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# Comparative Investigation of Road Accident Cost in The European Union


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# Introduction

- The increasing use of means of transport leads to human and material losses with huge social and economic costs.
- Road deaths and injuries to EU countries is estimated to cost 270 billion euro (SafetyCube, 2017).
- Fundamental aspects of road safety i.e., economic features, social indicators and transport networks should be investigated more profoundly.

# Literature Review

- The total road crashes costs correspond to 0.4% - 4.1% of GDP[1].
- Road fatalities rates are related to GDP per capita, vehicle density per road distance and population per hospital bed[2].
- An increase in unemployment implies an initial decrease in number of drivers involved in road crashes and a later increase (i.e., the following month) in the change in unemployment[3].
- Spending on health care system is associated with a decreasing fatal injuries rate among road crashes victims[4].

[1](SafetyCube, 2017), [2](Jacobs & Cutting, 1986), [3](Wagenaar, 1983), [4](Söderlund & Zwi, 1995)

# Objective

- This study aims at developing a comparative investigation of road accident cost in the European Union countries.

- Additionally, the implemented statistical models correlate accident cost with social, transport and economic indicators.

# Databases

- Eurostat database (2015):
  - Population
  - GDP per capita
  - Road fatalities
  - Modal split
  - Number of passenger enterprises per total enterprises
  - Transport costs share of total household consumption
- SafetyCube research project: Economic data
- Economist Intelligence: Misery Index (MI)
- World Health Organization (W.H.O.): Suicides

# Methodology

## Multiple Linear Regression Models:

- Cost per Fatal Accident
- Cost per Accident with Serious Injury

## Two-Step Cluster:

- EU countries were categorized into three solid categories

## Regression Model using Cluster Analysis:

- Use clusters as independent variables in regression

## Sensitivity/Elasticity Analysis:

- Elasticity
- Relevant Elasticity

# Results (1/3)

## Countries Clusters (two-step cluster):

- **High Economic Performance Countries:**
  Austria, Belgium, Denmark, Finland, Luxembourg, Netherlands, Norway, Sweden, Switzerland
- **Low Economic Performance Countries:**
  Bulgaria, Croatia, Czech Republic, Estonia, Greece, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovenia, Slovakia
- **Largest Countries:**
  France, Germany, Italy, Spain, United Kingdom

# Results (2/3)

## ➢ Regression with each country:

| | Cost per Fatal Accident | | Cost per Accident with Serious Injury | |
|---|---|---|---|---|
| | $R^2$ | ANOVA (p-value) | $R^2$ | ANOVA (p-value) |
| | 0,414 | 0,019 | 0,388 | 0,029 |
| **Independent Variables** | **t-statistic** | **p-value** | **t-statistic** | **p-value** |
| Constant | 1,939 | 0,066 | 8,378 | 0,000 |
| Cars per million population | 2,730 | 0,013 | - | - |
| Log(Suicides) | - | - | 2,346 | 0,029 |
| Misery Index | - | - | 2,259 | 0,035 |
| Misery Index$^2$ | 1,675 | 0,109 | - | - |
| Passenger car use rate | - | - | -2,917 | 0,008 |
| Passenger car use rate$^2$ | -2,208 | 0,039 | - | - |
| Road fatalities (per million population) | - | - | -2,760 | 0,012 |
| Suicides/Road fatalities | 1,760 | 0,093 | - | - |

Approval Criteria:

## ➢ Variable Correlation test:

- Pearson correlation index (≤0.6)

## ➢ Statistical tests:

- Correlation coefficient $R^2$ (≥0,3)
- T-student index (t-statistic >1,645 or p-value ≤0,05)

# Results (3/3)

## ➢ Regression using countries clusters:

| Independent Variables | Cost per Fatal Accident | |
|---|---|---|
| | $R^2$ | ANOVA (p-value) |
| | 0,57 | 0,08 |
| | t-statistic | p-value |
| Constant | 11,108 | 0,000 |
| Low economic performance countries | -4,136 | 0,001 |
| Largest countries | -1,954 | 0,066 |
| Passenger enterprises / Total enterprises | -1,89 | 0,074 |
| Log (Transport costs share of total household consumption) | 2,734 | 0,013 |
| Misery Index[4] | 1,661 | 0,113 |
| Passenger car use rate[2] | 1,676 | 0,110 |

# Elasticity analysis

Variables with the highest impact on fatality cost (descending order):

- Passenger car use rate
- Cars per million population
- Suicides/Road fatalities
- Misery Index

Specifically, passenger car use rate affects the cost about 11 times more compared to Misery Index

| Independent Variables | Cost per Fatal Accident | | |
|---|---|---|---|
| | Coefficient $\beta$ | Elasticity $\varepsilon$ | Relevant elasticity $\varepsilon$ |
| Cars per million population | 159217,002 | 0,788 | 7,156 |
| Misery Index | 1174,177 | 0,110 | 1,000 |
| Passenger car use rate | -325,614 | -1,269 | -11,526 |
| Suicides/Road fatalities | 28890854,530 | 0,357 | 3,248 |

# Conclusions (1/2)

- An increase of the economic indicator Misery Index (i.e., mainly due to the rise in unemployment), leads to an accident costs increase.
- The reduction of passenger car use rate is associated with the increase of accident costs, probably due to the high quality of public transportation in countries where human life is valued more.
- Suicides are positive correlated with accident costs, which needs more profoundly investigation.

# Conclusions (2/2)

- Combining cluster analysis with regression revealed that increasing GDP per capita, road fatalities per million population are reduced.
- By reducing the passenger transport enterprises share amongst the total number of road transport enterprises, the fatality cost is reduced.
- The increase of transport costs, which indicates a rise in fares and transport infrastructure, contributes to the increase of accident costs.

# Suggestions

- Economic and social indicators, such as suicides and unemployment, should be taken into account by the authorities when implementing road safety strategies.
- Investigating the passenger transport enterprises share can be concluded that by limiting heavy vehicle driving hours can significantly reduce the financial consequences of road crashes.
- Economic high performance countries should invest in research and development of accident management systems, aiming at diminishing fatalities, injuries, and losses.

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