European Commission

Workshop on the EU Methodology
for Network-Wide Road Safety Assessment
January 16, 2023

Study on a Methodology for Network-wide Road Safety Assessment

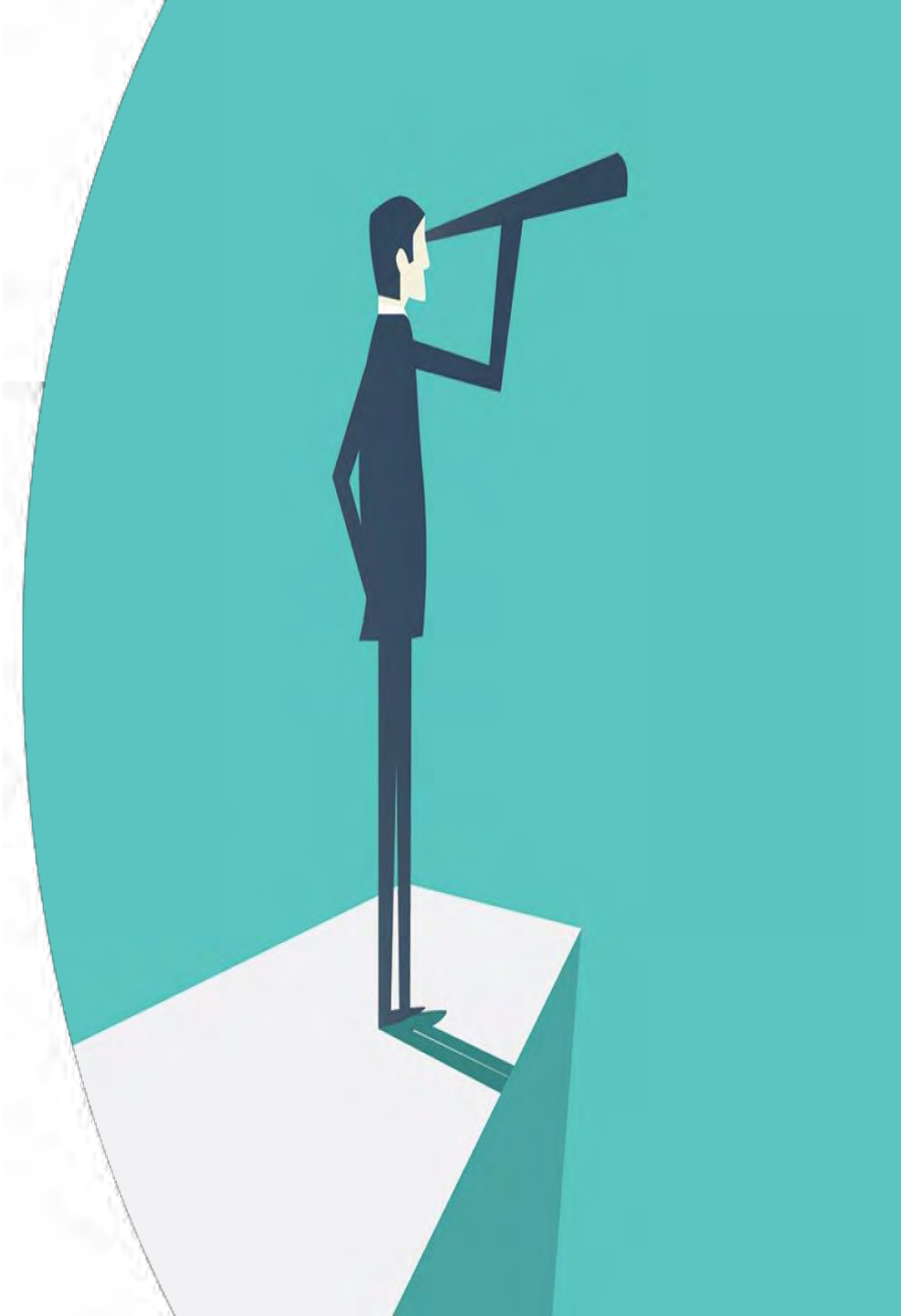
George Yannis, Anastasios Dragomanovits, Katerina Deliali – *National Technical University of Athens (NTUA), Greece*

Marko Sevrovic, Leonid Ljubotina – *University of Zagreb Faculty of Transport and Traffic Sciences (FPZ), Croatia*

Antonino Tripodi, Paola Tiberi, Edoardo Mazzia – *FRED Engineering s.r.l. (FRED), Italy*

Outline

1. RISM Study
2. In-built safety assessment methodology
3. Crash occurrence methodology
4. Integrated methodology
5. Pilot studies



