Economic analysis of road infrastructure safety projects

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Together with:
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The Assignment

- **Objective:**
  Develop a methodology for the assessment of the economic feasibility of road safety schemes, to be applied in the Greece Road Rehabilitation and Safety Project by Egnatia Odos SA

- **Duration:**
  3 months (December 2018 – March 2019)

- **Carried out for:**
  European Investment Bank (EIB) / European Investment Advisory Hub (EIAH)

- **With the cooperation of:**
  Egnatia Odos S.A.
Egnatia Odos Road Safety Project

- 15,000km of roads outside built-up areas examined, covering the national & regional network of Greece (not including motorways).
- Over 7,000 hazardous locations identified, spread over 2,500 km on 80 roads.
- Hazardous locations categorized as:
  - Proven (HL-PR)
  - Testimony (HL-T)
  - Potential (HL-P)
- 60 Road Safety Interventions Design Studies (RSIS) completed (2012-2015).
- Total project cost estimated at 470m€.
Road Safety Interventions

- Construction of road markings (delineation)
- Installation of traffic signs, including speed limit signage
- Construction of new asphalt pavement
- Construction of anti-slip asphalt course
- Installation of roadside delineator posts
- Installation of centerline roadway deflectors
- Installation of transversal rumble strips (for speed reduction at intersection approaches)
- Installation of safety barriers
- Installation of side roadway deflectors
- Improvement of roadside conditions (e.g. reconstruction of shoulders, removal of vegetation, removal of roadside obstacles)
- Installation of road lighting
Data sources

- **Crash data**
  National Road Accident Database of ELSTAT (2013 – 2017), maintained by NTUA

- **Traffic data**
  Local traffic counts in Imathia and Viotia, combined with AADT estimations from the National Traffic Model for Greece, by the Ministry of Infrastructure & Transport

- **Road geometry and existing equipment**
  RSIS of Egnatia Odos S.A., complemented by data collected during site inspections

- **Suggested interventions**
  RSIS of Egnatia Odos S.A.
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Pilot site inspections

- 103 sites inspected (out of 255)
  - 61 in Viotia and 42 in Imathia: representative of all site categories

- General findings:
  - Selection of hazardous sites is appropriate.
  - Suggested road safety interventions are generally appropriate. Minor updates required.
  - Suggested measures are indeed road safety improvements, with only very few exceptions of maintenance activities.

- Specific findings:
  - 27 of 126 schemes in Imathia inside built-up areas, in contrast to project guidelines. These were excluded from the analysis.
  - New asphalt course already constructed in 9 sites
  - Minor improvements required in suggested signage and road restraint systems in a few sites.
Accident Prediction Models (APM)

- Based on the **HSM predictive method** (AASHTO, 2010), calibrated for Viotia and Imathia sites using local crash data.

- Separate APMs for **roadway segments**: 
  \[ N_{spf} = (AADT) \times (L) \times (365) \times (10^{-6}) \times e^{-0.312} \]
  
  and **intersections**:
  - Three-leg intersections with minor-road stop control: 
    \[ N_{spf} = \exp [-9.86 + 0.79 \times \ln(AADT_{maj}) + 0.49 \times \ln(AADT_{min})] \]
  - Four-leg intersections with minor-road stop control: 
    \[ N_{spf} = \exp [-8.56 + 0.60 \times \ln(AADT_{maj}) + 0.61 \times \ln(AADT_{min})] \]

- **Crash Modification Factors (CMFs)** used to account for differences between the base conditions of the model and local conditions of each examined site.

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Accident Prediction Models

- **Step 1**
  APMs applied to predict accidents for each hazardous location for base year.

- **Step 2**
  Prediction results compared to actual police recorded accidents for model calibration

- **Step 3**
  Calibrated APMs used to estimate the number of accidents without the project ("Business-As-Usual" scenario).

- **Step 4**
  Calibrated APMs used to estimate the number of accidents with the project.

- **Step 5**
  The difference between step 4 and step 3 number of accidents represents the **road safety benefit** of the examined interventions.

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Results

- Approximately **40% reduction** in injury accidents

- Casualty reductions, from 2017 to 2035 in Viotia and Imathia (as a total) – depending on scenario:
  - approximately **21 fatalities**
  - approximately **25 serious injuries**
  - approximately **139 slight injuries**

- **Economic Rate of Return (ERR)** – depending on scenario:
  - Viotia: 20% to 27%
  - Imathia: 13% to 19%
  - Whole Project (preliminary estimation): 12% to 19%
Scientific and Social Impact

- The methodology can be effectively utilized for the economic evaluation of road safety schemes even with **limited data availability**.

- It has been demonstrated that road infrastructure safety projects exhibit **very high ERR**, due to the low construction costs combined with the high valuation of road safety benefits (2,15M€ per fatality).

- Therefore, targeted low cost safety interventions in hazardous locations are a **particularly cost effective measure** for road safety improvement.
Future Challenges

- Road Authorities and Operators should be encouraged to use **APMs as a decision making tool**, to quantitatively justify road safety funds.

- The availability of **high quality data** (crash, traffic & road infrastructure) can further improve the **reliability and accuracy** of economic assessment tools.

- Effective identification of hazardous locations and selection of appropriate treatments requires a combination of **quantitative tools** and **solid engineering judgment**.
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