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# ASSESSMENT OF ROAD SAFETY MEASURES IN GREECE

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# The need for the assessment of road safety measures

*Road Safety*
*is a typical field*
*with high risk*
*of important*
*Investments*
*not bringing results*

# Research Objectives

**Investigate the basic elements of cost-benefit evaluation techniques through the assessment of selected road safety measures in Greece**

- Use these techniques for the assessment **of selected road safety measures** in Greece.
- Develop an appropriate framework to estimate **safety effects** and **road accident cost** in Greece.
- Reveal the most important **barriers** of the assessment techniques.
- Identify the **efficiency** of selected road safety measures.

# The framework of the research

- The different parts of the research were carried out at the National Technical University of Athens, during the period 1998 – 2003.

- Data used:
  - Road accident data (National Statistical Service/Police)
  - Cost of road accidents (Police, NSS, WTP survey)
  - Traffic data (National Tolls Authority)
  - Traffic infringements (Police)
  - Implementation of measures (Authorities)
  - Cost of road safety measures (Authorities)

# Safety effect (1)

- The expected **reduction in target accidents/casualties** following the implementation of a treatment, given in the form of a percentage.
- Estimation of the safety effect:
  - **Odds-Ratio method**

    **Estimated effect = [Xa/Xm]/[Ca/Cb]**

    where:

    Xa - the number of road accidents observed at the examined area in the "after" period

    Xm - the number of road accidents observed at the examined area in the "before" period

    Ca - the number of road accidents observed at the control group area in the "after" period

    Cb - the number of road accidents observed at the control group area in the "before" period

# Safety effect (2)

- **Test $X^2$**
  - Comparison of the number of accidents occurring in the **area examined** with the accidents occurring in the **control group area**.

    $$\mathbf{X^2 = (\Psi - X^*A)^2 / (X+\Psi)^*A} \quad (1)$$

    where: $A = \Psi_E / X_E$ (2)

  - Comparison of $X^2$ with the $X^2_\alpha$ value for a given **probability standard** α and for n=1 **freedom standard**.

# Road accidents cost in Greece (1)

Estimation of the costs of various components of **accidents cost** for fatal accidents, injury accidents and material damage accidents, including:

- Material damage costs
- Police costs
- Fire brigade costs
- Insurance companies cost
- Court costs
- Lost production output
- Pain and grief
- Rehabilitation costs
- Hospital treatment and rehabilitation
- First aid and transportation costs

# Road accidents cost in Greece (2)

- Estimation of **human cost** in Greece based on willingness-to-pay method:

**VoSL = (NAEIS) / (LSE)**

where:

**VoSL**: **V**alue **o**f **S**tatistical **L**ife

**NAEIS**: **N**ational **A**nnual family **E**xpenditure on **I**mproving **S**afety

**LSE**: expected **L**ives **S**aved from this **E**xpenditure annually

| **Cost of Accident (1999) with:** | **Killed** | **Seriously Injured** | **Slightly Injured** |
|---|---|---|---|
| Material Damage cost (€) | 28.769 | 18.175 | 13.904 |
| Generalised cost (€) | 442.467 | 23.907 | 6.960 |
| Human cost (€) | 612.141 | 467.703 | 206.340 |
| **Total accident cost (€)** | **1.083.377** | **509.785** | **227.204** |

# 1. Cost-Benefit analysis on the development of motorways (1)

- Upgrade two sections of 70 km each, of the main national road axis Patras - Athens - Thessaloniki - Evzoni (~750 km) into **motorway**.
  - **Before**: two-way, one lane per direction, no median
  - **After**: two-way, three lanes per direction, median

Basic road safety related figures in the examined axis before-and-after the upgrade into motorway

| | Before (1986-1990) | | After (1996-1999) | | **Change** |
|---|---|---|---|---|---|
| | total | per year | total | per year | |
| Accidents | 1279 | 259 | 559 | 140 | **-46%** |
| Persons killed | 369 | 74 | 145 | 36 | **-51%** |
| Veh-Km (billion) | 8,5 | 2 | 9,54 | 2 | **40%** |
| Accidents per billion veh-Km | | 153 | | 59 | **-62%** |
| Killed per billion veh-km | | 43 | | 15 | |
| Killed per 100 accidents | | 28 | | 26 | **-9%** |

# 1. Cost-Benefit analysis on the development of motorways (2)

- "Before-and-after" assessment methodology with **large control group**.
- Safety effect was quantified by using the **odds-ratios** technique.