Study on a Methodology for Network-wide Road Assessment

In response to call for tenders: N° MOVE/C2/SER/2019-547

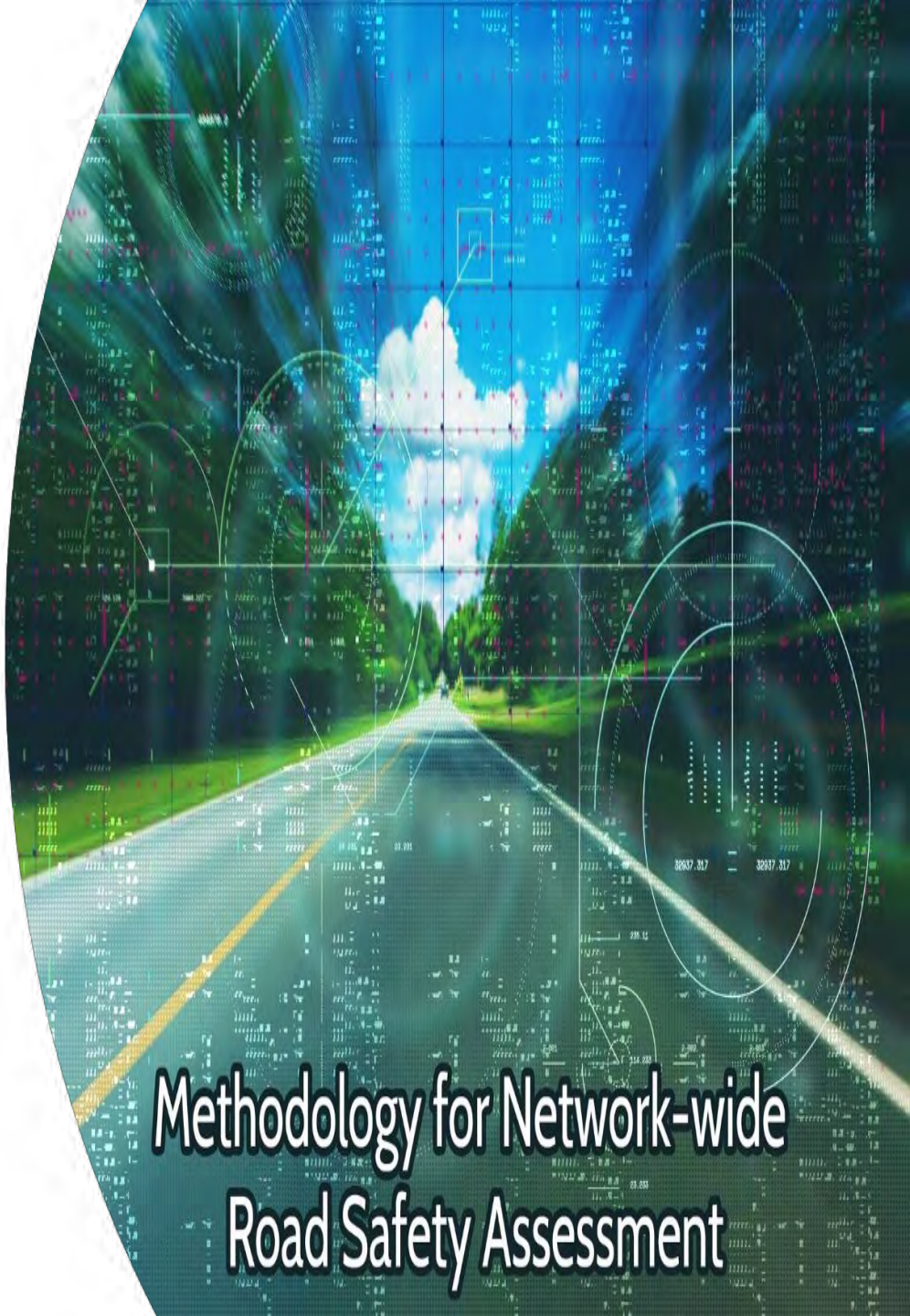
Project team

National Technical University of Athens (NTUA), Greece

University of Zagreb Faculty of Transport and Traffic Sciences (FPZ), Croatia

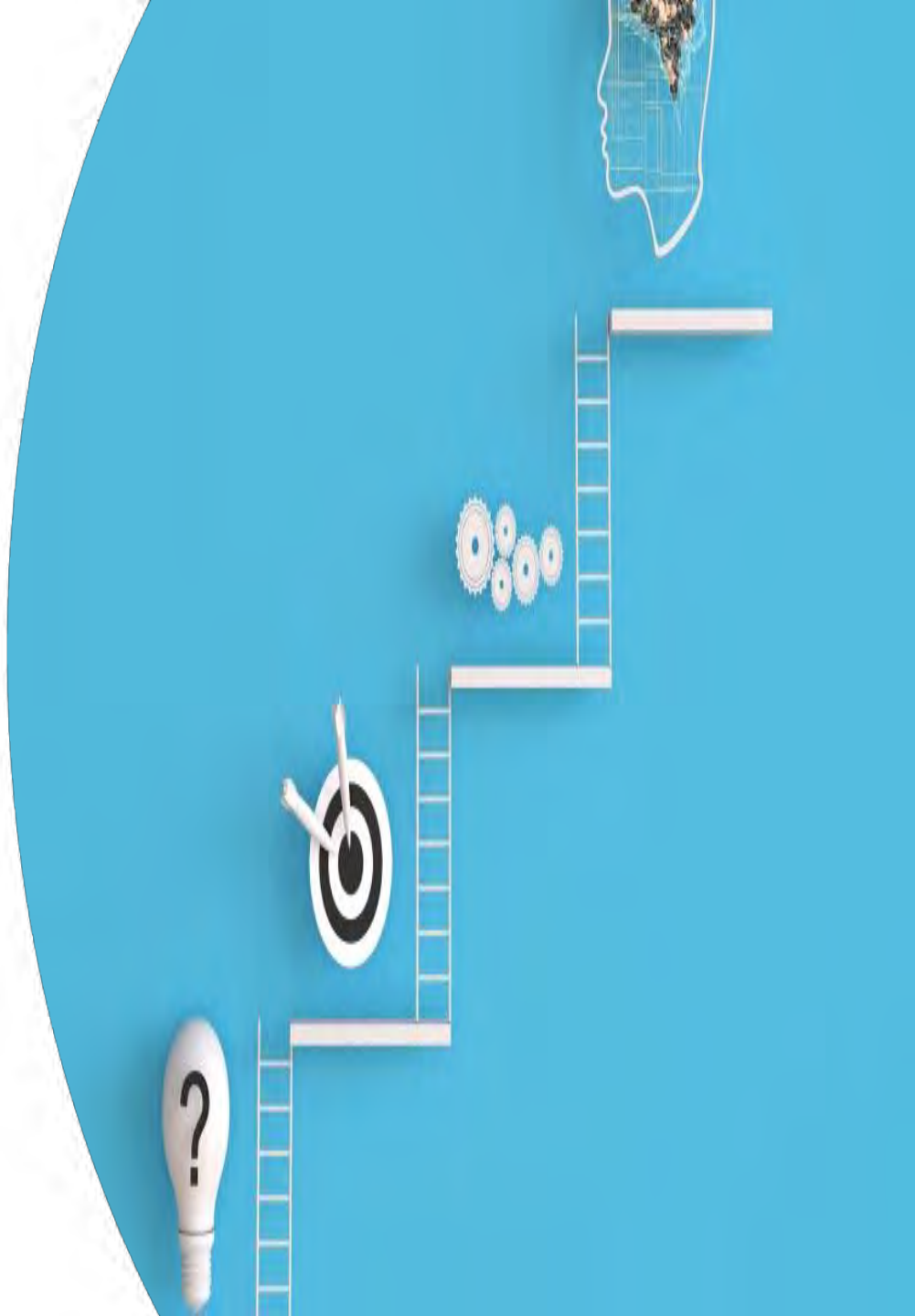
FRED Engineering s.r.l. (FRED), Italy

Project duration: September 2020-August 2023



Preliminary work for the methodology development (1/2)

- The first step was review and synthesize existing methodologies for the assessment of road infrastructure safety and to understand the needs and limitations of Member States regarding the assessment of road infrastructure safety.
- To meet those objectives, an extensive review of the literature (reports, guidelines, scientific papers, etc.) was conducted while a questionnaire survey was designed and disseminated to all Member States and relevant stakeholders.
- These analyses set the ground for developing a Network-Wide Assessment (NWA) methodology for motorways and primary roads.



Preliminary work for the methodology development (2/2)

- The NWA methodology was developed during the February 2021 to December 2022 period, when it was approved by EGRIS Members.
- During this time and on a regular basis, it was presented to EGRIS Members and to the EC to for review.
- Feedback received through EGRIS, concerning both scientific and practical aspects, has been incorporated before and after the pilot studies and has been used to finalize the adopted methodology.

2. In-built safety assessment methodology

Developing a methodology for the in-built safety assessment of roads

- Identification of appropriate road characteristics, i.e., a set of parameters, that affect network-level safety.
