TRB 103rd
ANNUAL MEETING
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Lectern Session 2126:
Analysis of International Road Safety Data
January 8, 2024

Network-wide Road Safety Assessment: Methodology of the European Union

Eva Michelaraki, NTUA

Together with:
Anastasios Dragomanovits, Antonino Tripodi,
Marko Sevrovic, George Yannis

The NetSafety Project

- Study on a Methodology for Network-wide Road Safety Assessment (NWA)

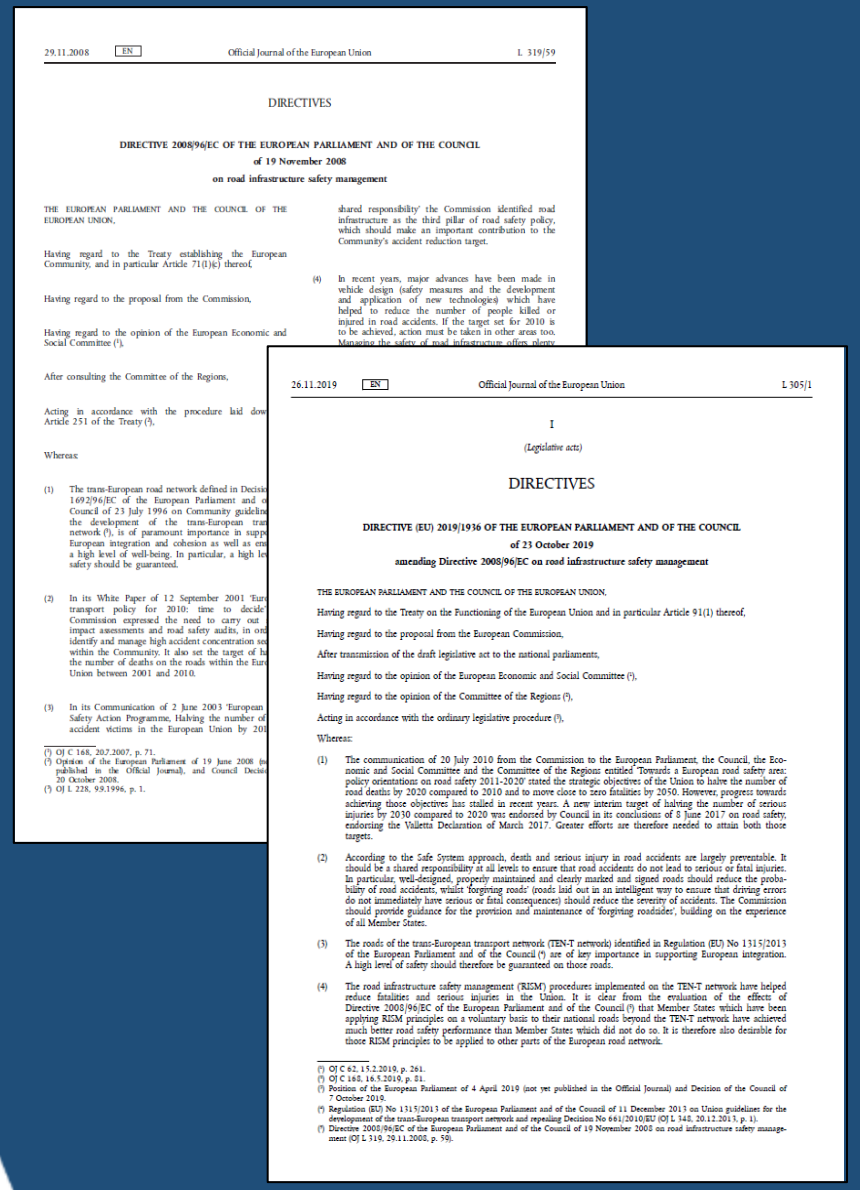
- Partners
  - National Technical University of Athens (NTUA), Greece
  - University of Zagreb Faculty of Transport and Traffic Sciences (FPZ), Croatia
  - FRED Engineering s.r.l. (FRED), Italy

- Duration
  36 months (September 2020 – September 2023)

- For the European Commission - Directorate General for Mobility and Transport

Background

- EU Directive 2019/1936/EC revised the procedures of EU DIR 2008/96 on Road Infrastructure Safety Management (RISM) and extended the scope.
- The revised directive introduces the procedure of the NetSafety, based on:
  - primarily, a visual examination, either on site or by electronic means, of the design characteristics of the road (in-built safety);
  - an analysis of sections of the road network which have been in operation for more than three years and upon which many serious crashes in proportion to the traffic flow have occurred.



