

TRB 103rd

ANNUAL MEETING

January 7–11, 2024 • Washington, D.C.

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



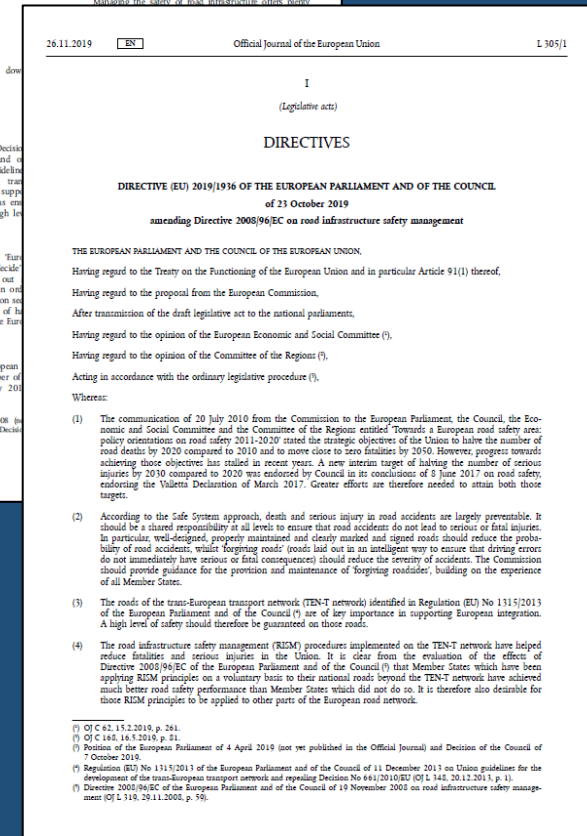
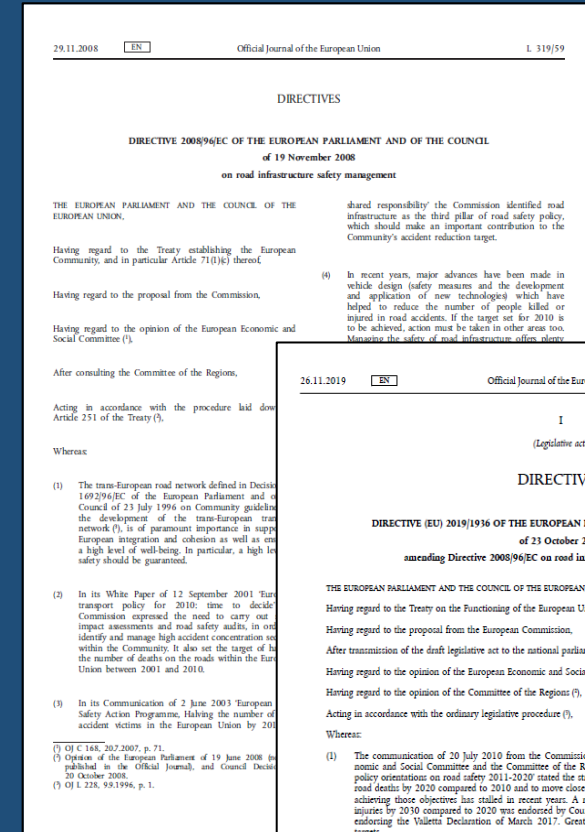
The NetSafety Project

- 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.