- Identification of a scientifically sound relationship between the set of parameters and safety outcomes.
- 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).

NWA-proactive methodology (1/2)

- Using a set of design and operational characteristics each one corresponding to a parameter, a road section is assessed. A perfectly safe road section is rated with a maximum score of 100 points. Reductions are applied for each identified unsafe condition.
- A CMF value lower than 1, or "Reduction Factor" (RF), is estimated per parameter to represent identified unsafe conditions. For safe conditions RF=1.
- The score for the road section i is estimated based on the formula:

$$Score_i = 100 \times RF_{1i} \times RF_{2i} \times \cdots \times RF_{ni}$$

NWA-proactive methodology (2/2)

- Each road section is classified in one out of 3 classes based on the scoring:
  - High Risk (class 3)
  - Intermediate (class 2)
  - Low Risk (class 1)
- Scoring and classification between motorways and primary roads is not comparable.
- Differentiation between rural and urban motorways is considered.
- A section is defined as a road stretch consisting of road segments and junctions.

Quantification of parameters' safety impact

- Identification of appropriate Crash Modification Factors (CMFs) based on international literature:
  - AASHTO Highway Safety Manual 2010, 2014
  - CMF Clearing House (individual studies)
  - PRACT Repository (individual studies)
  - The Handbook of Road Safety Measures, Elvik et al. (2009)
  - iRAP Factsheets (Star Rating Protocol)
- Reviewed studies include CMFs for all injury crashes at motorways and primary rural roads.
- Subsequent adjustments made, where appropriate, according to feedback from EGRIS.