29.11.2008 EN Official Journal of the European Union L 319/59

DIRECTIVES

DIRECTIVE 2008/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 19 November 2008
on road infrastructure safety management

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 71(1)(c) thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Economic and Social Committee (1),

After consulting the Committee of the Regions,

Acting in accordance with the procedure laid dow Article 251 of the Treaty (2),

Whereas:

(1) The trans-European road network defined in Decisi 1692/96/EC of the European Parliament and o Council of 23 July 1996 on Community guidelin the development of the trans-European tran network (3), is of paramount importance in supp European integration and cohesion as well as en a high level of well-being. In particular, a high le safety should be guaranteed.

(2) In its White Paper of 12 September 2001 'Eur transport policy for 2010: time to decide' Commission expressed the need to carry out impact assessments and road safety audits, in ord identify and manage high accident concentration se within the Community. It also set the target of h the number of deaths on the roads within the Eur Union between 2001 and 2010.

(3) In its Communication of 2 June 2003 'European Safety Action Programme. Halving the number of accident victims in the European Union by 201

(1) OJ C 168, 20.7.2007, p. 71.
(2) Opinion of the European Parliament of 19 June 2008 (n published in the Official Journal), and Council Decisi 20 October 2008.
(3) OJ L 228, 9.8.1996, p. 1.

shared responsibility' the Commission identified road infrastructure as the third pillar of road safety policy, which should make an important contribution to the Community's accident reduction target.

(4) In recent years, major advances have been made in vehicle design (safety measures and the development and application of new technologies) which have helped to reduce the number of people killed or injured in road accidents. If the target set for 2010 is to be achieved, action must be taken in other areas too. Managing the safety of road infrastructure offers plenty

26.11.2019 EN Official Journal of the European Union L 305/1

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(Legislative acts)

DIRECTIVES

DIRECTIVE (EU) 2019/1936 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 23 October 2019
amending Directive 2008/96/EC on road infrastructure safety management

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union and in particular Article 91(1) thereof,

Having regard to the proposal from the European Commission,

After transmission of the draft legislative act to the national parliaments,

Having regard to the opinion of the European Economic and Social Committee (1),

Having regard to the opinion of the Committee of the Regions (2),

Acting in accordance with the ordinary legislative procedure (3),

Whereas:

(1) The communication of 20 July 2010 from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions entitled 'Towards a European road safety area: policy orientations on road safety 2011-2020' stated the strategic objectives of the Union to halve the number of road deaths by 2020 compared to 2010 and to move close to zero fatalities by 2050. However, progress towards achieving those objectives has stalled in recent years. A new interim target of halving the number of serious injuries by 2030 compared to 2020 was endorsed by Council in its conclusions of 8 June 2017 on road safety, endorsing the Valletta Declaration of March 2017. Greater efforts are therefore needed to attain both those targets.

(2) According to the Safe System approach, death and serious injury in road accidents are largely preventable. It should be a shared responsibility at all levels to ensure that road accidents do not lead to serious or fatal injuries. In particular, well-designed, properly maintained and clearly marked and signed roads should reduce the probability of road accidents, whilst 'forgiving roads' (roads laid out in an intelligent way to ensure that driving errors do not immediately have serious or fatal consequences) should reduce the severity of accidents. The Commission should provide guidance for the provision and maintenance of 'forgiving roadsides', building on the experience of all Member States.

(3) The roads of the trans-European transport network (TEN-T network) identified in Regulation (EU) No 1315/2013 of the European Parliament and of the Council (4) are of key importance in supporting European integration. A high level of safety should therefore be guaranteed on those roads.

(4) The road infrastructure safety management ('RISM') procedures implemented on the TEN-T network have helped reduce fatalities and serious injuries in the Union. It is clear from the evaluation of the effects of Directive 2008/96/EC of the European Parliament and of the Council (5) that Member States which have been applying RISM principles on a voluntary basis to their national roads beyond the TEN-T network have achieved much better road safety performance than Member States which did not do so. It is therefore also desirable for those RISM principles to be applied to other parts of the European road network.

(1) OJ C 62, 15.2.2019, p. 261.
(2) OJ C 168, 16.5.2019, p. 51.
(3) Position of the European Parliament of 4 April 2019 (not yet published in the Official Journal) and Decision of the Council of 7 October 2019.
(4) Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU (OJ L 348, 20.12.2013, p. 1).
(5) Directive 2008/96/EC of the European Parliament and of the Council of 19 November 2008 on road infrastructure safety management (OJ L 319, 29.11.2008, p. 59).

