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HIT- HELLENIC INSTITUTE OF TRANSPORT

HELLENIC INSTITUTE OF TRANSPORTATION ENGINEERS

11th INTERNATIONAL CONGRESS on TRANSPORTATION RESEARCH

Clean and Accessible to All Multimodal Transport

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A Novel Methodology for Crash Hotspot Identification and Network-Wide Safety Ranking

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The i-safemodels project

International Comparative Analyses of Road Traffic Safety Statistics and Safety Modeling

➢ Project partners:

- NTUA Department of Transportation Planning & Engineering
- OSeven Telematics
- Tongji University
- Third country partners: University of Central Florida (US), Purdue University (US), Loughborough University (UK), German Aerospace Center, DE

➢ Duration of the project:

- 42 months (October 2019 – April 2023)

➢ Operational Program:

- Horizon 2020 - The EU Union Framework Programme for Research and Innovation - Mobility for Growth

Introduction

- Road crashes constitute a major global societal problem with more than 1,25 million fatalities per year
- Factors such as speeding and non-compliance with traffic regulations can increase the crash risk
- Imperative need for international scientific cooperation in order to identify crash risk factors and respective measures
- Development of an integrated international road safety management system

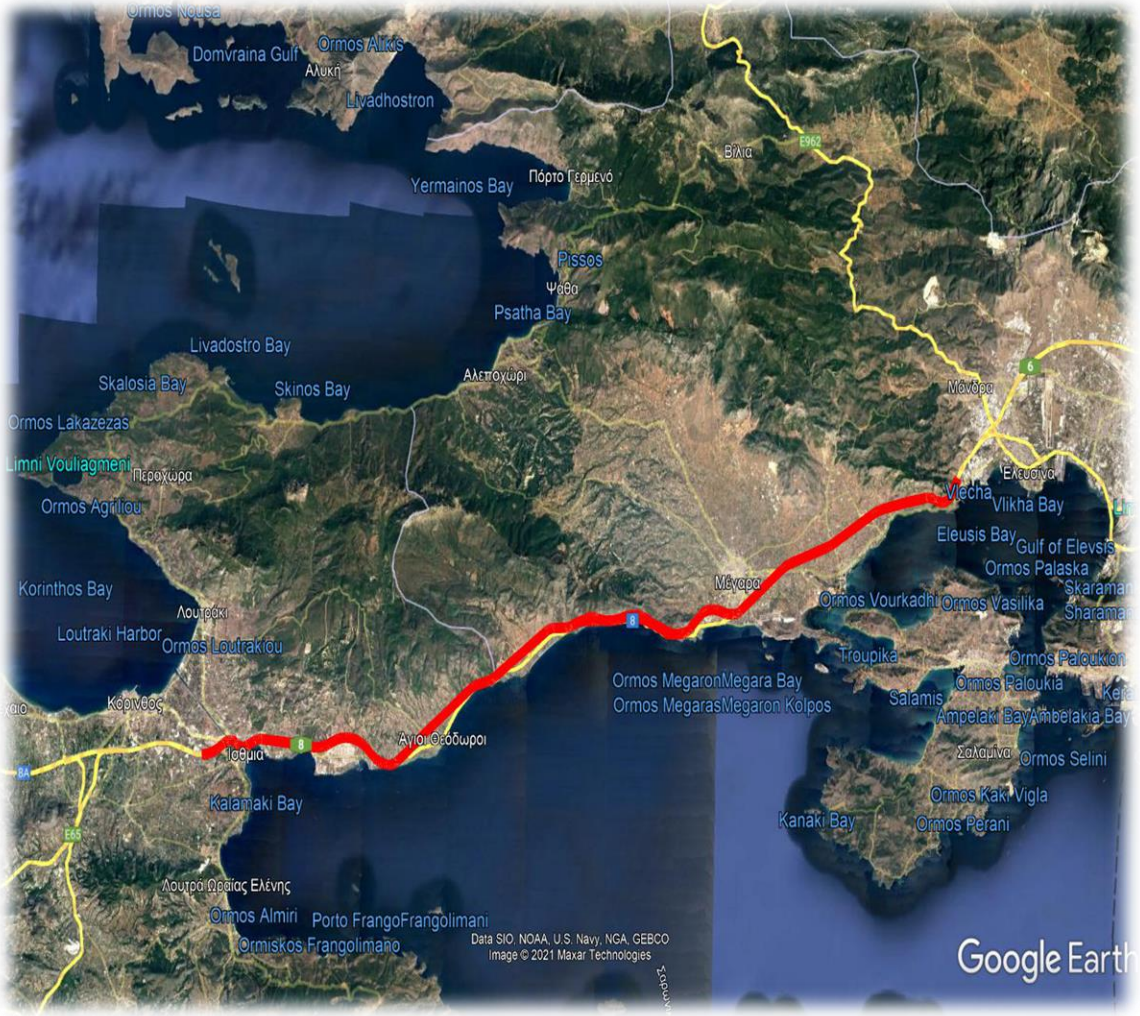
Objectives

- Development of advanced road safety standardization models at both:
  - macroscopic (e.g. country, region) and
  - microscopic levels (roadway segments/sites) in developed and developing countries
- Overall network ranking and identifying sections that are safe or less safe