Parameters used for the in-built safety assessment of roads

Based on the feedback from EGRIS Members as well the existing safety literature, 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*

3. Crash occurrence analysis methodology

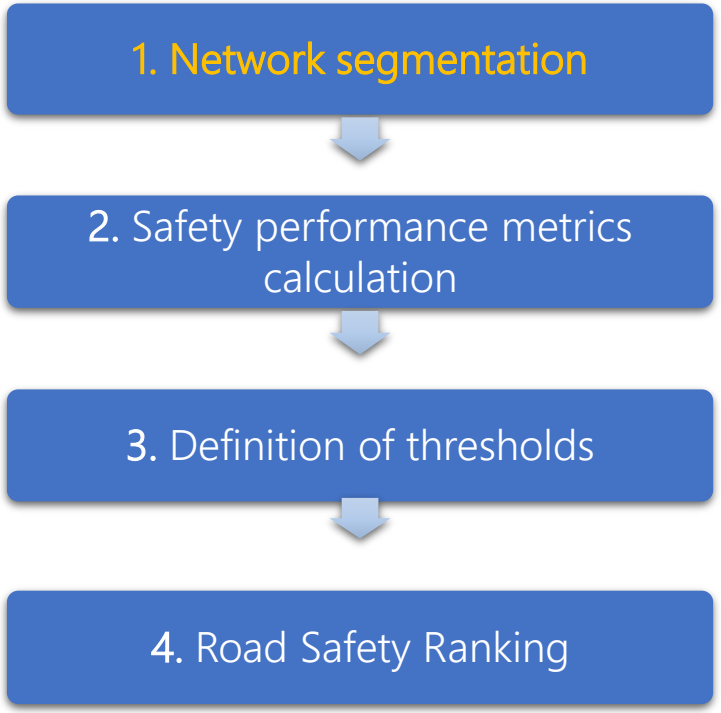
Developing a methodology for crash occurrence analysis

- Across Member States, it was found that different crash occurrence methods are used.
- They vary in terms of safety performance metric (e.g., crash rate), safety ranking, type of crashes used for the analysis, etc.
- 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 methodology (1/4)

1. Network segmentation

- Max section lengths have been defined per road type.
- The sections are homogeneous: hor. curve, no. lanes
- Three approaches exist to deal with junctions:
  - 1st approach: midpoint of the junction as the section limit
  - 2nd and 3rd approaches: boundary of the area of influence of the junction as limit of the section



NWA-reactive methodology (2/4)

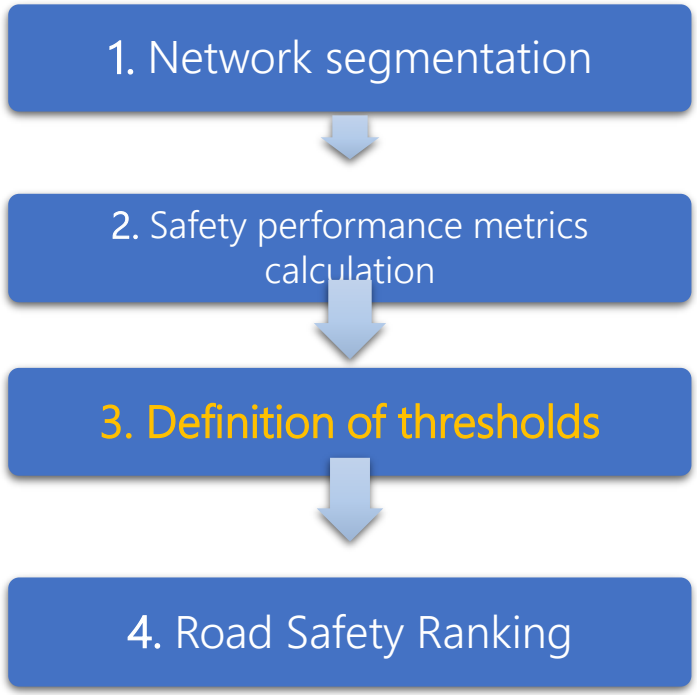
2. Safety performance metric calculation

- Crash data should be available for at least 3 years to implement the methodology.
- The number of crashes with fatalities and injuries across all modes are considered.
  - *Future: common definition AIS → crashes with serious injuries (MAIS 3+) and fatalities*
- For each section, the lower and upper number of expected crashes is estimated based on the Poisson method using the number of occurred crashes.
- Crash Rate (if traffic data are available) and Crash Density are estimated per section using the lower and upper number of expected crashes.

NWA-reactive methodology (3/4)

3. Definition of critical thresholds

- The safety performance of a section is compared against the safety performance of the Reference Population to which the section belongs to.
- The Reference Population is the set of roads across a Member State with same characteristics, e.g., all urban motorways.
- Crash Rate (if traffic data are available) and Crash Density are estimated for each Reference Population group.



NWA-reactive methodology (4/4)

4. Road Safety Ranking

- Based on the Crash Rate (or Density) value for the reference population (ARRF) and the lower & upper thresholds for the section's Crash Rate (AR-lower, AR-upper, respectively), a section is classified as:

Class 3: High Risk section

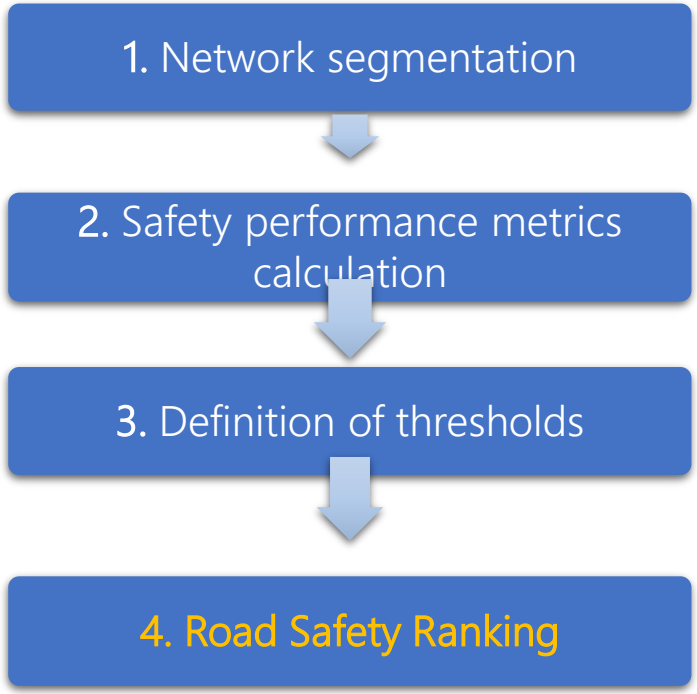
when ARRF < AR-lower < AR-upper

Class 2: Unsure section

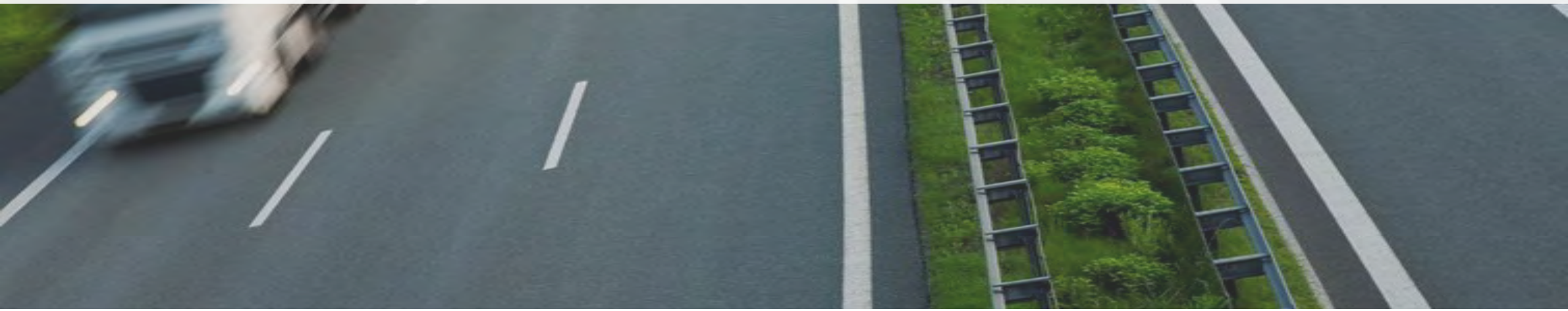
when AR-lower ≤ ARRF ≤ AR-upper

Class 1: Low Risk section

when ARRF > AR-upper > AR-lower



4. Integration of the proactive and reactive methodologies



NWA-integrated Framework (1/3)

- 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.

NWA-integrated Framework (2/3)

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

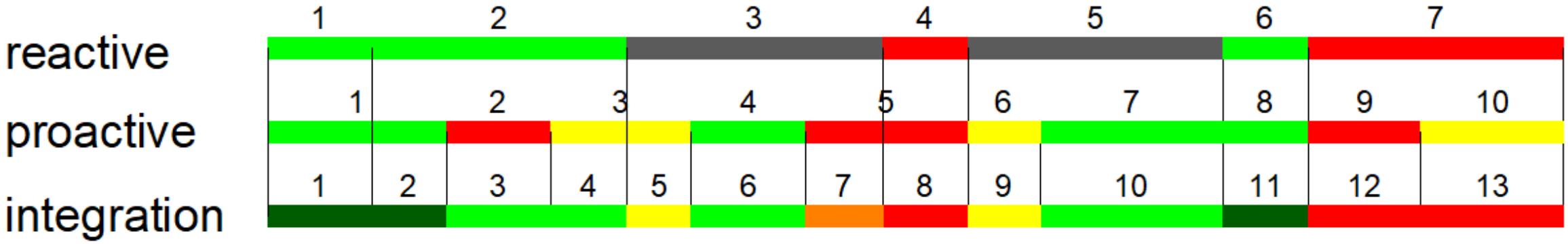
Very High Priority (class 5)	High Priority (class 4)	Intermediate Priority (class 3)	Low Priority (class 2)	Very Low Priority (class 1)