Study Concept & Objectives

Development of a common EU methodology for network-wide road safety assessment & safety rating system for the classification of the existing road network in categories, with the following specific objectives:

- Combine proactive, "in-built" safety assessment and reactive, crash analysis methods.
- Identify appropriate proactive parameters and scientifically sound relationships for assessing network-level safety.
- Achieve a balance between accuracy and level of detail, without being overly data-intensive and costly to use.
- Consider the needs of Member States (e.g., data availability, design standards) and achieve consensus.

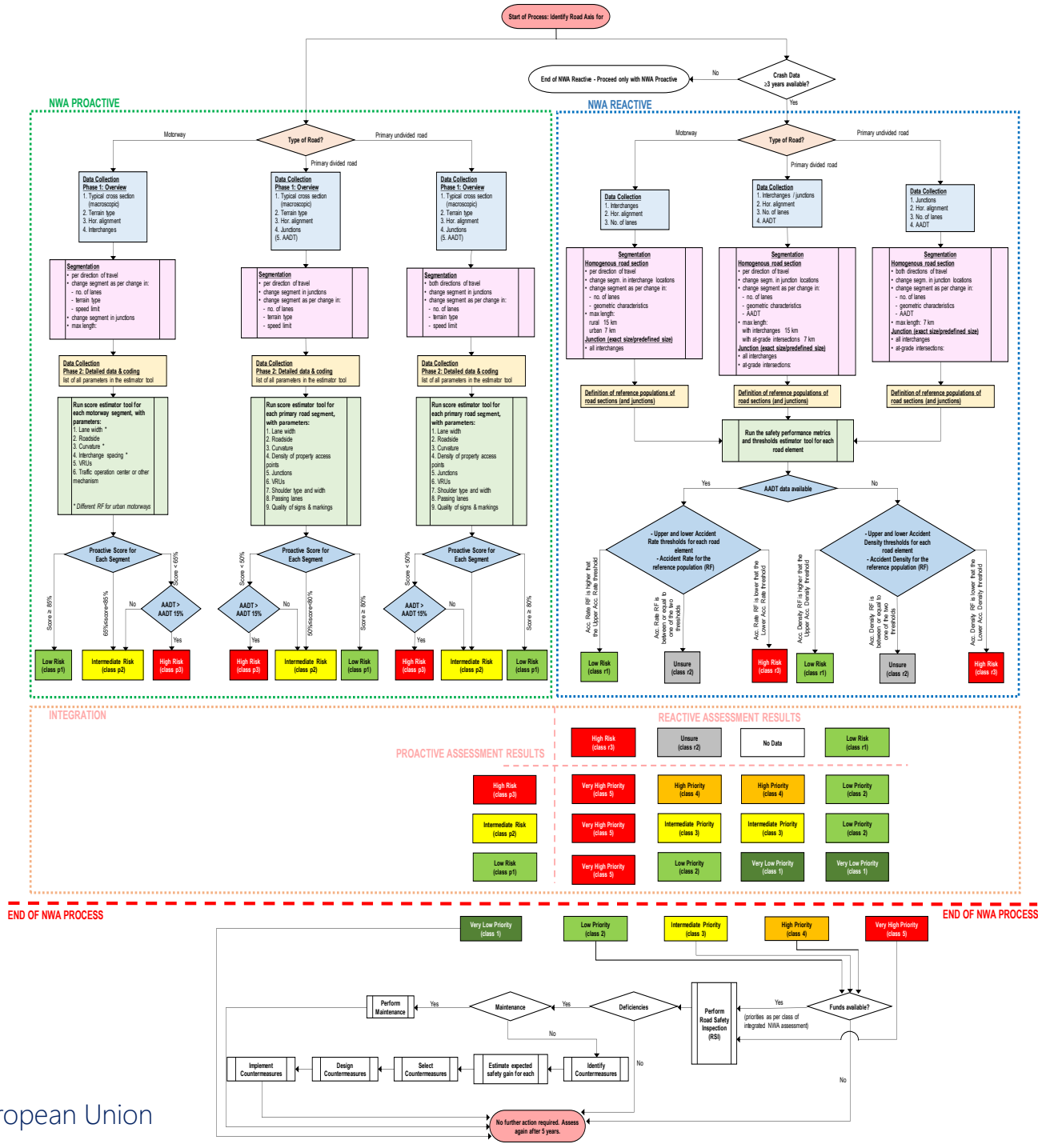
Preliminary Work

- Review and synthesis of existing methodologies for the assessment of road infrastructure safety.
- Understand the needs and limitations of Member States, through a questionnaire survey.
- The NWA methodology was developed during Feb. 2021 – Dec. 2022; then, it was approved by the EGRIS Members.
- During this time and on a regular basis, the process was presented to EGRIS Members and to the EC for review.
- Feedback received through EGRIS, has been incorporated before and after the pilot studies and has been used to finalize the adopted methodology.

