, N.C.R.I.A.-S.A. was declared the winner. The road safety pilot projects that have attracted the attention of the IRF, being a model to follow for all road administrations are: Roller Barriers; Impact attenuators; Road sector 2+1; Cable Road barriers; Illumination of dangerous sectors with light assemblies; Projects to increase road safety by creating elevated road crossings. The International Road Federation (IRF) encourages all companies and organizations in the road development sector to get involved in the awards program it grants, because by promoting innovative ideas a positive and motivating influence can be created. The National Company for Road Infrastructure Administration S.A, Traffic Safety Service participated in the "Find a Way Global Road Safety Award" organized by IRF. In this article, the road safety projects are presented, with their results and the road safety measures implemented by the national roads and highways administrator in Romania, so that other road administrations to be encouraged to implement as many road safety measures as possible.

Keywords: *Road Safety, Pilot Solutions, „Find a Way” IRF Prize.*

Rezumat. Pentru recunoașterea muncii remarcabile în domeniul siguranței rutiere, în special pentru implementarea proiectelor-pilot de siguranță rutieră, C.N.A.I.R.-S.A. a fost desemnată câștigătoare. Proiectele pilot de siguranță rutieră care au atras atenția IRF, fiind un model de urmat pentru toate administrațiile rutiere sunt: Parapetele rutier pe ruloari; Atenuatori de impact; Sector de drum 2+1; Parapete cu cablu; Iluminarea sectoarelor periculoase prin intermediul ansamblurilor luminoase; Proiecte de creștere a siguranței rutiere prin realizarea de pasaje rutiere. Federația Internațională a Drumurilor (FID) încurajează toate companiile și organizațiile din sectorul de dezvoltare rutieră să se implice în programul de premii pe care le acorda, pentru ca prin promovarea ideilor inovatoare se poate crea o influență pozitivă și motivatoare. Compania Națională de Administrare a Infrastructurii Rutiere din România, Serviciul Siguranța Traficului a participat la "Premiul Global pentru Siguranța Rutieră Find a Way" decernat de IRF. În cadrul acestui articol sunt prezentate rezultatele și măsurile de siguranță rutieră implementate de administratorul drumurilor naționale și autostrăzilor din

România, astfel încât și alte administrații rutiere să fie impulsionate să implementeze cât mai multe măsuri de siguranță rutieră.

Cuvinte cheie: *Siguranța Rutieră, Soluții Pilot, Premiul IRF „Find a Way”.*

1. Introduction

The public road network in Romania totalled 86,199 km on 31.12.2021, of which national roads represent 16,599 km and motorways 931 km. National roads, express roads and motorways are owned by the Ministry of Transport and Infrastructure, which manages them through the largest road network administrator in Romania, the National Company for Road Infrastructure Administration.

The National Company for Road Infrastructure Administration S.A. (N.C.R.I.A.-S.A.) is a company of national strategic interest whose mission is to implement programmes to develop the public road network and to maintain and increase road safety on the existing road network under its management.

The following figure shows the road network managed by N.C.R.I.A.-S.A.