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

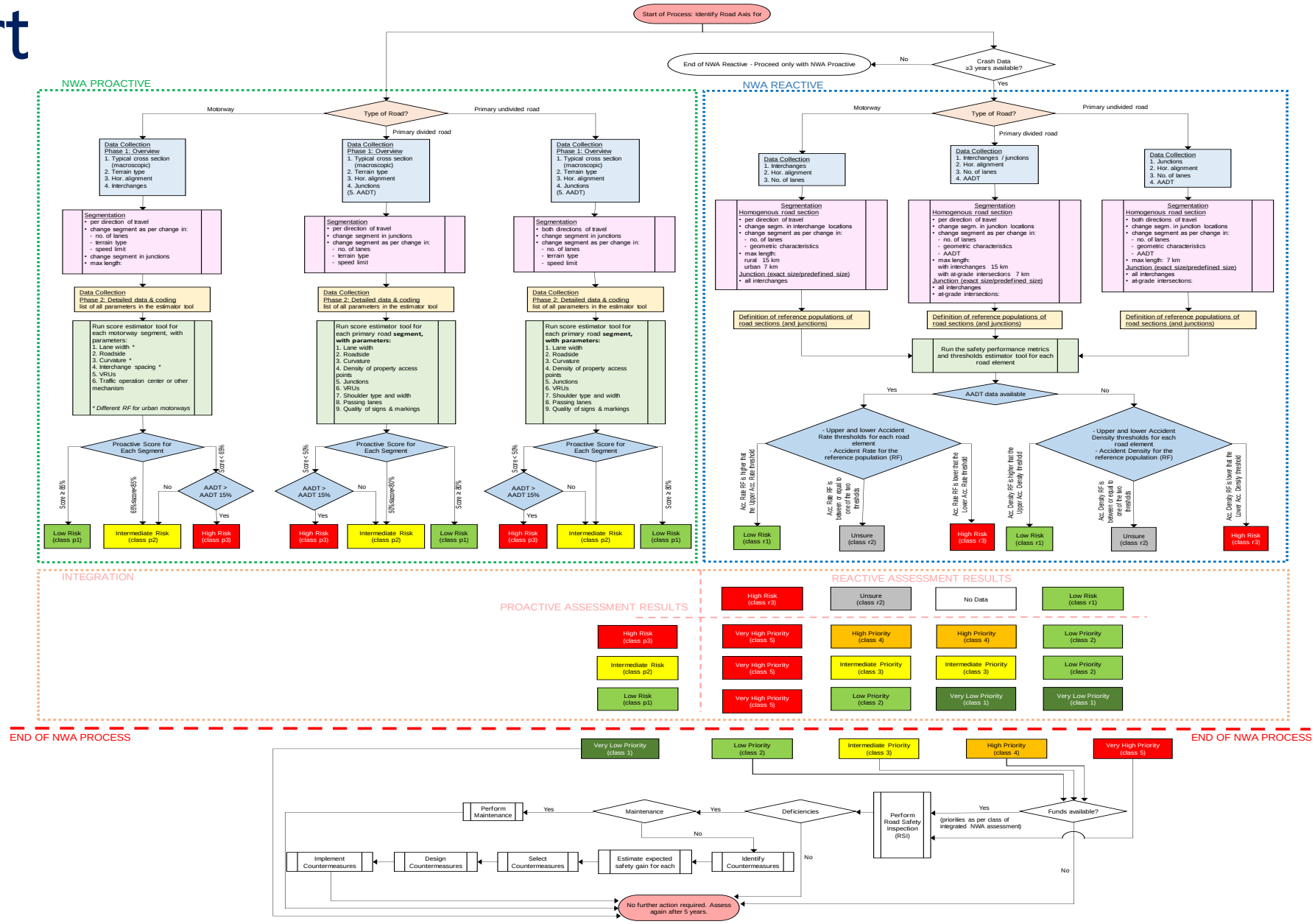
PROACTIVE ASSESSMENT RESULTS \ REACTIVE ASSESSMENT RESULTS	High Risk (class r3)	Unsure (class r2)	No Data	Low Risk (class r1)
High Risk (class p3)	Very High Priority (class 5)	High Priority (class 4)	High Priority (class 4)	Low Priority (class 2)
Intermediate Risk (class p2)	Very High Priority (class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

NWA-integrated Framework (3/3)

- The NWA-proactive and NWA-reactive methodologies use different segmentation approach.
- The following graph illustrates how the final ranking of the network is performed.