Methodology

The NWA methodology comprises two assessment approaches both applied over the same network and then combined:

1. the proactive methodology (NWA-proactive) assessing the in-built safety of roads,
2. the reactive methodology (NWA-reactive) assessing the roads on the basis of crash occurrence analysis,
3. the integration methodology combining assessment outcomes to provide the final road network rating and ranking.



In-Built Safety Assessment Methodology (NWA-Proactive)

Developing the NWA-Proactive

- Identification of appropriate road characteristics, i.e., a set of parameters, that affect the network-level road infrastructure safety.
- Definition of a reasonable relationship, based on research findings, to connect the set of parameters and safety outcomes.
- Reaching of a balance between accuracy and level of detail, without being data-intensive and costly to use.
- Consideration of the needs of Member States (e.g., do they have all data needed for the assessment?)

NWA-Proactive (1/2)

- To apply the methodology, a network is divided in smaller parts, known as "sections".
- Sections are assessed based on the condition of a set of road characteristics (e.g., width of the lanes) each one corresponding to a parameter.
- A safe road section receives the maximum score.
- A "Reduction Factor" (RF) is estimated per parameter to represent the identified unsafe conditions of the respective road characteristic. For safe conditions RF=1, while for unsafe RF<1.
- The safety score for a road section is estimated as:

$$Score = 100 \times RF_1 \times RF_2 \times \cdots \times RF_n$$

NWA-Proactive (2/2)

- Based on the final section score, a road section is classified in one out of 3 classes:
  - High Risk (class 3)
  - Intermediate Risk (class 2)
  - Low Risk (class 1)
- High Risk sections are associated with a poor level of safety, and they are prone to crashes that can be attributed to the section's design characteristics.
- Low Risk sections are generally correctly designed and so, have very low risk of crashes.

NWA-Proactive Parameters

The NWA-proactive methodology considers the following parameters for the assessment of motorways and primary roads:

#	Parameter
	MOTORWAYS
1	Lane width *
2	Roadside (clear zone width, obstacles, presence of barriers)
3	Curvature *
4	Interchanges *
5	Conflicts between pedestrians/ bicyclists and motorized traffic
6	Traffic operation centers and / or mechanisms to inform users for incidents
	PRIMARY ROADS
1	Lane width **
2	Roadside (clear zone width, obstacles, presence of barriers) **
3	Curvature
4	Density of property access points **
5	Junctions
6	Conflicts between pedestrians/ bicyclists and motorized traffic
7	Shoulder type and width **
8	Passing lanes **
9	Signs and markings

* *Different assessment between urban and rural motorways*

** *Different assessment between (primary) divided and undivided rural roads*

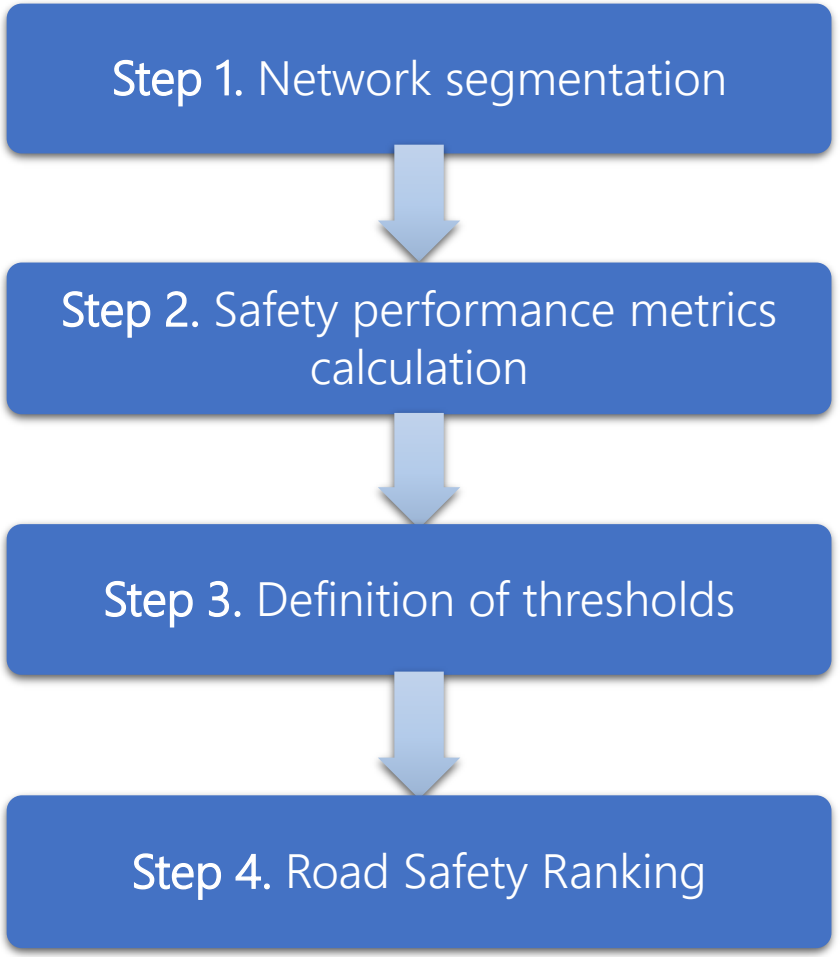
Crash Occurrence Analysis Methodology (NWA-Reactive)

