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SAFETY ASSESSMENT OF COUNTY ROAD INFRASTRUCTURE IN ROMANIA – CASE STUDY: DJ 608

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Abstract: *The assessment of road infrastructure safety for the roads in the TEN-T network is essential according to EU Directive 2019/1936. The main purpose is to maximize the efficiency of investments in road safety, with priority given to sections with low safety levels. The European Commission has provided methodology and evaluation tools for primary roads and highways. However, for county roads, adaptation is crucial. The aim of our research is to develop a proactive Excel tool dedicated to assessing the safety of county roads, adjusting parameters according to Romanian standards. This adaptation ensures the proper application of the evaluation methodology for county roads, in line with European requirements and Romanian regulations, thus contributing to improving road safety on these roads.*
Key words: *road infrastructure safety, county roads, Excel tool for proactive evaluation.*

1. INTRODUCTION

Road infrastructure is a vital component of any country, with a significant impact on road safety and sustainable mobility of the population. Directive (EU) 2019/1936 [1] on road infrastructure safety management amending Directive 2008/96/EC [2], shows that some Member States have had a greater positive impact on road safety. This improvement in road safety is due to the extension of road infrastructure safety management (RISM) procedures to other categories of roads.

The data of the "European Road Safety Observatory", taken over in the "National Road Safety Strategy – 2022-2030", show that Romania registers one of the highest rates of road deaths among Member States [3].

By Romanian Government Ordinance no. 3/2022 [4] which amends Law no. 265/2008 [5] the provisions of Directive (EU) 2019/1936 are implemented so that county roads are included in the regulatory scope for the application of RISM procedures.

County roads are covered by the road infrastructure safety assessment procedure, followed by specific road safety inspections carried out by the Romanian Road Authority – ARR. The analysis of the database of serious accidents registered by the traffic police (2017-2022) shows that the county road network is responsible for producing about 20% of road deaths in Romania [6]. By comparison, on the network of national roads and motorways are registered approx. 51% deaths.

In 2022, the European Commission made available to Member States the "Integrated Methodology for Road Network Infrastructure Safety Assessment", while also providing working tools, Excel files for proactive assessment and reactive assessment of road infrastructure safety [7]. By combining the results obtained from the application of proactive assessment and reactive assessment, a classification of the road network into 5 risk classes is obtained. The sections classified with the highest road risk shall be subject to specific road safety inspection.

The Romanian Road Authority – ARR has completed the safety assessment of the national network of motorways and national roads. The next stage is the evaluation of the county road network. According to data taken from the website of the National Institute of Statistics –

INS, it has a length of 35,132 km. By comparison, the length of the national road network is 17,582 km and the length of motorways is 949 km [8].

Due to the specific characteristics of county roads, the number and causes of serious accidents reported to road authorities, the volume of traffic and the peculiarities of road traffic, we need to adjust the proactive Excel tool used to assess road safety on national roads and highways so that it is also applicable to county roads.

The main goal of this research is to develop a specialized proactive Excel tool for assessing the built-in safety of county road infrastructure.

The central objectives of this research project include analysis of each parameter present in the Excel tool according to predetermined criteria, adaptation of parameter calculation values and formulas to match the specific design and construction requirements of county roads, motivation of decisions made in the process of adjusting each parameter of the Excel tool.

The result of this research is a fully functional Excel file that can be used to effectively assess safety on county roads in Romania.

2. METHODS AND RESULTS

The Excel assessment tool, used so far for the assessment of the safety embedded in the motorway and national road (DN) network by the Romanian Road Authority – ARR, contains two distinct sections. The first section comprises 7 specific parameters for the assessment of motorways and the second section comprises 9 specific parameters for the assessment of national roads (DN). To assess the proactive safety of county road (DJ) infrastructure, it is necessary to modify some parameters and values used in the formulas for calculating the section that is used to evaluate national roads (DN). The change is made according to the answers that the research provides to the following questions:

- What is the relevance of each parameter for the evaluation of DJ?
- What are the ways in which the parameter changes will best respond to the assessment needs of DJ?
- Are the reference and calculation values in the formulas of each parameter in accordance with the provisions of the design and construction norms of DJ?
- Are the parameter changes consistent with the results of statistical analysis of serious accident data on DJ?
- What are the changes in CMF values - change factor at accident?