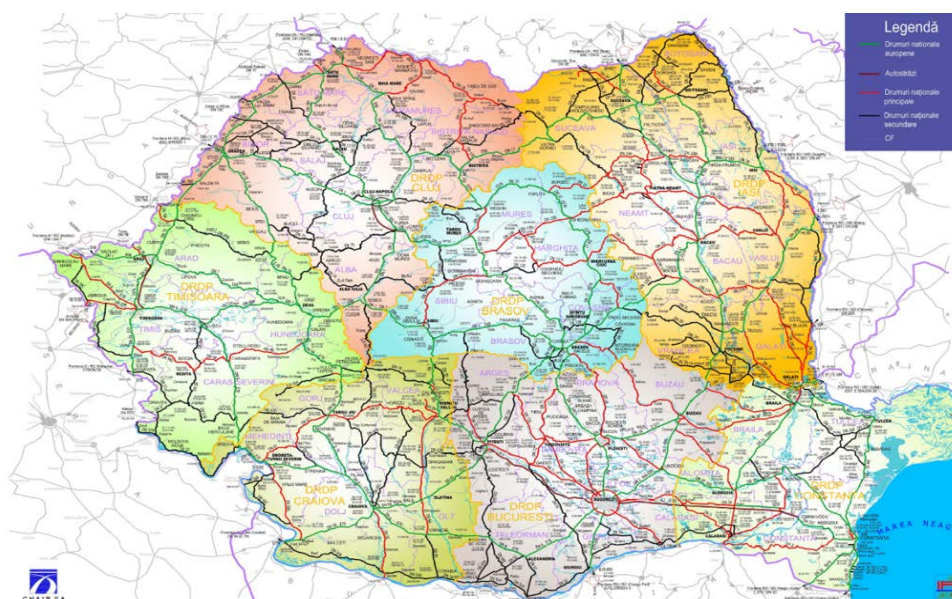


Figure 1. The road network managed by N.C.R.I.A.-S.A. [1].

In view of the commitment reaffirmed in December 2020 by the European Commission on the long-term goal of achieving almost zero road deaths by 2050 - "Vision Zero" and, as an intermediate step, reducing by a further 50% the number of people killed in road accidents and by 50% the number of people seriously injured in the period 2021-2030, Romania joins the European effort and takes over the European target.

Road safety is a priority at both global and European level and the reduction of road fatalities has been set as a target by N.C.R.I.A.-S.A. due to the need to get as close as possible to zero road fatalities by 2050.

N.C.R.I.A.-S.A. is involved in activities to improve traffic safety by promoting traffic safety programmes and projects and implementing technical measures to reduce accidents.

2. Current road safety situation

The European Commission has set an ambitious target of a 50% reduction in the number of road fatalities for the period 2010-2020, which it is maintaining for the next decade, 2020-2030 [2].

In terms of the results achieved, the target was not met, the European average was 37%, from 29,691 to 18,844 people killed, and for Romania, on all public roads there was only a 31% reduction, from 2,377 to 1,646 people killed in road accidents [3].

The road safety measures implemented by N.C.R.I.A.-S.A. have led to positive results on the national road network in terms of reducing the number of fatalities, i.e. a reduction of 43.9%, well above the European average and close to the target set by the Commission.

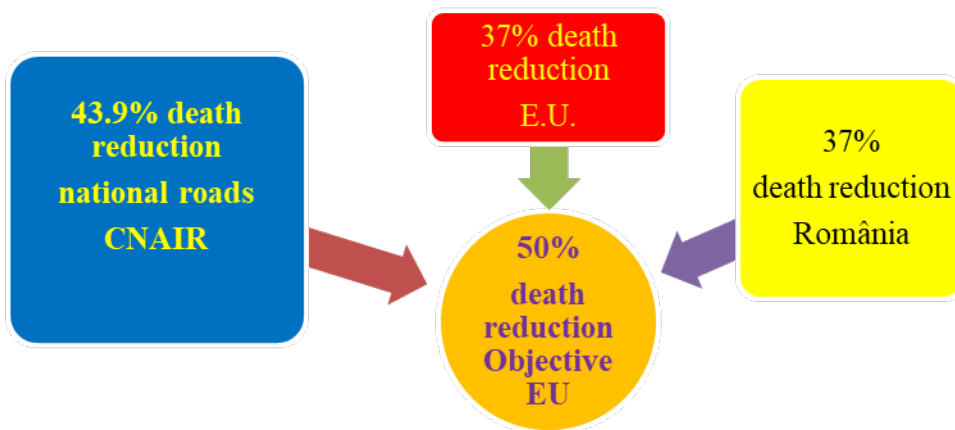


Figure 2. Road safety situation in 2020 compared to 2010 [2].

Even if at national level, the target set by the European Commission of reducing by 50% the number of road fatalities has not been met, when analysing the causes behind the results recorded, it is imperative to take into account the increase in the number of vehicles and licence holders.

Thus, between 2010 and 2020, there was a massive annual increase in the number of vehicles registered in Romania, both in terms of cars and vehicles in general.

At the end of 2020 the car fleet was 68.9% (2,968,445 units) larger than in 2010, and the overall registered vehicle fleet at the end of 2020 was 70.2% (3,803,099 units) larger than in 2010. The evolution of the car fleet in the period 2010-2020 is shown in the following Table 1 [2].