**Safety effect** of the construction of motorways

| | **Athens - Lamia sections** | | | | **Athens - Korinthos sections** | | | |
|---|---|---|---|---|---|---|---|---|
| | Treatment group | | Control group | | Treatment | | Control group | |
| | Before | After | Before | After | Before | After | Before | After |
| Number of accidents | 159 | 66 | 437 | 341 | 210 | 79 | 437 | 341 |
| Odds | 0,415 | | 0,780 | | 0,376 | | 0,780 | |
| Odds ratio | 0,532 | | | | 0,482 | | | |
| Ln(OR) | -0,631 | | | | -0,730 | | | |
| **Safety effect** | **47%** | | | | **52%** | | | |
| Lower limit | 27% | | | | 64% | | | |
| Upper limit | 61% | | | | 35% | | | |
| **Number of accidents prevented** | **157** | | | | **245** | | | |

# 1. Cost-Benefit analysis on the development of motorways (3)

- **Accidents costs**: calculated by weighting the reference values to the respective proportion of casualties per severity in the examined sections.

- **Total implementation costs**: obtained from the Ministry of Environment, Physical Planning and Public Works. Costs corresponding to the examined "after" period (1996-1999) calculated as a proportion of the total cost of the project and 15% of the total construction cost was considered as maintenance costs.

**Cost-benefit analysis** on motorways (in terms of safety only)

| | **Athens - Lamia** | **Athens - Korinthos** |
|---|---|---|
| Number of accidents prevented | 157 | 245 |
| Average accident cost | 347.920 | 373.902 |
| **Present value of benefits (€)** | 54.571.805 | 91.477.809 |
| **Total Cost (€)** | 31.602.789 | 43.084.780 |
| **Benefit - Cost Ratio** | **1,7 : 1** | **2,1 : 1** |

# 2. Cost-Benefit analysis on traffic calming measures (1)

- Installation of **speed humps** and **woonerfs** in one-lane, one-direction streets between the years 1991 and 1999 in the Municipal Area of Neo Psychiko.
- Implementation cost for **speed humps**: designing and construction/installation costs, road markings. 49 speed humps were installed in 21 one-lane, one-direction roads.
- Implementation cost for **woonerfs**: design cost, configuration and pavement cost, hydraulic works cost, electrical works and sewage pipelines installation. Total area of 100.000m2 in 40 local roads was transformed into woonerfs.

# 2. Cost-Benefit analysis on traffic calming measures (2)

Traffic calming measures **implementation cost** (1998)

| **Traffic calming measures** | **Amount** | **Cost** |
|---|---|---|
| Speed humps | 49 units | 111.518€ |
| Woonerfs | 100.000$m^2$ | 3.081.438€ |
| **Total Implementation Cost** | 3.192.956€ | |
| **Implementation Cost (Period examined)** | 1.596.478€ | |

# 2. Cost-Benefit analysis on traffic calming measures (3)

All **injury accidents** in one direction - one lane streets

| **Time period** | **Area** | |
|---|---|---|
| | Area examined | Control group |
| Before (1985-1990) | X = 36 | $X_E = 101$ |
| After (1994-1999) | $\Psi = 33$ | $\Psi_E = 149$ |
| **Change** | -8.3% | 47.5% |

- Estimated $X^2 = 3.972 > 3.84$ ($X^2$ value for 95% probability standard). Statistical significant reduction in accidents.