Based on these questions, the study presents the results of research to adapt each parameter.

2.1 (LW) Parameter 1- average lane width

The analysis of the distribution of serious accidents on DJ between 2017 and 2022, presented in Fig. *1*, shows that about 63% of accidents occur on roads that have a lane width between 2.75 m and 3.25 m.

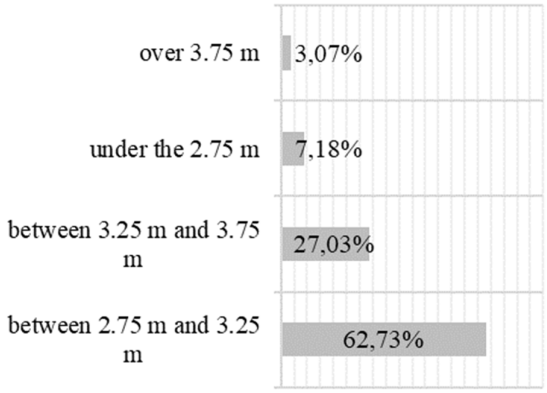


Fig. 1. Distribution of accidents on county roads according to lane width.

To change the parameter, the bandwidth values are replaced in the calculation formulas in accordance with the design norm of DJ in Romania [9]. Table 1 shows the initial values of the Excel tool for lane width and adapted values for different technical classes of DJ.

Table 1

Adapted lane width values - DJ.

Technical class	Values Initial (m)	Values Adapted (m)
III	LW ≥ 3.40	LW≥3.50
IV	3.40 > LW ≥ 3.15	3.50 >LW≥3.00
V	3.15 > LW > 2.70	3.00 >LW≥2.75

The CMF values in the calculation formulas are not changed because the differences between

the initial values and the present values are insignificant [10].

2.2 (RS) Parameter 2- roadside hazard level

This parameter is also applicable to county roads. No calculation values have been changed.

2.3 (CU) Parameter 3 – Road risks arising from the shortest-radius horizontal curve

Considering the design speeds for different technical classes of DJ and depending on the recommended radii of horizontal curves, p.4 [11], the value of the recommended radius is chosen, 500 m. This is the reference threshold value from which the lowest value is chosen among the radii of the horizontal curves of the road segment under assessment. A determining element in calculating the estimated road risk is the value of the speed recorded for each road segment assessed.

In the case of DJ, significant differences are found between the design speeds [9] and the maximum legal speed equal to the value of the design speed corresponding to the technical class of the DJ and is chosen depending on the relief form crossed by the road.

2.4 (PA)Parameter 4- density of access points

Road traffic on DJ involves crossing a larger number of rural localities and intersects more access roads to agricultural areas, compared to the network DN.

The analysis of serious accidents between 2017 and 2022 and the impact of the parameter (PA) on the risk calculation shows the following:

-on DN, the influence of the parameter (PA) on the road risk score per segment is no more than 50%, and this influence remains constant even when the density of access points exceeds 15 accesses/ km,

-percentage analysis of the distribution of accidents that occurred at intersections or access points shows that DJs have 2.4 times fewer accidents compared to DN [6],

-the total length of the DJ road network is approximately twice that of the DN network,

-compared to the total length of the national road networks DJ and DN, the rate of serious accidents recorded at intersections/accesses on DJ is approximately 4.7 times lower than on DN,

-most intersections/accesses on DJs have an hourly traffic below 100 vehicles/h and the evaluating operator records them in the Excel file as access points [12].

In view of the data submitted, the reference values used to calculate road risk due to the density of access points are amended so that the impact of the parameter (PA) is reduced by 50%.

2.5 (JU) Parameter 5- intersections

No changes are made to the values and calculation formulas of the parameter. To make it easier to choose types of intersections, the drop-down list of intersections is reorganized, rarer types of intersections, in the case of DJs, have been moved to the end of the list.