Table 1

Evolution of the car fleet between 2010-2020				
Year	Automobiles	Vehicles	Annual evolution	Evolution since the reference year (2010)
2010	4,306,283	5,419,181		
2011	4,321,584	5,482,746	1.2%	1.2%
2012	4,485,148	5,710,773	4.2%	5.4%
2013	4,695,660	5,985,085	4.8%	10.4%
2014	4,907,564	6,270,582	4.8%	15.7%
2015	5,155,059	6,600,325	5.3%	21.8%
2016	5,472,423	7,010,608	6.2%	29.4%
2017	5,998,194	7,635,775	8.9%	40.9%
2018	6,452,536	8,193,278	7.3%	51.2%
2019	6,902,984	8,708,863	6.3%	60.7%
2020	7,274,728	9,222,280	5.9%	70.2%

The evolution of the car fleet in the period 2010-2020 is shown in the following Figure 3.

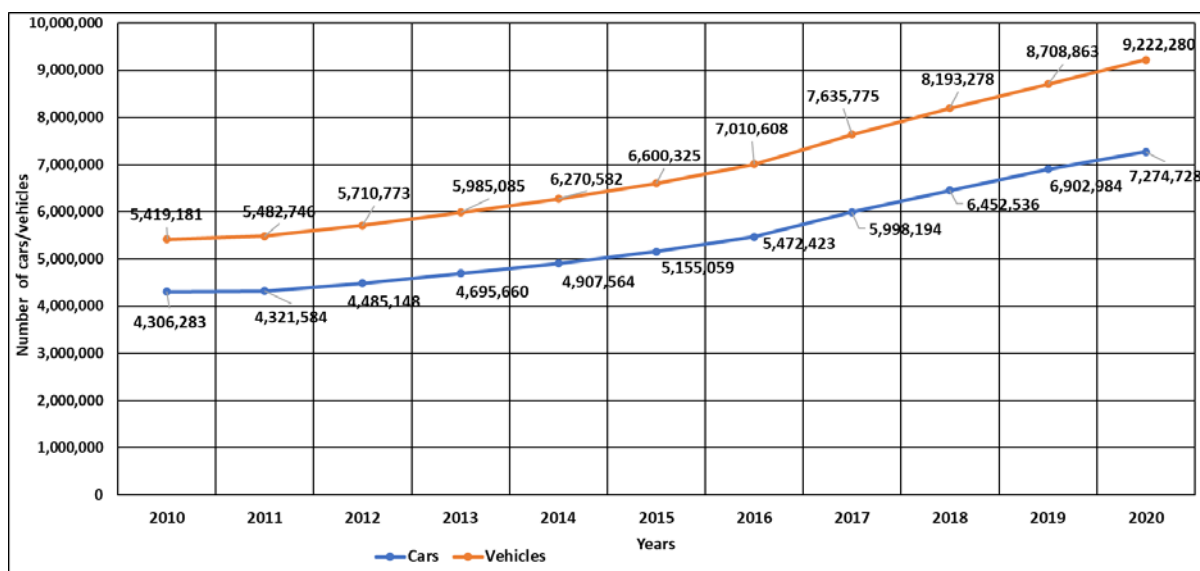


Figure 3. Evolution of the car fleet between 2010-2020 [2].

Thus, between 2010 and 2020 there was a massive annual increase in the number of vehicles registered in Romania, both in terms of passenger cars and vehicles in general.

As regards the number of holders of driving licences, there is a continuous increase from 6,431,415 holders of driving licences in 2011 to 8,065,846 licence holders in 2020, representing an increase of 25.4%, as can be seen in the following Table 2 [2].

Table 2

Evolution of the number of drivers between 2010-2020

Year	No. Permits	Annual evolution	Evolution since the reference year (2011)
2011	6,431,415		
2012	6,806,045	5.8%	5.8%
2013	6,791,626	-0.2%	5.6%
2014	6,967,034	2.6%	8.3%
2015	7,142,478	2.5%	11.1%
2016	7,347,009	2.9%	14.2%
2017	7,554,743	2.8%	17.5%
2018	7,721,323	2.2%	20.1%
2019	7,907,928	2.4%	23.0%
2020	8,065,846	2.0%	25.4%

In order to improve road safety, Romania has taken the necessary legislative measures by adopting Law 265/2008 „Road infrastructure traffic safety management” [3] which is the transposition into national law of Directive 2008/96/EC „Road infrastructure safety management” [4].