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

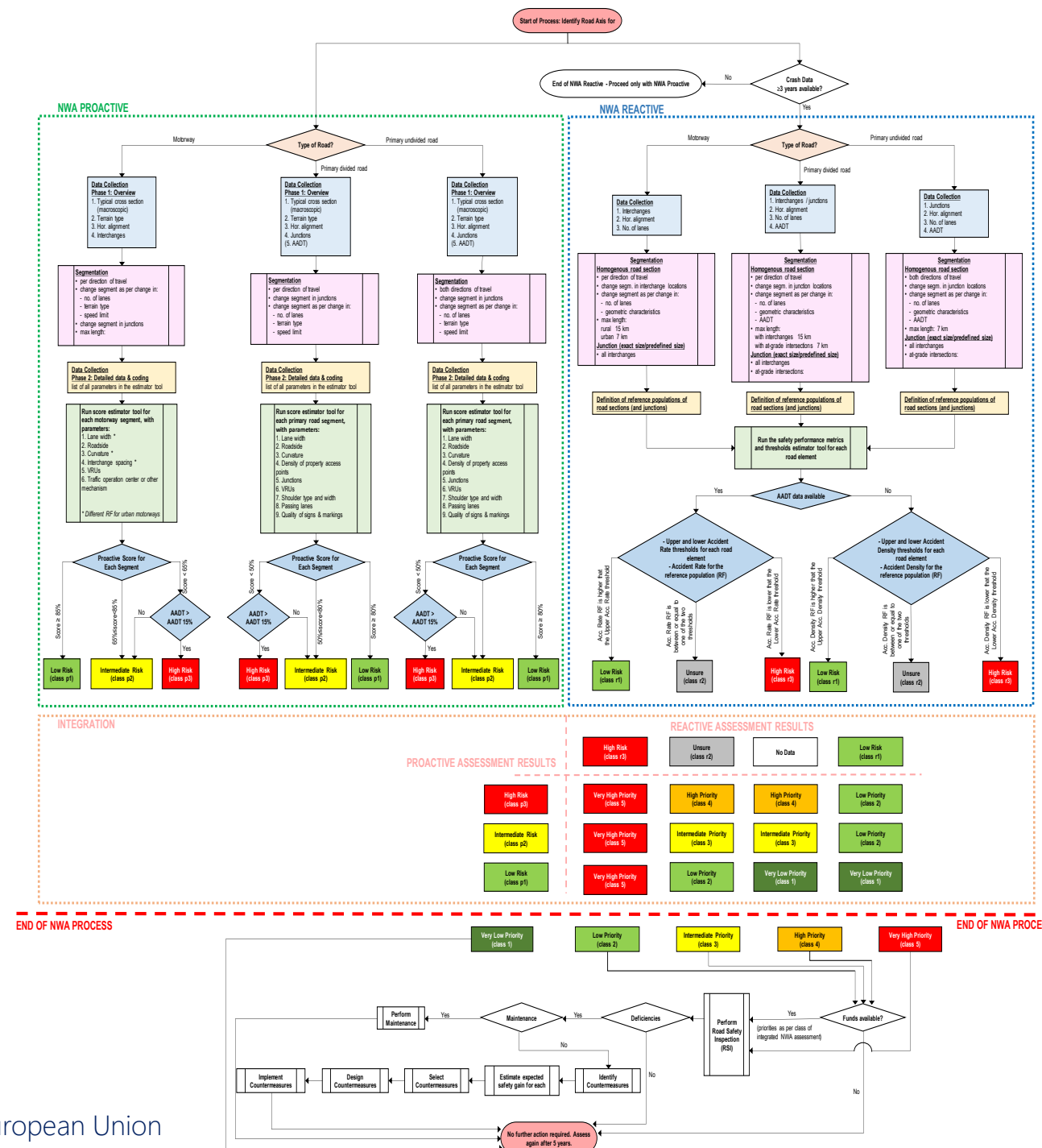
- Review and synthesis of **existing methodologies** for the assessment of road infrastructure safety.
- **Understand the needs and limitations** of Member States, through a questionnaire survey.
- The NWA methodology was **developed** during Feb. 2021 – Dec. 2022; then, it was approved by the EGRIS 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.



An aerial photograph of a multi-lane highway. A white truck is driving in the left lane, moving towards the viewer. Other vehicles, including a blue truck and a silver car, are visible in the distance. The road is bordered by green grass and a metal guardrail. The title text is overlaid on a white horizontal band across the middle of the image.

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:

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



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)