Developing the NWA-Reactive

- Across Member States, it was found that different crash occurrence methods are used.
- To accommodate the needs of Member States a modular approach was used: combination of possible methods for each step allowing flexibility to Member States to implement the method that is more compatible to:
  - existing data
  - available budget
  - previous experience

NWA-Reactive (1/2)

- The NWA-reactive methodology relies on crash data to determine the safety level of a road network.
- It aims to identify sections that concentrate a high number of crashes (with specific characteristics) proportionally to section's length and/or level of traffic intensity.
- Crash records of at least three years, that include crashes that resulted in injuries or fatalities.
- The methodology consists of 4 steps.



NWA-Reactive (2/2)

Step 1. Network segmentation:

- Homogenous sections or junctions.

Step 2. Safety performance metric calculation

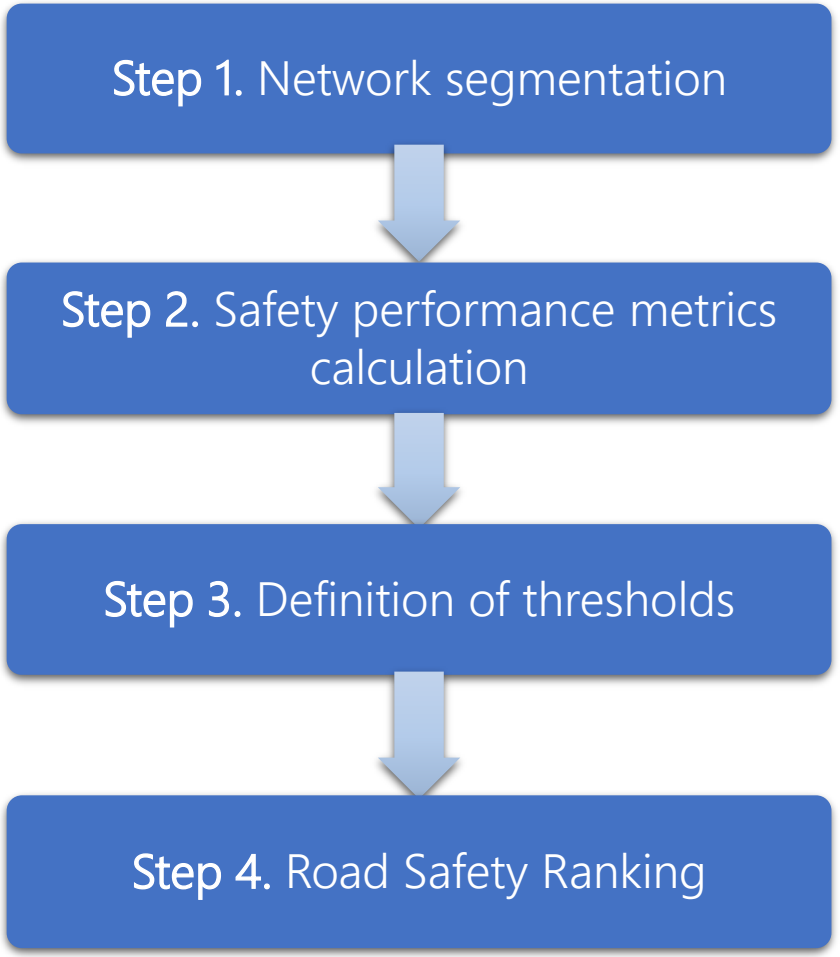
- Crash Density
- Crash Rate (if traffic volume data are available)