Starting from 2016 the National Company for Road Infrastructure Administration contracted:

- around 470 Road Safety Impact Assessments and Road Safety Audits. Road Safety Impact Assessments and Road Safety Audits (for all stages) for all new road infrastructure projects and for the projects that makes substantial changes to existing road network.

- road safety inspections on 2,994 km of roads under its management. Road safety inspections are carried out on deficiencies of existing roads, that can lead to road accidents.

3. Road safety pilot projects

From its role as the largest road administrator, N.C.R.I.A.-S.A. has a moral obligation to implement the latest and most effective solutions so that by the power of example, efficient pilot projects can be transformed into a normality in terms of the chosen technical solutions [5].

Starting from the database of road accidents where analyzes are performed on homogeneous road sectors, the causes that were the basis for the occurrence of road accidents, N.C.R.I.A.-S.A. road safety specialists choose the latest technical solutions on the profile market and implement pilot projects in order to track the behavior of these technical solutions.

After implementation, the pilot projects that prove their benefits and meet the expectations of specialists, become a norm in terms of technical solutions that they will use in the current activity.

Successful road safety pilot projects implemented by N.C.R.I.A.-S.A.:

- *Roller barriers (guardrails on rollers).*
- *Impact attenuators.*
- *Road sector 2+1.*
- *Cable barriers.*
- *Illumination of dangerous sectors by means of light assemblies.*
- *Projects to increase road safety by building road overpasses.*

3.1. Roller barriers

In 2019, the pilot project to increase road safety by placing rollers barriers was implemented, which consisted of installing 1,000 m of guardrails on 5 sectors where accidents were frequent. The sectors where these barriers were installed are shown in the Table 3.

Table 3

Implementation of the roller guardrail pilot project			
National Road (number)	Installed sector (km+m – km+m)	Placement (right/left/axial)	Quantity (m)
7	14+700 - 14+920	Right edge	220
7	14+750 - 14+920	Left edge	170
7	18+700 - 18+820	Left edge	120
2	51+670 - 51+900	Left edge	230
2	51+690 - 51+950	Right edge	260
TOTAL			1,000

Due to the positive results obtained, namely a reduction in the number of serious accidents and the need to stop intervening on the barrier sectors, the use of this barrier has been extended and the pilot project has become normal practice, as can be seen in the Figure 4.

As it can be seen in the Figure 5, serious accidents have turned into minor accidents, with an increase in the number of minor accidents.



Figure 4. Sections of guardrails on rollers on national roads.