**Safety effect** of speed humps and woonerfs

| **Treatment type** | **Estimated effect-WME** | **WME confidence interval** |
|---|---|---|
| Speed humps and woonerfs in the Municipality of Neo Psychiko | 0.621 | (0.363, 1.061 ) |

- Safety effect: **38% reduction** in total number of road accidents (**14 accidents** prevented).

# 2. Cost-Benefit analysis on traffic calming measures (4)

- **Time lost** due to reduced travel speeds:

$$T = D * Q * V * P$$

where:

T: value of time lost due to delays resulting traffic calming measures implementation

D: average delay per vehicle (60 sec)

Q: average daily traffic volume in area considered (8.680 veh.)

V: average value of time (hourly) per vehicle (4,5€/hour)

P: period (260 days/year)

- **Accident cost** for accidents in urban areas: costs of fatal and injury accidents weighted in relation to average distribution of accident casualties per casualty severity in urban areas.

# 2. Cost-Benefit analysis on traffic calming measures (5)

## Calculation of the **cost-benefit ratio**

| | **Scenario 1**<br>**Safety benefits only** | **Scenario 2**<br>**Including time lost** |
|---|---|---|
| **Present value of benefits** | | |
| Number of accidents prevented | 14 | 14 |
| Average accident cost - 1999 (€) | 284.667 | 284.667 |
| Value of time lost - 1999 (€) | - | 902.720 |
| Total (€) | 3.985.338 | 3.082.613 |
| **Present value of costs** | | |
| Implementation cost - 1999 (€) | 1.660.337 | 1.660.337 |
| **Cost-benefit Ratio** | **2,4 : 1** | **1,9 : 1** |

- In both scenarios, the implementation of speed humps and woonerfs in a broad local area can be **cost-effective**, despite the high implementation cost.

# 3. Cost-Benefit analysis on speed and alcohol enforcement (1)

- Since 1998, intensification of road safety enforcement; gradual increase of road controls for the two most important infringements: **speeding**, **drinking and driving**.

**Basic trends** of road safety related figures in Greece (1998 - 2002)

| | 1998 | 1999 | 2000 | 2001 | 2002 | 5-year change |
|---|---|---|---|---|---|---|
| **injury road accidents** | 24.819 | 24.231 | 23.127 | 19.710 | 16.852 | **-32%** |
| **persons killed** | 2.182 | 2.116 | 2.088 | 1.895 | 1.654 | **-24%** |
| **vehicles (x1000)** | 4.323 | 4.690 | 5.061 | 5.390 | 5.741 | **33%** |
| **speed infringements** | 92.122 | 97.947 | 175.075 | 316.451 | 418.421 | **354%** |
| **drink & drive infringements** | 13.996 | 17.665 | 30.507 | 49.464 | 48.947 | **250%** |
| **drink & drive controls** | 202.161 | 246.611 | 365.388 | 710.998 | 1.034.502 | **412%** |

# 3. Cost-Benefit analysis on speed and alcohol enforcement (2)

- **Enforcement costs**: police labour costs, police vehicle costs and police speed and alcohol enforcement equipment costs (speed cameras, alcoholmeters etc).

**Enforcement Implementation Costs** 1998 - 2002 (prices of 2002)

| | **Speed** | | **Alcohol** | |
|---|---|---|---|---|
| | Shifts | Arrests | Shifts | Arrests |
| Number of infringements | 1.007.894 | | 146.583 | |
| Number of activities | 62.993 | 30.237 | 128.260 | 14.658 |
| Person-hours per activity | 24 | 14 | 24 | 14 |
| Hourly rate (€) | 7,50 | | 7,50 | |
| Labour Costs | 11.338.808 | 3.174.866 | 23.086.823 | 1.539.122 |
| **Total Labour Costs (€)** | **14.513.674** | | **24.625.944** | |
| Number of vehicles per activity | 1 | 1 | 1 | 1 |
| Average distance travelled per activity (Km) | 20 | 5 | 5 | 5 |
| Unit Cost per Km (€) | 0,10 | 0,10 | 0,10 | 0,10 |
| Vehicle Costs | 125.987 | 15.118 | 64.130 | 15.118 |
| **Total Vehicle Costs (€)** | **141.105** | | **79.248** | |
| **Total Equipment Costs (€)** | **159.950** | - | **4.670** | - |
| **Total Implementation Costs (€)** | **39.524.591** | | | |