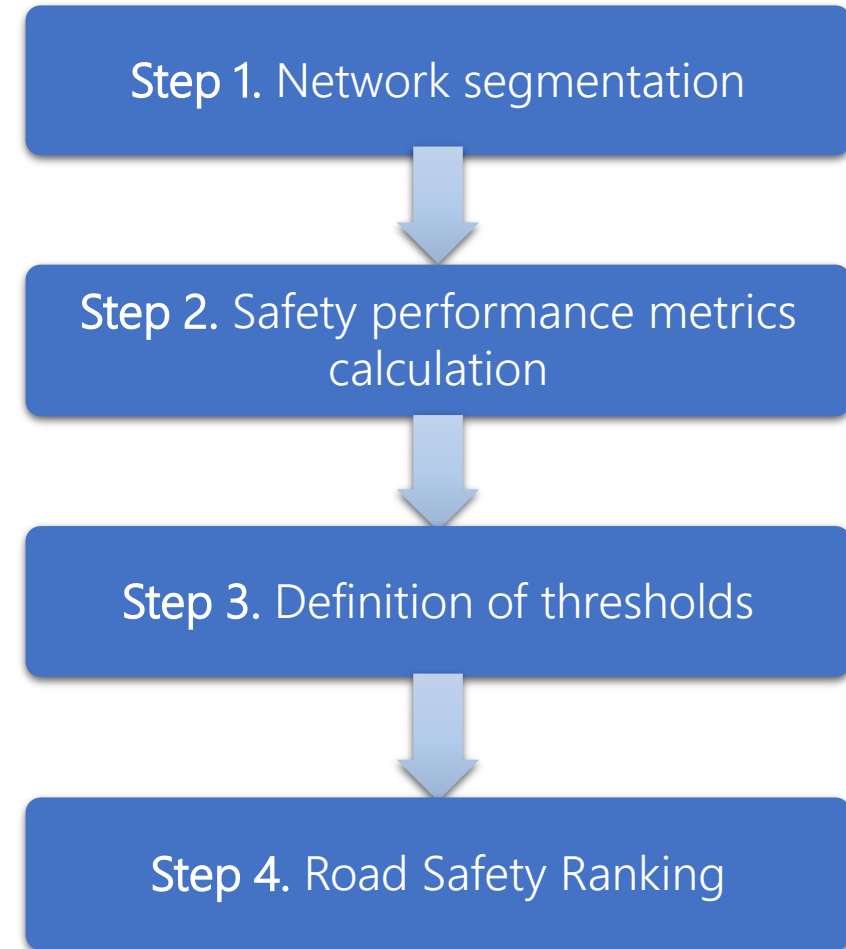
Developing the NWA-Reactive

- 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

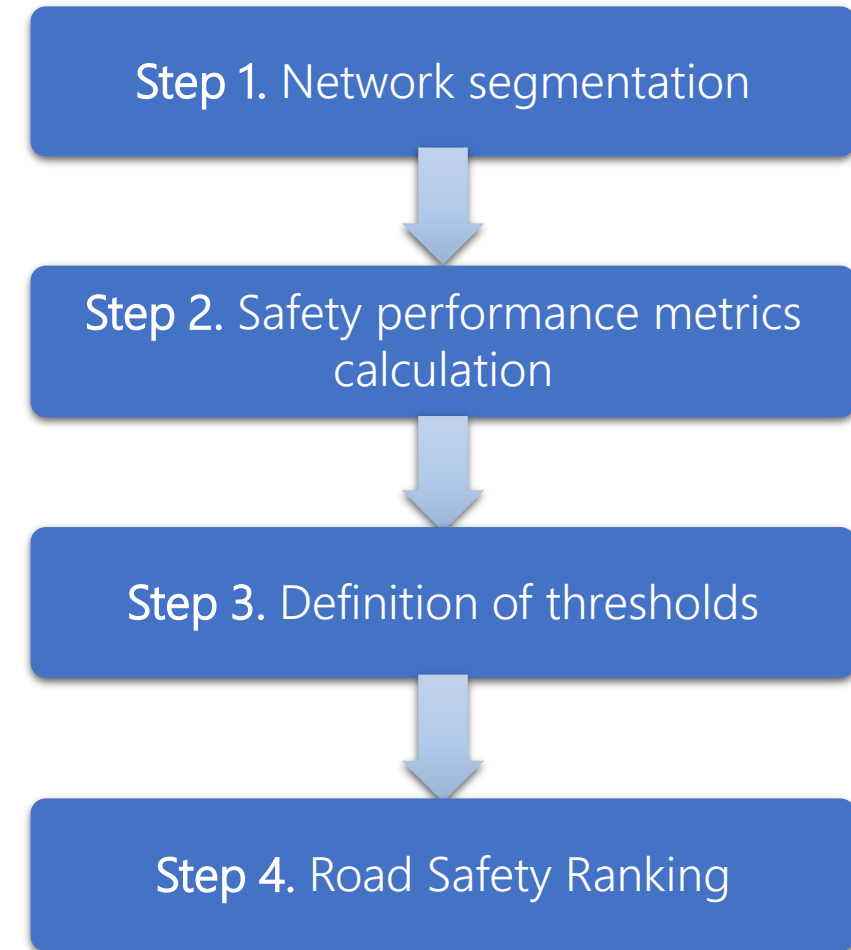
- Crash Density
- Crash Rate (if traffic volume data are available)