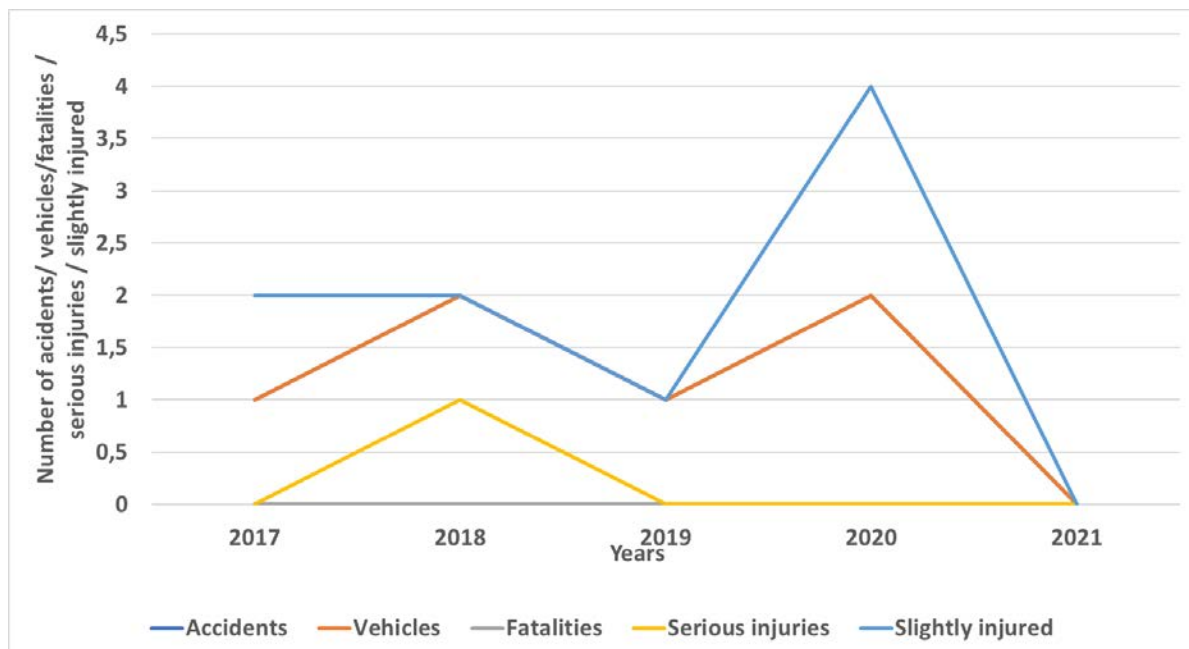


Figure 5. Results of a sector with roller barrier.

A major advantage of this type of guardrail is that, on the sectors where it has been installed, the road accidents that have subsequently occurred have been transformed from major to minor and the guardrail has not suffered degradation requiring replacement, thus increasing the efficiency of the road administrator's activity of increasing road safety and ensuring a climate of safety for drivers, due to the fact that this protection system fulfils its role repeatedly and consecutively.



Figure 6. Roller guardrails that took over the road event.

In the following figure, it can be seen that the crash barrier has taken up loads from accidents that have occurred but have not affected the structure of this protection system.

Thus, in 2021 and 2022, the campaign of installing roller barriers was continued, being installed on other sectors as follows, Tables 4 and 5.

Table 4

Sectors with roller barriers installed in 2021			
National Road (number)	Installed sector (km+m – km+m)	Placement (right/left/axial)	Quantity (m)
71	21+200	Left marginal	70
72	5+676- 5+900	Right marginal	224
72	5+400 - 5+544	Left marginal	144
2	48+400 - 49+022	Axial	622
1	31+500 - 31+600	Right marginal	100
1	31+450 - 31+600	Left marginal	150
6	32+242 - 32+392	Right marginal	150
6	32+112 - 32+188	Left marginal	70
6	32+088 - 32+188	Right marginal	100
1	205+800 - 205+950	Left marginal	150
1	206+050 - 206+200	Left marginal	150
1A	171+450 - 171+550	Left marginal	150
TOTAL			2,080

Table 5

Sectors with roller barriers installed in 2022			
National Road (number)	Installed sector (km+m – km+m)	Placement (right/left/axial)	Quantity (m)
1	147+080 - 147+200	Right marginal	120
1	146+820 - 146+870	Right marginal	50
1	145+250 - 145+470	Right marginal	220
1	144+500 - 144+550	Right marginal	50
VOBV	2+440 - 2+600	Right marginal	160
28	33+620 - 34+287	Axial	630
22	255+000 - 255+200	Right marginal	200
22	256+450 - 256+650	Right marginal	200
2	262+000 - 262+500	Axial	500
2	254+800 - 255+300	Axial	500
TOTAL			2,630

Note: VOBV- Braşov Bypass Variant.

The sectors installed in 2021 and 2022 are under observation in order to follow the results to be obtained.

3.2. Impact attenuators

In order to achieve „friendly roads” that will lead to a reduction in the severity of road accidents resulting in leaving the road surface for various reasons, during the period (2017-2020) N.C.R.I.A.-S.A. has installed a number of approximately 150 impact attenuators.

Impact attenuators are installed on road sections with a high risk of frontal vehicle collisions. The purpose is to protect vehicle passengers when they leave the road and collide with a rigid object outside the carriageway.

Attenuators are designed to gradually absorb the kinetic energy of the vehicle at the moment of collision, thereby bringing the vehicle to a controlled stop, which may result in avoiding collision with the obstacle, while maintaining a limited amount of deceleration on the vehicle occupants.

