Investigating the Correlation between Driver's Characteristics and Safety Performance

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Scope

- **Interaction** of driving behavior’s elements with each other
- Definition of the overall **traffic behavior** of the driver
- Identification of those characteristics that contribute to a more **risky driving** behavior compared to those of more cautious drivers

Correlation of driver's characteristics and road safety performance
Background (1/2)

- **Road accidents factors**
  - Vehicle
  - Road environment
  - Human factor

- **Driving behaviour characteristics**
  - Speeding
  - Harsh braking/ acceleration/ cornering
  - Understanding, perception and quality of traffic participation
  - Seatbelt use
  - Mobile phone use
Background (2/2)

**Literature Review** findings:

- Development of a driver's **risk indicator** with aim to assess the effects of driver's characteristics on road safety.

- Use of **factor analysis**, to minimize the dimensionality of a dataset and identify the critical factors that describe adequately driving behavior.

- Use of **cluster analysis**, to classify drivers as "less risky" and "risky" or "efficient" and "inefficient" drivers.

- **Drivers’ self-assessment** in conjunction with feedback for their actual driving behavior may reduce their driving risk.
Methodology

Statistical analysis of the selected data in two steps:

- **Factor analysis to reduce the dimensionality of the dataset and identify the main factors**
  - Significant number of variables
  - Correlation between the variables
  - Collation of variables into factors
  - Interpretation of the factors

- **Multiple linear regression model**
  - Continuous (dependent) variable $Y$
  - Explanatory (independent) variables $X$
  - No correlation among the independent variables

\[ Y_i = \beta_0 + \beta_1 * X_{1i} + \beta_2 * X_{2i} + \beta_3 * X_{3i} + \cdots + \beta_k * X_{ki} + \epsilon_i \]
Data collection (1/2)

- **On-road driving experiment**
  - Assessment of **12 participants** on 16 driving characteristics
  - **8.8 kilometers** of urban and interurban road network
  - **21 minutes** total travel time
  - **Interurban** section was selected in the analysis
  - **In-car** safety behavior expert
Data collection (2/2)

- Survey
  - Questionnaire of **78 questions**
  - Basic **demographics** (age, gender, education, etc.)
  - Driving **experience** (kilometers travelled inside and outside urban areas, etc.)
  - Potential **offending** behavior (number of accidents, traffic infringements, etc.)
  - **Self-evaluation** questions about driving behavior (risky driving, steep acceleration, how cautious is as a driver, etc.)
## Table 1: List of driving indicators used for the assessment of driver's performance

<table>
<thead>
<tr>
<th>a/a</th>
<th>Indicator</th>
<th>a/a</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speed adaptation</td>
<td>9</td>
<td>Understanding, perception and quality of traffic participation</td>
</tr>
<tr>
<td>2</td>
<td>Braking</td>
<td>10</td>
<td>Crossing or junction</td>
</tr>
<tr>
<td>3</td>
<td>Accelerating</td>
<td>11</td>
<td>Anticipation and perception of road signs and traffic signals</td>
</tr>
<tr>
<td>4</td>
<td>Turning</td>
<td>12</td>
<td>Joining the traffic stream</td>
</tr>
<tr>
<td>5</td>
<td>Headways</td>
<td>13</td>
<td>Visual behavior and communication</td>
</tr>
<tr>
<td>6</td>
<td>Lateral Position</td>
<td>14</td>
<td>Mirror use</td>
</tr>
<tr>
<td>7</td>
<td>Ability to choose the correct lane</td>
<td>15</td>
<td>Use of direction indicator</td>
</tr>
<tr>
<td>8</td>
<td>Lane change</td>
<td>16</td>
<td>Steering firmness</td>
</tr>
</tbody>
</table>
Main factors (1/2)

- **4 factors** are extracted, from which only the three first variables are analyzed, since the last one cannot be adequately interpreted.
- All 3 factors explain the **68.54%** of the total variance.
- These factors describe drivers’ characteristics and their perceptions on their behavior.
### Table 2: Variable loadings on the estimated factors

<table>
<thead>
<tr>
<th>Variables</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>In how many accidents were you involved as a driver?</td>
<td>.740</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During the last two years, how many times did you offend the Traffic Law while driving?</td>
<td></td>
<td>.714</td>
<td>-.541</td>
<td></td>
</tr>
<tr>
<td>At what extent do you keep the speed limits while driving on motorways?</td>
<td>-.926</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How aggressive would you assess yourself as a driver?</td>
<td></td>
<td>-.667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often do you consider your braking to be harsh?</td>
<td>.860</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often do you consider your acceleration to be harsh?</td>
<td>.680</td>
<td>.660</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How often do you consider your turning to be harsh?</td>
<td>.898</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Braking</td>
<td></td>
<td>-.523</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerating</td>
<td></td>
<td>.589</td>
<td>.625</td>
<td></td>
</tr>
<tr>
<td>Headways</td>
<td></td>
<td></td>
<td>-.550</td>
<td>.653</td>
</tr>
</tbody>
</table>
Dependent variable:
- Overall on-road driving performance score (Indicator of driver’s overall performance under normal driving conditions, as assessed by an expert, at a scale from 0% to 100%)

Independent variables:
- Years of driving
- Headways (participant’s distance from the vehicle in front)
- Self-Efficiency (participant’s self-assessment on driving efficiency)
- Defensive driving (participant’s ability to forecast, identify and take all necessary actions to safely avoid potential accident risks)
Linear regression model (2/2)

Table 3: Parameter estimates and fit of the linear regression model

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>.449</td>
<td>.056</td>
<td>8.067</td>
<td>.000</td>
</tr>
<tr>
<td>Years of driving</td>
<td>.010</td>
<td>.003</td>
<td>.569</td>
<td>3.250</td>
</tr>
<tr>
<td>Headways 4</td>
<td>.142</td>
<td>.044</td>
<td>.555</td>
<td>3.198</td>
</tr>
<tr>
<td>Efficient driver 3</td>
<td>.141</td>
<td>.049</td>
<td>.554</td>
<td>2.857</td>
</tr>
<tr>
<td>Defensive driving 3</td>
<td>.108</td>
<td>.044</td>
<td>.424</td>
<td>2.444</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.721</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F statistic</td>
<td>8.155</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusions (1/2)

- **Driving experience** is the most important factor in predicting driving safety behavior and efficiency as expressed in the total driving assessment.

- Overall, the total set of actions/behavior that allows the driver to predict, identify and take appropriate action to avoid potential risk composes the factor of **defensive driving** and significantly affects total driving safety behavior.

- Keeping the appropriate **headways** from the vehicle ahead and self-reported dexterity have a positive impact on the overall performance indicator.
Conclusions (2/2)

The factors describing the correlation between driver safety features and performance can be grouped into three groups each of which includes:

- Drivers' perception of **superficial driving**, including features related to dangerous road behaviors.

- The perception of **aggressive behavior**, through questions related to the reported number of violations and errors as assessed in the experimental process.

- Drivers' perception of **cautious driving**, including the self-reported frequency with which the driver abruptly brakes, but also how well he keeps distances from the vehicle ahead.
Future research

- Implementation of the experiment with a larger number of participants, in different traffic conditions and other road environments (urban, motorway, high / low traffic, day / night etc.).

- Comparison between the findings of this research and the driving characteristics of a driver in a driving simulator.

- Use state-of-the-art technology for driver's behavior monitoring together with driving assessment by an expert.

- Further statistical analysis by applying other methods of a different family than the one selected.
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