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

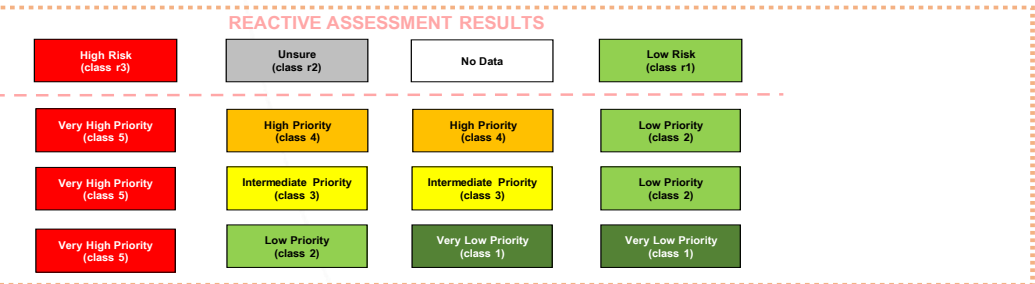
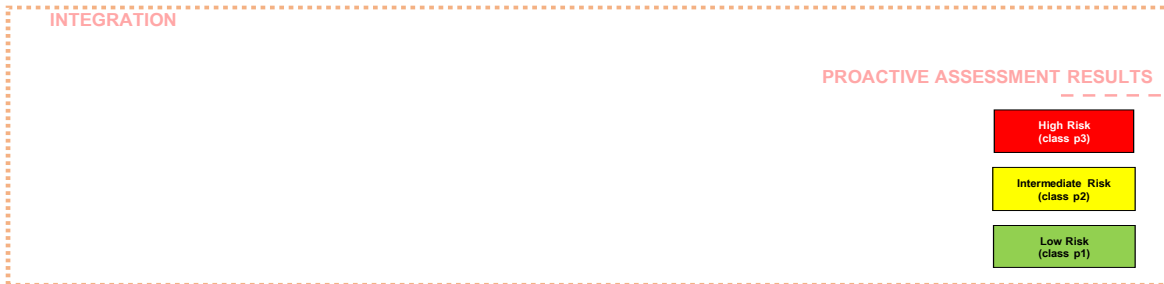
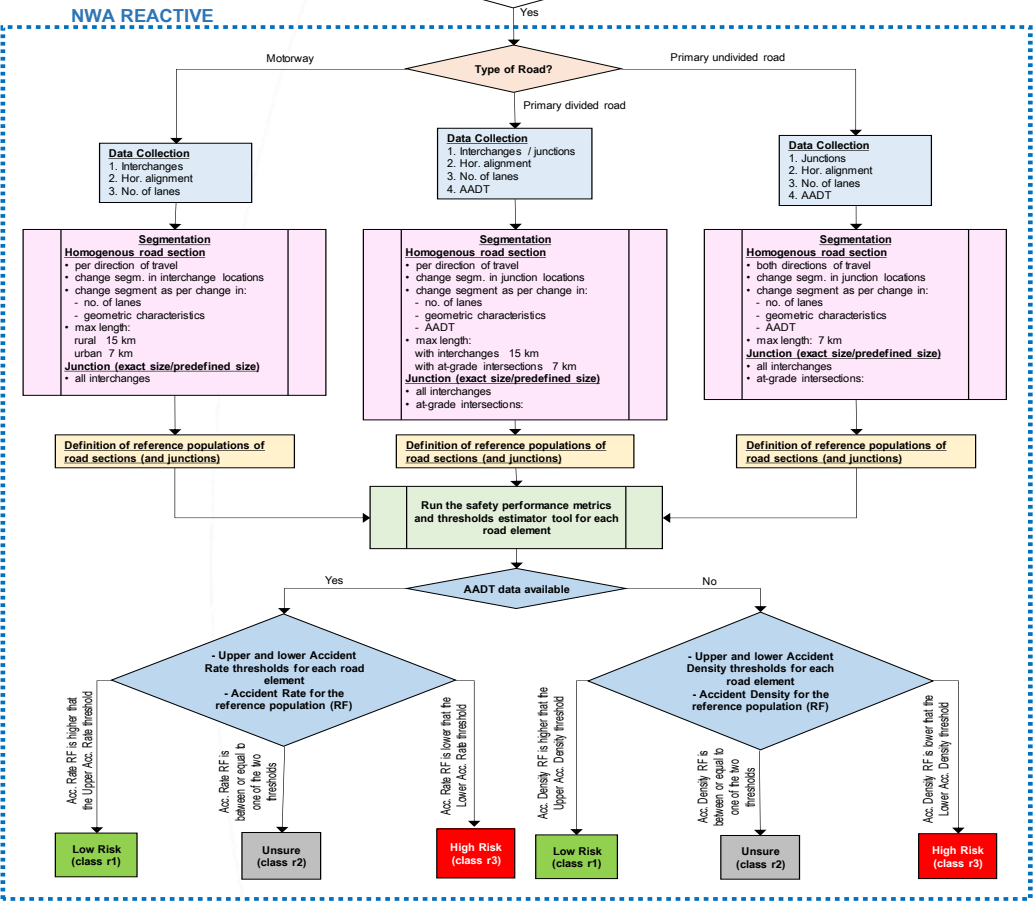
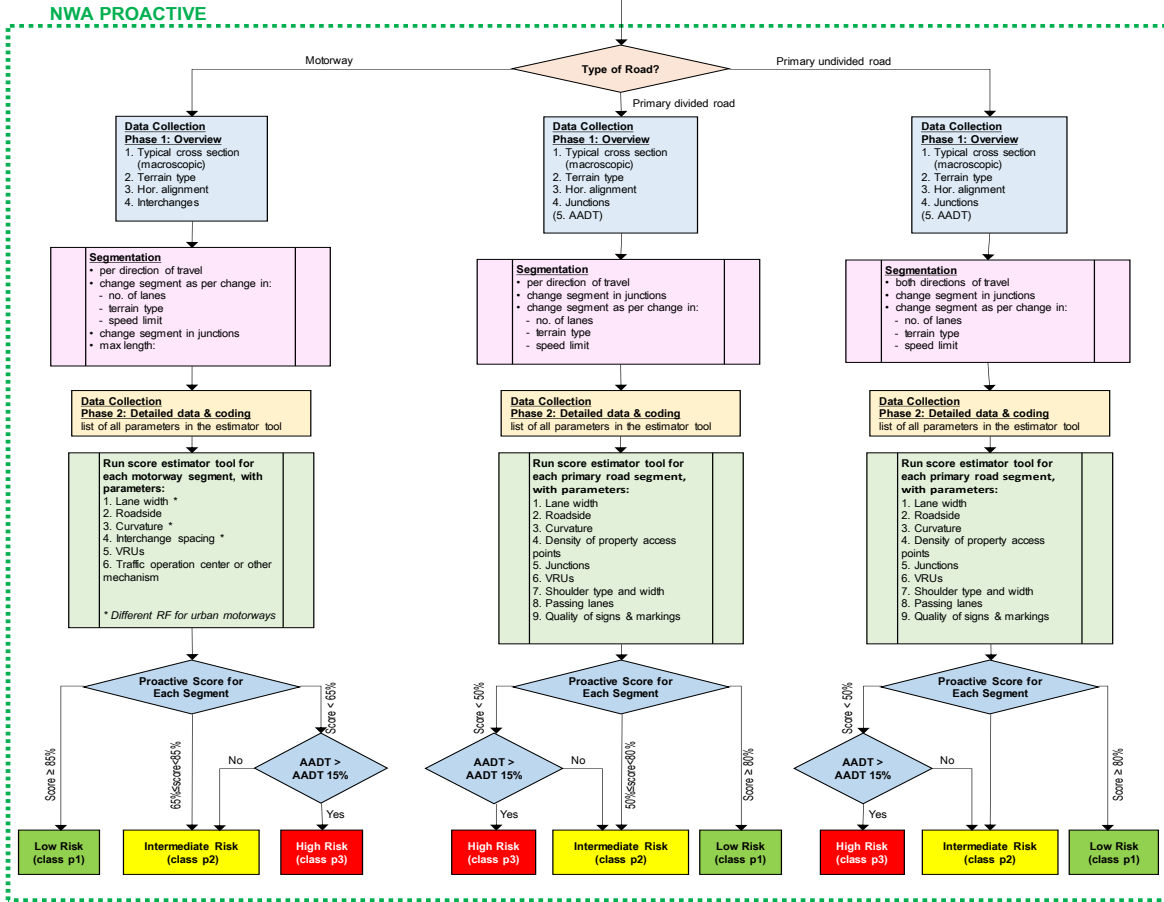
- The objective of the integrated methodology is to **combine** the proactive and reactive methodologies.
- The integrated methodology **determines the final safety ranking** of a road section, and in turn, of the network.
- When developing the NWA-integrated methodology two main aspects had to be determined:
 - 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