The performance evaluation of impact attenuators is carried out according to the European standard EN 1317-3 based on various speed limits and impact angles.

The following figure (Figure 7) shows a damaged crash attenuator which has fulfilled its purpose and resulted in a serious accident being transformed into a minor one, resulting only in material damage to the car involved.



Figure 7. Degraded impact attenuator.

3.3. Road sector 2+1

In 2019, was implemented a pilot project, transforming a sector with 2 lanes and 2 big shoulders in 2 + 1 solution (traffic lanes) on the sector is between km 30 + 605 (Sinești) - 40 + 240 (Movilița) with a length of 9.6 km.

Before the implementation of this system, in the previous 5 years, there were 43 serious road accidents resulting in 14 deaths and 70 injuries. From implementation, only 2 serious accident occurred.

The following figure (Figure 8) shows the 2+1 sector.



Figure 8. Sector on DN 2 in 2+1 traffic system.

3.4. Cable parapet

In the Figure 9 we can see the implementation of the pilot cable barrier project, mounted within the range of Afumati village, between km 12+500 and km 14+500, is a road sector of DN 2 with 4 lanes, each the traffic lane having of 3.5 meters width and a speed limit of 50 km/h, due to the location of the sector, inside the locality [6].



Figure 9. Sector on DN 2 with the cable parapet pilot project.

No deaths have been reported since implementation:

- **Before: 3 or 4 serious accidents (every year).**
- **After: 0 serious accidents (in 3 years).**

On the most beautiful road in the world, namely Transfagarasan, from the Figure 10, it was decided to install cable road barriers.



Figure 10. Transfagarasan road.

This decision was taken, to ensure a level of road safety during the summer, when traffic is allowed and in winter when traffic is closed, the railing allows it to be placed on the ground so as not to suffer damage due to avalanches.

3.5. Illumination of hazardous areas by lighting assemblies

To increase the visibility of dangerous points on the road network, light assemblies consisting of 5 light poles powered by photovoltaic panels were used to provide increased visibility at night.

In the last 2 years, about 700 light sets have been installed to illuminate traffic lights, entrance/exit islands and pedestrian crossings, examples in Figure 11.



Figure 11. Lighting assemblies mounted on hazardous sectors.

3.6. Projects to increase road safety through the construction of road overpasses

In order to reduce the number of road events and at the same time to ensure the traffic flow on the busiest national road sector in Romania, which connects the South and the North, the capital (Bucharest) and a very large city Brasov, as well as the connection with the mountain resorts of the Prahova Valley, N.C.R.I.A.-S.A. has also started road safety projects that will also have European funding, namely the Large Infrastructure Operational Programme, as follows:

Road overpasses – 4 buc – amounting to 225,606,567.06 lei without VAT.

Elaboration of feasibility study and technical execution project for:

- Construction of a road overpass at the intersection of DN 1 and Republicii Boulevard (Sinaia South).
- Construction of a road overpass at the intersection of DN 1 and Ferdinand Boulevard (Sinaia Nord).
- Construction of a road overpass at the intersection DN 1 with Prahovei street (Azuga).
- Construction of a road overpass at the intersection DN 1 with DN 73A (Predeal).

The road overpasses are shown in Figure 12.



Figure 12. Road overpass.

Underground pedestrian passages – 5 buc amounting to 32,646,020.74 lei without VAT

Elaboration of feasibility study and technical execution project for:

- Construction of the pedestrian underpass in the Central Square of Comarnic - intersection DN 1 with Ghiosesti street.
- Construction of pedestrian underpass at Comarnic Town Hall.
- Construction of pedestrian underpass - intersection DN 1 with Urlatoarei, Gloriei and Nicolae Balcescu streets (Poiana Tapului).
- Construction of pedestrian underpass - intersection DN 1 with Telecabinei street (Busteni).
- Construction of pedestrian underpass - intersection DN 1 with Panduri street (Predeal).

The pedestrian underpasses are shown in Figure 13.

As far as the expected benefits are concerned, the feasibility study has shown in the Table 6.



Figure 13. Pedestrian underpass.