Step 3. Definition of thresholds

- Comparison group: safety performance of roads with similar characteristics (Reference Population)

Step 4. Road Safety Ranking

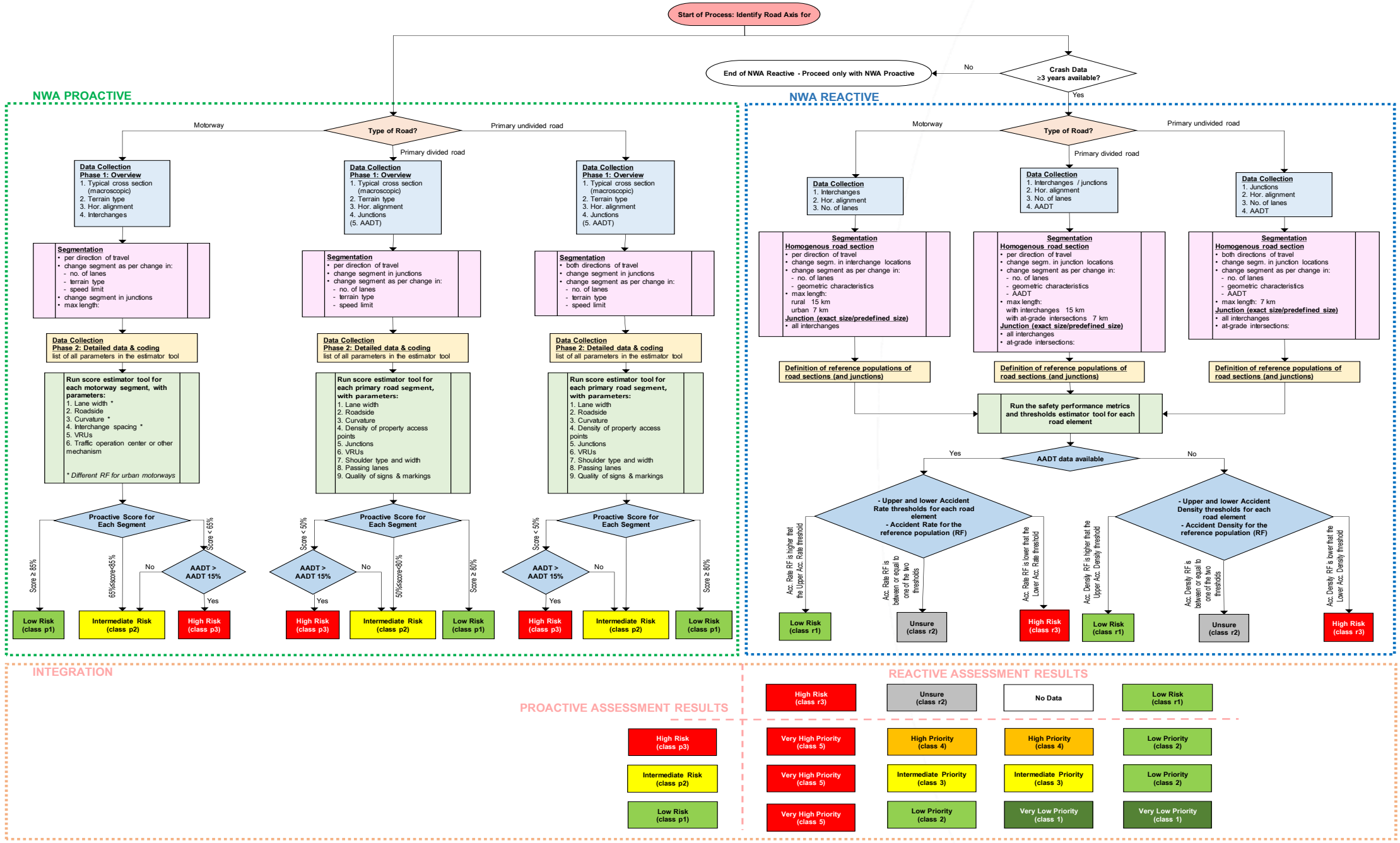
- High Risk section (class 3)
- Unsure section (class 2)
- Low Risk section (class 1)



Integration of the Proactive & Reactive Methodologies (NWA-Integrated)

NWA-Integrated

- The objective of the integrated methodology is to combine the proactive and reactive methodologies.
- The integrated methodology determines the final safety ranking of a road section, and in turn, of the network.
- When developing the NWA-integrated methodology two main aspects had to be determined:
  - The number of safety classes to be considered *According to the RISM Directive they have to be at least three classes*
  - A set of rules to combine the NWA-proactive and the NWA-reactive outcomes.