Data Collection

- Data from Olympia Odos motorway (rural motorway)
  - 50,6km road length
  - Cross-section part with 2 or 3 lanes per direction of traffic plus emergency lane, central median with concrete barrier

- 3 types of data:
  - Crash data 2015-2019
  - Traffic data as an exposure metric to better understanding of crashes occurance
  - Road design/ road geometry data for segmentation purposes



Experiment Cases (1/2)

Case 1 Homogenous road sections & injury crashes	• **Description**: Division of Olympia Odos motorway into 13 homogenous sections both in direction Athens - Korinthos and Korinthos - Athens.
Case 2 Homogenous road sections & all crash types	• **Description**: Same segmentation as in Case 1 and the modification of the original methodology entails the use of all crashes, i.e., injury-related ones and property damage-only ones.
Case 3 Homogenous road sections & injury crashes- different alpha	• **Description**: Same values and parameters as in Case 1 • Different sensitivity alpha (a=0.1, a=0.01)
Case 4 Traffic volume-based sections & injury crashes	• **Description**: Modifying the segmentation criteria in order to test the performance of the methodology in the setting of network-wide setting

Experiment Cases (2/2)

Case 1

Reference data - Road sections	
Data on the road under assessment:	
Time period of accident data (years)	5
Total n. accidents	23
Total length of all road sections (km)	46
Data on the Reference Population to which the road sections belong:	
Total km of roads	95
Total n. accidents	46
Average AADT	9,969
Average accident density - calculated *(acc./km)*	0.10
Average accident density - input *(acc./km)*	
Average accident rate - calculated *(acc./veh.*km)*	2.66
Average accident rate - input *(acc./veh.*km)*	
Average AADT - calculated	-

Case 2

Reference data - Road sections	
Data on the road under assessment:	
Time period of accident data (years)	5
Total n. accidents	29
Total length of all road sections (km)	49
Data on the Reference Population to which the road sections belong:	
Total km of roads	95
Total n. accidents	56
Average AADT	9,969
Average accident density - calculated *(acc./km)*	0.12
Average accident rate - calculated *(acc./veh.*km)*	3.24
Average AADT - calculated	-

Case 3

Reference data - Road sections	
Data on the road under assessment:	
Time period of accident data (years)	5
Total n. accidents	489
Total length of all road sections (km)	46
Data on the Reference Population to which the road sections belong:	
Total km of roads	95
Total n. accidents	1,122
Average AADT	9,969
Average accident density - calculated *(acc./km)*	2.36
Average accident rate - calculated *(acc./veh.*km)*	64.87

Case 4

Reference data - Road sections	
Data on the road under assessment:	
Time period of accident data (years)	5
Total n. accidents	633
Total length of all road sections (km)	49
Data on the Reference Population to which the road sections belong:	
Total km of roads	95
Total n. accidents	1,122
Average AADT	9,969
Average accident density - calculated *(acc./km)*	2.36
Average accident rate - calculated *(acc./veh.*km)*	64.87
Average AADT - calculated	-

Results (1/2)

- 8 sections (35,5km per direction of traffic) are ranked as "Unsure"
- "Low risk" sections for Olympia Odos motorway are mostly the sections that have zero crashes
- "High Risk" sections correspond on average to 11,7% of the total length in Direction "T" and to 18% of the total length in Direction "E"

		Direction "T"		Direction "E"	
		Total Length (Km)	No. sections	Total Length (Km)	No. sections
Case 1	High Risk	8.20	3	5.20	2
	Unsure	31.20	8	36.20	8
	Low Risk	6.60	2	7.40	3
Case 2	High Risk	3.40	1	20.00	4
	Unsure	36.60	10	28.80	9
	Low Risk	6.00	2	0.00	0
Case 3 - a=0,01	High Risk	4.80	2	5.20	2
	Unsure	34.60	9	36.20	8
	Low Risk	6.60	2	7.40	3
Case 3b - a=0,10	High Risk	8.20	3	10.60	3
	Unsure	31.20	8	30.80	7
	Low Risk	6.60	2	7.40	3
Case 4	High Risk	2.20	1	3.00	1
	Unsure	43.80	7	45.80	7
	Low Risk	0.00	0	0.00	0