2.6 (PB) Parameter 6- pedestrian/ cyclist conflicts and motorized traffic

The influence of the parameter has a significant impact on the road risk score in the assessed segment, especially when the road infrastructure is not equipped with facilities for pedestrians and cyclists. The Commission's Excel tool for assessing proactive safety does not include pedestrian and cyclist flow values in the calculation formulae. This data is not available in Romania nor in most Member States. To assess road safety against the parameter (PB), the presence of pedestrians and cyclists on the assessed road segment shall be analyzed. When the presence of pedestrians and cyclists on the assessed segment is found, the types of facilities identified for cyclists as well as pedestrians along the road and in the crossing are chosen from the Excel file.

The necessary changes to adapt the drop-down lists according to the type of existing facilities on the DJ and the design and construction norms, [9], [11], are as follows:

a)-from the list of facilities for cyclists to travel along the road, replace the headings "dedicated cycle paths on the carriageway" and "width of the reinforced roadway (> 1 m)" with a new position – "dedicated cycle paths on the carriageway/reinforced verge (> 0.5 m)", (CMF=17),

b)-to the list of facilities for pedestrian movement along the road is added a new position, "possible movement near the

carriageway" - if pedestrians can move on the unconsolidated verge, (CMF = 12),
c)-from the list of pedestrian facilities for crossing the road are deleted the headings "no. pedestrian crossings separated from the road", "no. unsigned, marked, level pedestrian crossings with and without refuge".

The normative act regulating road traffic on public roads explicitly establishes in Article 72 that the signaling of pedestrian crossing facilities is cumulatively carried out, both by vertical and horizontal signaling [13].

Analysis of the accident database on DJs, in terms of their causes, shows that there are four main causes that are responsible for approx. 53% of serious accidents [6]. In Fig. 2 shows the percentage distribution of accidents by the most important causes:

1 - "speed not adapted to road conditions",
2 - "cyclist misconduct",
3 - "irregular pedestrian crossing",
4 - "pedestrians on the carriageway" and
5 - 34 other main cases.

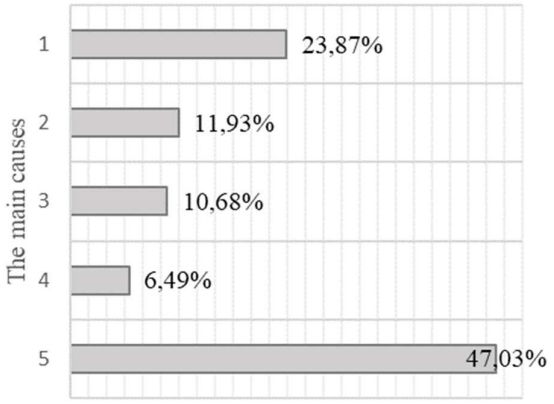


Fig. 2. The main causes of serious accidents.

The result of the analysis of serious accidents recorded on DJs from the point of view of the road environment (urban/ extra-urban) in which they occur is shown in Fig. ***3***. More than twice as many serious accidents occur in urban areas compared to extra-urban road environments [6].

Statistical analysis of the serious accident database on DJ illustrated in Fig. ***4***, shows which root causes, both in urban and interurban road environments. In urban areas, "irregular pedestrian crossing" (12.4%), "failure to give priority to pedestrians" (9.58%), "speed not adapted to road conditions" (9.57%) and "cyclist deviations" (8.8%) are the causes responsible for producing approx. 40% of the total number of serious accidents on DJs.

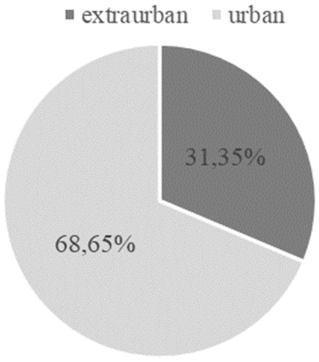
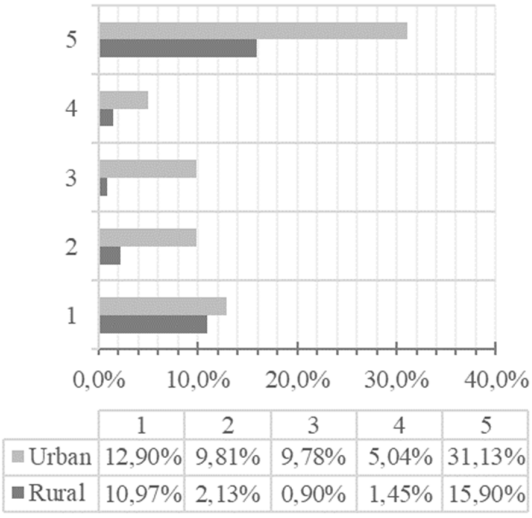


Fig. 3. Cast of serious accidents on DJs.