Start of Process: Identify Road Axis for
End of NWA Reactive - Proceed only with NWA Proactive
No
Crash Data ≥3 years available?
Yes
NWA PROACTIVE
NWA REACTIVE
Type of Road?
Motorway
Primary divided road
Primary undivided road
Data Collection Phase 1: Overview
1. Typical cross section (macroscopic)
2. Terrain type
3. Hor. alignment
4. Interchanges
Segmentation
• per direction of travel
• change segment as per change in:
- no. of lanes
- terrain type
- speed limit
• change segment in junctions
• max length:
Data Collection Phase 2: Detailed data & coding
list of all parameters in the estimator tool
Run score estimator tool for each motorway segment, with parameters:
1. Lane width *
2. Roadside
3. Curvature *
4. Interchange spacing *
5. VRUs
6. Traffic operation center or other mechanism
* Different RF for urban motorways
Run score estimator tool for each primary road segment, with parameters:
1. Lane width
2. Roadside
3. Curvature
4. Density of property access points
5. Junctions
6. VRUs
7. Shoulder type and width
8. Passing lanes
9. Quality of signs & markings
Proactive Score for Each Segment
Score ≥ 85%
65%≤score<85 %
Score < 65%
AADT > AADT 15%
No
Yes
Low Risk (class p1)
Intermediate Risk (class p2)
High Risk (class p3)
Score < 50%
50%≤score<80 %
Score ≥ 80%
Data Collection
1. Interchanges
2. Hor. alignment
3. No. of lanes
1. Interchanges / junctions
2. Hor. alignment
3. No. of lanes
4. AADT
1. Junctions
2. Hor. alignment
3. No. of lanes
4. AADT
Segmentation
Homogenous road section
• per direction of travel
• change segm. in interchange locations
• change segment as per change in:
- no. of lanes
- geometric characteristics
- AADT
• max length:
rural 15 km
urban 7 km
with interchanges 15 km
with at-grade intersections 7 km
Junction (exact size/predefined size)
• all interchanges
• at-grade intersections:
• both directions of travel
Definition of reference populations of road sections (and junctions)
Run the safety performance metrics and thresholds estimator tool for each road element
AADT data available
- Upper and lower Accident Rate thresholds for each road element
- Accident Rate for the reference population (RF)
Acc. Rate RF is higher that the Upper Acc. Rate threshold
Acc. Rate RF is between or equal to one of the two thresholds
Acc. Rate RF is lower that the Lower Acc. Rate threshold
Low Risk (class r1)
Unsure (class r2)
High Risk (class r3)
- Upper and lower Accident Density thresholds for each road element
- Accident Density for the reference population (RF)
Acc. Density RF is higher that the Upper Acc. Density threshold
Acc. Density RF is between or equal to one of the two thresholds
Acc. Density RF is lower that the Lower Acc. Density threshold
INTEGRATION
PROACTIVE ASSESSMENT RESULTS
REACTIVE ASSESSMENT RESULTS
High Risk (class r3)
Unsure (class r2)
No Data
Low Risk (class r1)
High Risk (class p3)
Intermediate Risk (class p2)
Low Risk (class p1)
Very High Priority (class 5)
High Priority (class 4)
Intermediate Priority (class 3)
Low Priority (class 2)
Very Low Priority (class 1)

NWA-Integrated Classes

- A 5-class ranking system is used to combine the results of the proactive (3 classes) and reactive (2 classes + unsure + no data) methodologies.

Very High Priority (class 5)	High Priority (class 4)	Intermediate Priority (class 3)	Low Priority (class 2)	Very Low Priority (class 1)

- The NWA-reactive (when data is available and it can be completed) is prioritized over the NWA-proactive:

PROACTIVE ASSESSMENT RESULTS \ REACTIVE ASSESSMENT RESULTS	High Risk (class r3)	Unsure (class r2)	No Data	Low Risk (class r1)
High Risk (class p3)	Very High Priority (class 5)	High Priority (class 4)	High Priority (class 4)	Low Priority (class 2)
Intermediate Risk (class p2)	Very High Priority (class 5)	Intermediate Priority (class 3)	Intermediate Priority (class 3)	Low Priority (class 2)
Low Risk (class p1)	Very High Priority (class 5)	Low Priority (class 2)	Very Low Priority (class 1)	Very Low Priority (class 1)

Pilot Implementation Results

- The NWA methodology was pilot implemented in 14 EU countries, to the following road types:
  - Urban motorways: 71 km
  - Rural motorways: 742 km
  - Divided primary roads: 220 km
  - Undivided primary roads: 269 km
- Results were reasonable and can be obtained with reduced effort compared to other existing methodologies.
- The applicability of the NWA methodology across Member States was verified.
- The high percentage of "unsure" crash analysis results (non statistically significant) highlights the value of the proactive part of the methodology.