		Direction "T"		Direction "E"	
		% of total Length	% of tot. sections	% of total Length	% of tot. sections
Case 1	High Risk	17.83	23.08	10.66	15.38
	Unsure	67.83	61.54	74.18	61.54
	Low Risk	14.35	15.38	15.16	23.08
Case 2	High Risk	7.39	7.69	40.98	30.77
	Unsure	79.57	76.92	59.02	69.23
	Low Risk	13.04	15.38	0	0
Case 3 - a=0,01	High Risk	10.43	15.38	10.66	15.38
	Unsure	75.22	69.23	74.18	61.54
	Low Risk	14.35	15.38	15.16	23.08
Case 3b - a=0,10	High Risk	17.83	23.08	21.72	23.08
	Unsure	67.83	61.54	63.11	53.85
	Low Risk	14.35	15.38	15.16	23.08
Case 4	High Risk	4.78	12.5	6.15	12.5
	Unsure	95.22	87.5	93.85	87.5
	Low Risk	0	0	0	0

Results (2/2)

- Relying of different crash types affects the identification of crash hotspots and the safety ranking
- No correspondence between “High Risk” and “Low Risk” sections across Cases 1 and 2
- Injury-related hotspots do not necessarily align with hotspots that include crashes of all severity levels

Direction "T"		
Length (km)	Case 1 - Injury Crashes	Case 2 - All Crashes
	Ranking	Ranking
3.0	Unsure	Unsure
3.6	Unsure	Unsure
5.4	Unsure	Unsure
2.4	Unsure	Unsure
3.4	High Risk	Low Risk
4.0	Low Risk	Unsure
3.0	Unsure	Unsure
4.2	Unsure	Unsure
5.2	Unsure	Unsure
4.4	Unsure	Unsure
3.4	High Risk	High Risk
2.6	Low Risk	Low Risk
1.4	High Risk	Unsure

Direction "E"		
Length (km)	Case 1 - Injury Crashes	Case 2 - All Crashes
	Ranking	Ranking
1.4	High Risk	Unsure
2.6	Low Risk	Unsure
5.8	Unsure	High Risk
1.8	Low Risk	Unsure
5.0	Unsure	Unsure
2.4	Unsure	Unsure
3.0	Low Risk	Unsure
2.4	Unsure	Unsure
4.0	Unsure	Unsure
5.4	Unsure	High Risk
3.8	High Risk	High Risk
5.0	Unsure	High Risk
6.2	Unsure	Unsure

Direction "T"			
Length (km)	Case 1 Poisson method: alpha = 0,05	Case 3 Poisson method: alpha = 0,01	Case 3 Poisson method: alpha = 0,10
	Ranking	Ranking	Ranking
3.0	Unsure	Unsure	Unsure
3.6	Unsure	Unsure	Unsure
5.4	Unsure	Unsure	Unsure
2.4	Unsure	Unsure	Unsure
3.4	High Risk	High Risk	High Risk
4.0	Low Risk	Low Risk	Low Risk
3.0	Unsure	Unsure	Unsure
4.2	Unsure	Unsure	Unsure
5.2	Unsure	Unsure	Unsure
4.4	Unsure	Unsure	Unsure
3.4	High Risk	Unsure	High Risk
2.6	Low Risk	Low Risk	Low Risk
1.4	High Risk	High Risk	High Risk

Direction "E"			
Length (km)	Case 1 Poisson method: alpha = 0,05	Case 3 Poisson method: alpha = 0,01	Case 3 Poisson method: alpha = 0,10
	Ranking	Ranking	Ranking
1.4	High Risk	High Risk	High Risk
2.6	Low Risk	Low Risk	Low Risk
5.8	Unsure	Unsure	Unsure
1.8	Low Risk	Low Risk	Low Risk
5.0	Unsure	Unsure	Unsure
2.4	Unsure	Unsure	Unsure
3.0	Low Risk	Low Risk	Low Risk
2.4	Unsure	Unsure	Unsure
4.0	Unsure	Unsure	Unsure
5.4	Unsure	Unsure	High Risk
3.8	High Risk	High Risk	High Risk
5.0	Unsure	Unsure	Unsure
6.2	Unsure	Unsure	Unsure

- Small impact of alpha parameter in the Poisson method
- Only one or two sections are affected per direction of traffic across the different cases

Conclusions

- In all tested variations (as well as in most methodologies based on recorded crash data), a considerable percentage of the analyzed road network, is characterized as "unsure"
- For these sections, useful insights for road safety can be gained only through the application of proactive microscopic road safety analysis
- The choice of alpha parameter is not a critical factor for the classification
- By extending the section length in Case 4, the “zero-crash” sections were eliminated as they included parts of the road with crashes

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