	1	2	3	4	5
Urban	12,90%	9,81%	9,78%	5,04%	31,13%
Rural	10,97%	2,13%	0,90%	1,45%	15,90%

Fig. 4. Distribution of serious accidents by cause.

2.7 (SW) Parameter 7- Type and width of shoulders.

The safety assessment of the roadsides is adapted to the configuration and specific values of the DJ [9]. The average widths for each type of shoulder (paved and unpaved) and for each side of the road are recorded. Table 2 presents the values of the widths of the moorings by type according to the technical design and construction classes of the DJ [9].

Table 2

Shoulders widths by type.

Technical class	Paved shoulder width	Unpaved shoulder width
III	0.5 m	0.5 m
IV; V	0.25 m	0.75 m

2.8 Parameter 8 — Passing lanes.

The parameter is removed from the Excel file for proactive assessment of DJ infrastructure safety. The design norm, paragraph no. 2.9, [9], states that one of the conditions for the construction of the passage lane on certain segments of public roads is the preponderant circulation of heavy vehicles (over 20% of the AADT value of the road). For DJs, 2022 road traffic census data shows that the average AADT value for heavy vehicles is 17.8% [14].

2.9 (SM) Parameter 9 - Signs and markings

In terms of horizontal signaling [15] and vertical signaling [16], national norms for road design and construction differ. To achieve a more detailed assessment of road safety, the Excel file is modified by replacing parameter (SM) with two parameters. One is intended only for assessing the safety of vertical signaling infrastructure (Parameter 9) and the second for horizontal signaling (Parameter 10).

3. PROACTIVE ASSESSMENT OF INFRASTRUCTURE SAFETY - DJ 608

The proactive Excel tool was tested on DJ 608 for road safety assessment. This road covers various types of terrain, including lowlands, hills, and mountainous areas, for 66 km. The assessment was carried out using both the standard tool provided by the European Commission and the adapted DJ tool.

It was observed that when using the standard assessment tool for national roads, the average risk score indicates approximately 2.2 times lower road safety compared to the adapted version of the tool. It was also found that the average risk score is influenced by the variation in results of four of the instrument's assessment parameters, as follows: parameter 3 (curve radius), parameter 4 (density of access points) and the two parameters for assessing risks related to county road signaling and marking.

4. CONCLUSION

Road infrastructure has a significant impact on safety and mobility. The amendments made to national legislation according to EU Directive 2019/1936 extend the application of safety procedures to county roads (DJs). The central aim of the research is to develop a specialized Excel tool for assessing the safety of DJ infrastructure, adjusting parameters to the specific requirements of these roads. In Romania, DJs contributed significantly to serious accidents, accounting for about 20% of road deaths, while the national network and motorways had about 51%. The European Commission has provided the methodology and tools for assessing major roads, and the DJ assessment is the next step. These changes ensure an efficient and DJ-specific assessment, helping to reduce road risk.

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5. REFERENCES

[1] European Parliament, Council of the European Union, “Directive (EU) 2019/1936 amending Directive 2008/96/EC on road infrastructure safety management,” 26 November 2019. [Online]. Available: http://data.europa.eu/eli/dir/2019/1936/oj. [Accessed 10 July 2022].

[2] European Parliament, Council of the European Union, “Directive 2008/96/EC, on road infrastructure safety management,” 29 November 2008. [Online]. Available: http://data.europa.eu/eli/dir/2008/96/oj. [Accessed 23 August 2022].