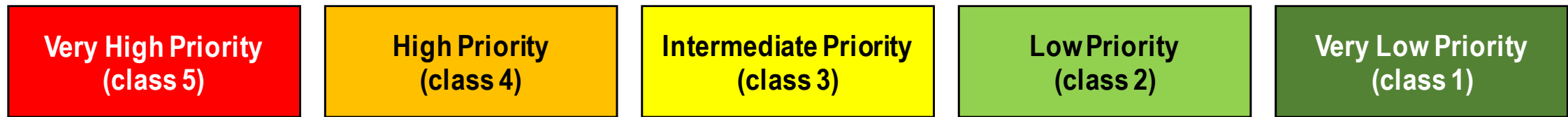
End of NWA Reactive - Proceed only with NWA Proactive

Crash Data ≥ 3 years available?

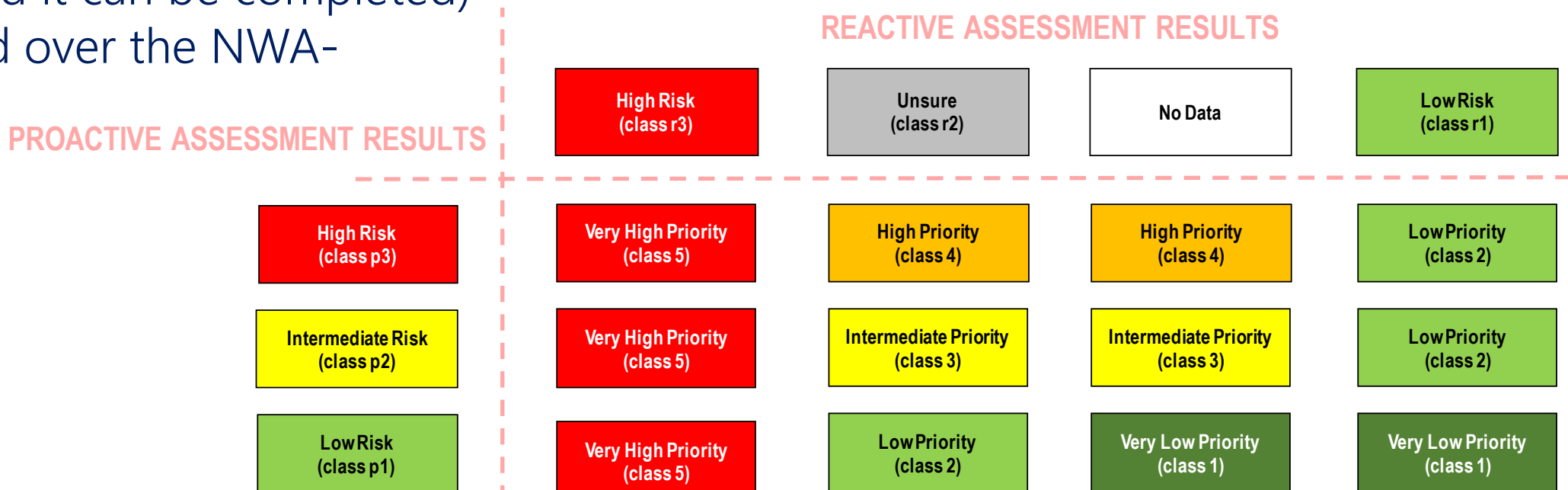


NWA-Integrated Classes

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



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



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				
		Percentage				
Member State	Road Axis	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-Hyvinää	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				
		Percentage				
Member State	Road Axis	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				
		Percentage				
Member State	Road Axis	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				
		Percentage				
Member State	Road Axis	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.



TRB 103rd

ANNUAL MEETING

January 7–11, 2024 • Washington, D.C.

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