# 3. Cost-Benefit analysis on speed and alcohol enforcement (3)

- **Cluster analysis** aiming at identifying groups with similar characteristics within 52 departments of Greece.
- Development of **Poisson regression models** for quantification of the separate effect of various types of enforcement.
- Two categories of models:
  - Models with **no time-halo** in the effect of enforcement
  - Models with a **time-halo** in the effect of enforcement

**Safety effect** of enforcement 1998 - 2002

| | No time-halo-effect | | | | Two months time-halo-effect | | | |
|---|---|---|---|---|---|---|---|---|
| Department Group | I | II | III | IV | I | II | III | IV |
| Marginal effect* of speed infringements | | -1,239 | | -1,542 | | -2,224 | | -2,053 |
| Marginal effects* of alcohol controls | | -1,929 | | -1,373 | | -2,265 | | -2,684 |
| Number of accidents prevented | | 475 | | 297 | | 614 | | 528 |
| **Total number of accidents prevented** | **772** | | | | **1.142** | | | |

*expected accidents prevented from a 1000 infringements/controls increase

# 3. Cost-Benefit analysis on speed and alcohol enforcement (4)

**Cost-Benefit Analysis** on speed and alcohol enforcement

| | **Conservative scenario** No time-halo-effect | **Best Scenario** Two months time-halo-effect |
|---|---|---|
| Number of accidents prevented | 772 | 1.142 |
| Average accident cost | 309.723 | 309.723 |
| **Present value of benefits (€)** | 259.313.657 | 383.471.514 |
| Cost of speed enforcement | 14.814.729 | |
| Cost of alcohol enforcement | 24.709.862 | |
| **Total Implementation Cost (€)** | 39.524.591 | |
| **Benefit - Cost Ratio** | **6,6 : 1** | **9,7 : 1** |

- Nationwide intensification of speed and alcohol enforcement in Greece was found to be **highly cost-effective.**
- Important accident and casualty prevention could motivate **decision makers** towards further improvement of the implementation and monitoring of the measures.

# Conclusions (1)

- Cost benefit analyses can provide reliable and interesting results as far as **input data and methodology application** are appropriate.
- **Important benefits** can be obtained with relatively limited resources.
- **Behaviour enforcement** is highly effective (6,6 - 9,7) due to moderate implementation cost and significant casualty reduction.
- **Infrastructure improvement** is less effective (motorways: 1,7 - 2,1, low cost measures 1,9 - 2,4) due to high implementation cost and moderate casualty reduction.

# Conclusions (2)

- Several common **technical issues**, which might occur during the Cost-Benefit Analysis evaluations are:
  - correct application of the odds-ratio technique
  - ways for checking the statistical significance of the evaluation results
  - selection of side-effects to be considered along with safety effects
  - correct distinction between the implementation costs and negative side-effects of the measure
- Major **barriers** for performing efficiency assessment of road safety measures are:
  - lack of information on safety effects and costs
  - doubts on the validity of the available values
  - lack of obligatory procedure for the performance of cost-benefit evaluations of safety effects

# ASSESSMENT OF ROAD SAFETY MEASURES IN GREECE

As described at the National Road Safety Strategic Plan, only a systematic monitoring of both the road safety performance and the road safety measures and their effects, can provide a useful tool for the efficient implementation of all Programmes and measures foreseen.

***If you can not measure it,***

***you can not improve it***

***Lord Kelvin***