[3] The Government of Romania, “Annex to Government Decision no. 682/2022 for the approval of the National Road Safety Strategy for the period 2022-2030,” The Official Monitor of Romania, vol. I, no. 535 bis, pp. 3-74, May 31, 2022.

[4] The Government of Romania, “Ordinance no. 3/2022 for the amendment and completion of Law no. 265/2008 regarding the management of traffic safety on the road infrastructure,” The Official Monitor of Romania, vol. I, no. 91, pp. 1-8, January 28, 2022.

[5] The Romanian Parliament, „Law no. 265/2008, republished and updated with subsequent amendments, regarding the management of traffic safety on the road infrastructure,” The Official Monitor of

Romania, vol. I, nr. 608, pp. 6-18, 07 August 23, 2012.
[6] Romanian Police, “Graphs of the main statistical indicators regarding police activity - Statistics Archive,” 2022. [Online]. Available: https://www.politiaromana.ro/ro/utile/statistici-evaluari/statistici. [Accessed 07 July 2023].
[7] The European Commission Mobility & Transport - Road Safety_, “Road infrastructure guidelines,” 13 01 2023. [Online]. Available: https://road-safety.transport.ec.europa.eu/eu-road-safety-policy/priorities/infrastructure/road-infrastructure-guidelines_en. [Accessed 29 06 29].
[8] National Institute of Statistics - INS, Romania, “TEMPO ONLINE - Road transport,” 2023. [Online]. Available: http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table. [Accessed 10 August 2023].
[9] Ministry of Transport from Romania, “Order no. 1296 as of August 30, 2017, for the approval of the Technical Norms regarding the design, construction, and modernization of roads,” The Official Monitor of Romania no. 746, pp. 2-15, 18 09 2017.
[10] Federal Highway Administration. United States, "Crash Modification Factors in Practice: Using CMS to Quantify the Safety in the Value Engineering Process," WASHINGTON, DC 20590, 2013.
[11] A.S.R.O. - Standards, "STAS 863-85, Road works. Geometrical elements of the routes. Design prescriptions.," Bucharest.
[12] National Highways and National Roads Company - C.N.A.D.N.R., "AND 600," 11 November 2010. [Online]. Available: http://www.cnadnr.ro/ro/comunicare/publicatii/proiectare. [Accessed 10 January 2024].
[13] The Government of Romania, „Emergency ordinance no. 195/2002, republished, with subsequent changes and additions, regarding traffic on public roads,” The Official Monitor of Romania, vol. I, nr. 670, pp. 1-80, August 3, 2006.
[14] C.E.S.T.R.I.N.- Center for Technical Road and Computer Studies, „Transparency, census 2023,” 2022. [Interactive]. Available: https://cestrin.ro/. [Accessed 30 Jun 2023].
[15] A.S.R.O. - Standards, “SR 1848-7 Road signalization. Road marking,” ASRO, www.asro.ro, Bucharest, 2015.
[16] A.S.R.O. - Standards, "SR 1848-1 - Road signs. Indicators and means of road signaling. Part 1: Classification, symbols, and location," Romanian Standardization Association (A.S.R.O.), Bucharest, 2011.

EVALUAREA SIGURANȚEI INFRASTRUCTURII DRUMURILOR JUDEȚENE DIN ROMANIA – DJ 608

Rezumat: Evaluarea siguranței infrastructurii rutiere pentru drumurile din rețeaua TEN-T este esențială conform Directivei UE 2019/1936. Scopul principal este de a maximiza eficacitatea investițiilor în siguranța rutieră, prioritatea fiind acordată tronsoanelor cu niveluri scăzute de siguranță. Comisia Europeană a furnizat metodologie și instrumente de evaluare pentru drumurile primare și autostrăzi. Cu toate acestea, pentru drumurile județene, adaptarea este crucială. Scopul cercetării noastre este să dezvoltăm un instrument Excel proactiv dedicat evaluării siguranței drumurilor județene, ajustând parametrii conform standardelor românești. Această adaptare asigură aplicarea corespunzătoare a metodologiei de evaluare pentru drumurile județene, în concordanță cu cerințele europene și cu normativele românești, contribuind astfel la îmbunătățirea siguranței rutiere pe aceste drumuri.

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