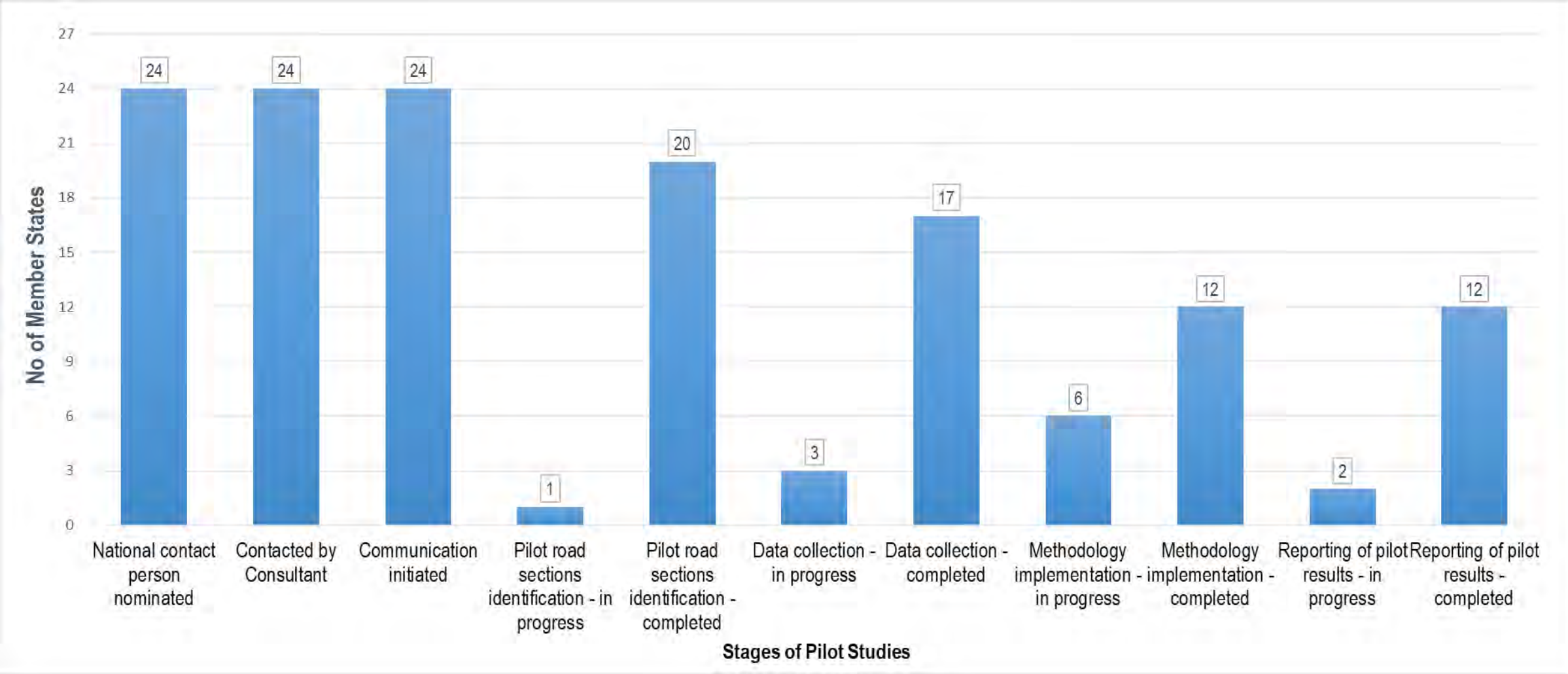


NWA flowchart



5. Pilot Studies

Summary of the pilot studies (1/2)

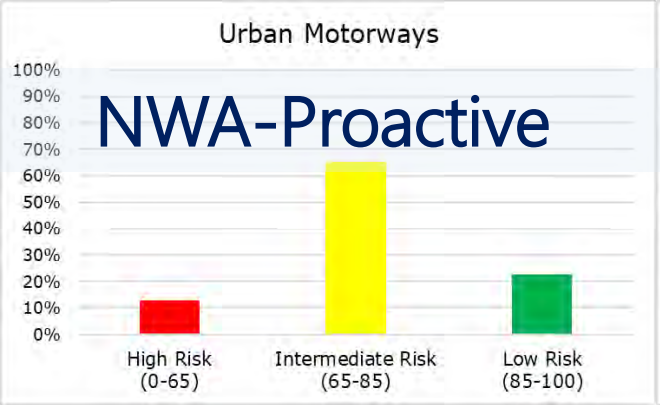


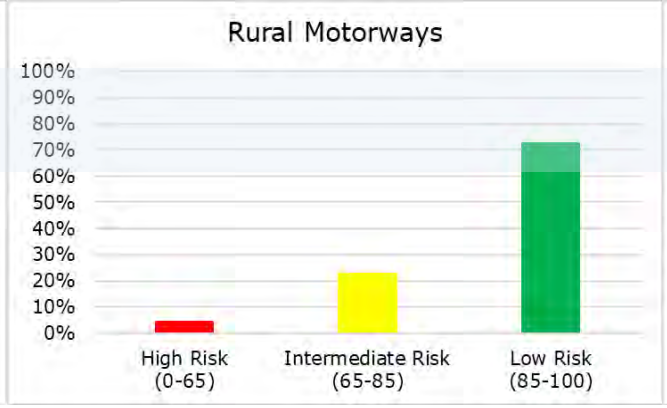
Summary of the pilot studies (2/2)

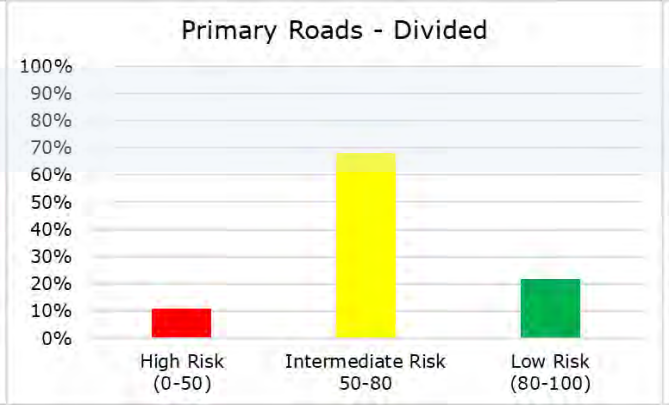
➢ Through the pilot studies, the adopted NWA methodology has been fully tested in:

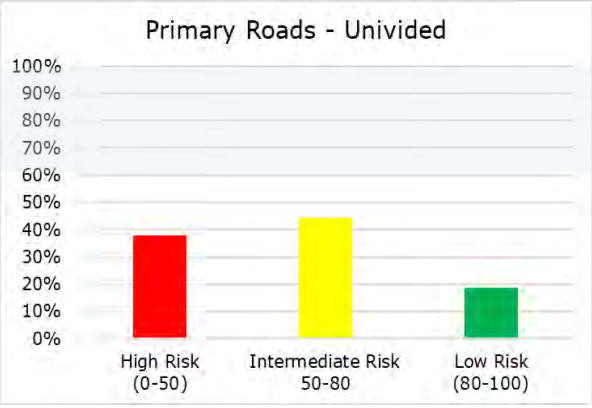
Road type	Number of axes	Total KM	Member States
Urban motorway	2	56,4*	CY, PT
Rural motorway	9	684,8*	CY, EL, ES, FI, FR, HR, IT, LT
Primary divided road	3	177,6*	EL, FR, IT
Primary undivided road	9	214,6	CY, ES, FI, FR, IE, LT, SE

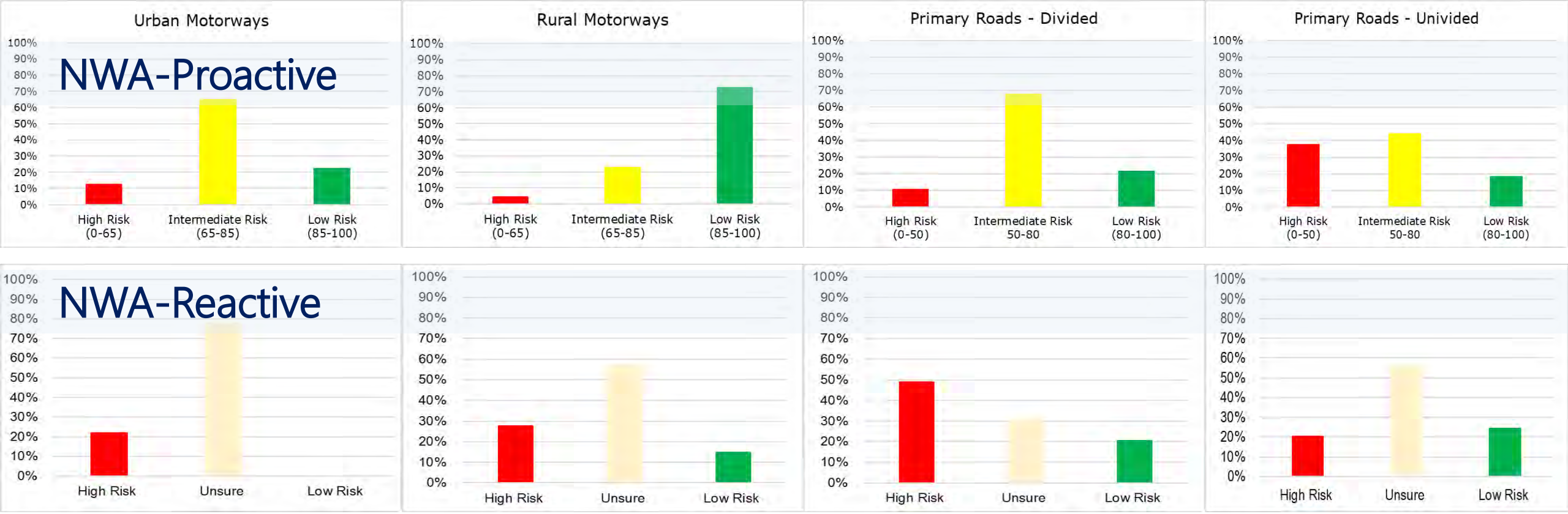
- *In divided roads, the total length represents the sum of both directions of travel*


Urban Motorways
NWA-Proactive
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
High Risk (0-65)
Intermediate Risk (65-85)
Low Risk (85-100)


Rural Motorways
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
High Risk (0-65)
Intermediate Risk (65-85)
Low Risk (85-100)


Primary Roads - Divided
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
High Risk (0-50)
Intermediate Risk 50-80
Low Risk (80-100)


Primary Roads - Univided
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
High Risk (0-50)
Intermediate Risk 50-80
Low Risk (80-100)



- Results of the proactive and the reactive methodologies.
- A significant part of the assessed road network is classified as “Unsure” with the proactive methodology, indicating the need for an additional assessment (i.e., proactive).


Urban Motorways
Rural Motorways
Primary Roads - Divided
Primary Roads - Univided
NWA-Proactive
High Risk (0-65)
Intermediate Risk (65-85)
Low Risk (85-100)
High Risk (0-50)
Intermediate Risk 50-80
Low Risk (80-100)
NWA-Reactive
High Risk
Unsure
Low Risk
NWA-Integrated
Very High Priority (Class 5)
High Priority (Class 4)
Intermediate Priority (Class 3)
Low Priority (Class 2)
Very Low Priority (Class 1)

European Commission

Workshop on the EU Methodology
for Network-Wide Road Safety Assessment
January 16, 2023

Study on a Methodology for Network-wide Road Safety Assessment

George Yannis, Anastasios Dragomanovits, Katerina Deliali – *National Technical University of Athens (NTUA), Greece*

Marko Sevrovic, Leonid Ljubotina – *University of Zagreb Faculty of Transport and Traffic Sciences (FPZ), Croatia*

Antonino Tripodi, Paola Tiberi, Edoardo Mazzia – *FRED Engineering s.r.l. (FRED), Italy*