Table 6

Benefits from road overpasses [7-10]				
Benefits	Overpass Sinaia S	Overpass Sinaia N	Overpass Azuga	Overpass Predeal
Improving the average speed of traffic, %	81	90	27.9	79 %
Reducing the average delay of a vehicle, s	47.37	55.89	20.00	48.62
Decrease maximum queue length, m	504	442	150	560
Reduce traffic flow density, %	43	43	42	54
Reducing the total duration of road journeys, hours	441	394	102	351

In the Comarnic area, where 2 pedestrian crossings will be built, the following benefits is expected, shown in the Table 7.

Table 7

Benefits from pedestrian underpasses [11,12]		
Pedestrian underpass	Expected benefits	
	Improving average road speeds, %	reduction of average delay per vehicle, s/vehicle
Underground pedestrian passage Central Market Comarnic - intersection DN 1 with Ghiosești street	2	3.57
Construction of pedestrian underpass Comarnic Town Hall	5	3.78

4. Discussion

The IRF encourages all companies and organisations in the road development sector to get involved in its awards programme, as promoting innovative ideas can create a positive and motivating influence. The spread area of the IRF affiliated states is shown in the Figure 14.

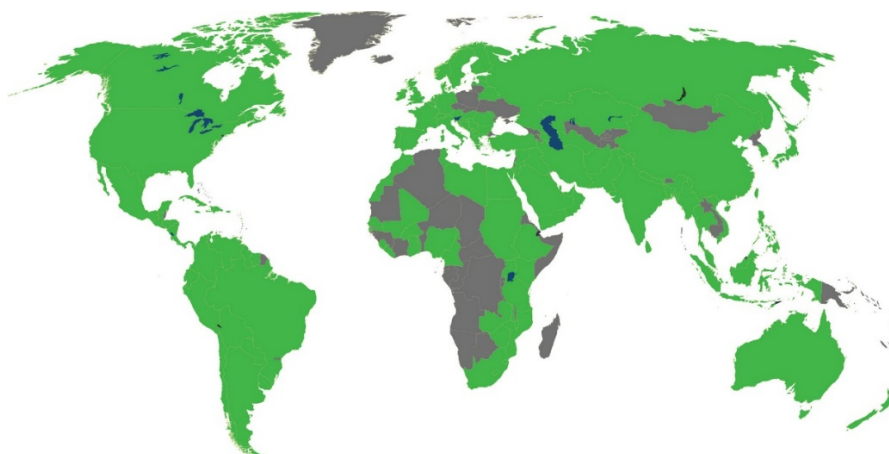


Figure 14. International Road Federation members (with green) [13].

In 2012, recognizing the value of political leadership to drive road safety strategies, His Excellency Abdullah Al-Mogbel, President of the International Road Federation (IRF), established an annual IRF Global "Find a Way" Road Safety Award, which recognizes outstanding commitment to safer roads by national, regional or city governments. Starting in

2021, this award is given to one agency per IRF region. At the recommendation of IRF representatives who were aware of the projects carried out in the field of road safety by N.C.R.I.A.-S.A., the Traffic Safety Service participated in the "Global Road Safety Award Find a Way" organized by the IRF, in recognition of our company's outstanding work in the field of road safety, especially for the implementation of road safety pilot projects, for which it was named winner.

The Figure 15 shows the award information letter, the IRF "Find a Way" award plaque and a picture of the award ceremony.



Figure 15. IRF "Find a Way" award, N.C.R.I.A.-S.A. winner of 2022.

5. Conclusions

The results obtained from the implementation of road safety pilot projects were presented for each solution and the conclusion was that those projects with positive results were transformed into a common practice.

Road safety pilot projects that can serve as a model for all road administrations are:

- Roller Barriers.
- Impact attenuators.
- Road sector 2+1.
- Cable Road barriers.
- Illumination of dangerous sectors with light assemblies.
- Projects to increase road safety by creating elevated road crossings.

From N.C.R.I.A.'s point of view, as the largest administrator, the road safety projects that have been implemented since 2019 have led to a 43.9% reduction in the number of road fatalities, (on its network) leading to positive results on the national road network, close to the target imposed by the Commission, even though Romania is at the bottom of the European ranking when we refer to the entire public road network.

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