Motorway - Rural

Member State	Road Axis	Percentage				
		Very High Priority (Class 5)	High Priority (Class 4)	Intermediate Priority (Class 3)	Low Priority (Class 2)	Very Low Priority (Class 1)
AT-Austria	A2 SüdAutobahn	4%	51%	36%	8%	1%
CY-Cyprus	A1	21%	18%	18%	42%	0%
ES-Spain	A11	0%	0%	76%	24%	0%
FI-Finland	RA1 - Nurmijärvi-Hyvinkää	5%	0%	0%	95%	0%
FR-France	APRR (A31 & A311)	0%	0%	10%	14%	76%
GR-Greece	Olympia Odos	15%	0%	13%	71%	0%
HR-Croatia	A3	91%	0%	0%	9%	0%
IT-Italy	A4	1%	0%	1%	52%	46%
IT-Italy	A14	10%	10%	34%	42%	4%
LT-Lithuania	A2	1%	0%	1%	98%	0%
RO-Romania	A3	0%	0%	20%	80%	0%
	Total	**25%**	**4%**	**13%**	**48%**	**9%**

Motorway - Urban

Member State	Road Axis	Percentage				
		Very High Priority (Class 5)	High Priority (Class 4)	Intermediate Priority (Class 3)	Low Priority (Class 2)	Very Low Priority (Class 1)
CY-Cyprus	A1	31%	19%	38%	12%	0%
PT-Portugal	A16	14%	17%	34%	34%	0%
RO-Romania	A3	0%	0%	69%	31%	0%
	Total	**14%**	**14%**	**42%**	**30%**	**0%**

Primary Roads - Divided

Member State	Road Axis	Percentage				
		Very High Priority (Class 5)	High Priority (Class 4)	Intermediate Priority (Class 3)	Low Priority (Class 2)	Very Low Priority (Class 1)
FR-France	DIR Nord (RN42)	0%	0%	0%	0%	100%
GR-Greece	Stavrou - Lavriou	88%	7%	6%	0%	0%
IT-Italy	E45	50%	4%	45%	2%	0%
PL-Poland	Wilamowa-Nysa	12%	1%	51%	30%	6%
RO-Romania	DN6/E70	80%	20%	0%	0%	0%
	Total	**49%**	**5%**	**25%**	**3%**	**17%**

Primary Roads - Undivided

Member State	Road Axis	Percentage				
		Very High Priority (Class 5)	High Priority (Class 4)	Intermediate Priority (Class 3)	Low Priority (Class 2)	Very Low Priority (Class 1)
CY-Cyprus	B1	0%	91%	9%	0%	0%
	B9	64%	23%	14%	0%	0%
ES-Spain	N630	100%	0%	0%	0%	0%
FI-Finland	RA2 - Tampere-Vaasa	34%	66%	0%	0%	0%
	RA3 - Kuusamo-Ruka	53%	47%	0%	0%	0%
FR-France	DIR Nord (RN2)	48%	0%	52%	0%	0%
IE-Ireland	N25	6%	12%	37%	40%	4%
LT-Lithuania	A16	16%	0%	57%	27%	0%
PL-Poland	Wilamowa-Nysa	26%	12%	37%	14%	11%
RO-Romania	DN6/E70	0%	48%	28%	17%	7%
SE-Sweden	E45	0%	0%	0%	100%	0%
	Total	**22%**	**21%**	**28%**	**27%**	**2%**

Scientific & Social Impact

- Integrated proactive and reactive safety assessment approach addresses limitations of commonly applied crash-based assessments.
- Large scale road safety assessment at network level in a cost-efficient way is made possible, thus allowing more targeted allocation of resources for detailed road safety inspections to high risk segments.
- Common understanding of the safety level of all major road networks across the EU Member States.
- Contribution towards the reduction of road fatalities and injuries in the European Union.

Future Challenges

- Full scale implementation by Member States across the European Union, by the end of 2024.
- Development of additional methodologies for the network-wide safety assessment of:
  - urban arterials & city streets, and
  - minor & local rural roads.
- Enhancement of data collection and management by Member States road authorities.
- Automating and standardizing data collection and assessment procedures, e.g., using advanced technological equipment.
- Consideration of automated driving and requirements of CAVs in future versions of the methodology.

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