Power-Two Wheelers Critical Risk Factors
A European Study

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The 2BESAFE project

- Research on Power Two Wheeler (PTW) crash causes and human error
- The world’s first naturalistic riding experiment involving instrumented PTW
- Research on motorcycle rider risk awareness and perception
- Development of new research tools
- In-depth research on PTW crash factors
- Development of recommendation for practical counter measures
Powered-Two Wheelers

• PTWs is an individual transport mean

• Share the same operational environment of car and trucks but have huge differences from the rest of vehicles

• PTW riders with high risk and accident involvement
Powered-two Wheelers

• Several PTW-related research projects have already been undertaken in Europe:
  – To better understand rider accidentology (e.g. MAIDS, RIDER);
  – to improve PTW passive safety (e.g. APROSYS SP4, MYMOSA, SIM, COST 357-PROHELM);
  – to use ADAS and IVIS to improve riders' safety (e.g. WATCH-OVER, PreVENT, TRACE, SAVE-U);
  – to understand the sociology of PTW riders (e.g., MAIDS);
  – To study of the normal (or naturalistic) behaviours of PTW riders in normal and emergency riding situations → 2-BE-SAFE
Scope

• To study the interactions of PTW accidents with:
  1. Rider/Driver Behavior
  2. Infrastructure
  3. Weather

• Questions addressed:
  1. What knowledge has already been obtained for each road user?
  2. What are the most relevant accident configurations at European level?
  3. Why accidents of those configurations take place?
Rider-Driver Interactions

- **Methodology**
  - Analyses in macro and micro level (2 years period, from 2006 to 2007)
Rider-Driver Interactions

• Prevailing PTW accident scenarios were identified
  – 20 PTW accident configurations were detected, common or not to the five countries involved.

• 9 accident scenarios were selected for further analysis.
  – For example single moped/motorcycle accidents inside/outside urban area, accidents between a moped/motorcycle and other vehicle and so on
Rider-Driver Interactions

• Critical factors from Microscopic Analysis:
  – Perception of drivers/riders
  – Human errors
    • failure in perceiving the moped by another vehicle driver
    • Loss of control when experiencing a guidance problem
    • poor reaction to an external distraction due to excessive speeds, risk taking, and so on
  – Collision type (rural/urban, PTW single accident or more than one vehicle accidents etc)
  – Conspicuity, perception of drivers for motorcycles
• Macroscopic analysis - Data

– Accident statistics from national databases of Greece, Spain, Great Britain and Italy from 2005 to 2007
– Basic framework of comparable queries
– Specific queries and cross-tabulations for “extra benefits”
Road Infrastructure

• Risk factors:
  – Type of area (inside / outside urban area)
  – Junction type (Intersection or not)
  – Type of collision
  – Road geometry
  – Specific results
    • curves and descending gradients (Greece)
    • Roundabouts and age (GB)
    • Less front to side accidents at roundabout in comparison to other junction types, however more sidewipe accidents (Spain)
    • Accidents on wet and slippery roads are less severe than on dry roads (Italy)
Road Infrastructure

- Microscopic Analysis Methodology
  - In-depth accident data analysis (CIDAUT)

- Linkage of crash data, road geometry data and road surface data using special measurement vehicle and software tools (BASt, AIT)
Road Infrastructure

• Risk factors from microscopic analysis
  – Critical sequence of curve radii (especially consecutive curves with very different or with decreasing curve radii)
  – Left curves (especially in sections with descending gradient)
  – Critical curve radii lower than 100m
  – Deficits concerning the longitudinal evenness and the transversal evenness seems to present risk factors for PTW rider
Weather Conditions

• Problem:
  – Accident statistics biased by weather conditions

• Literature:
  – Hardly anything controlled for exposure
  – Nothing about PTWs

• Macroscopic Analysis:
  – Executed, but no solution
Weather Conditions

Weather impact by:

- Exposure
- Intrinsic risk
- Risk compensation

- Riders
- Riders on the road
- Riders in danger
- Rider risk

OVERALL RISK
Methodology and data

X.... Weather Station

... Accident
Weather Conditions - Findings

<table>
<thead>
<tr>
<th>Regression Curve</th>
<th>Function</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekend</td>
<td>$y = 26,109e^{-0.474x}$</td>
<td>0.9061</td>
</tr>
<tr>
<td>Workday</td>
<td>$y = 18,298e^{-0.378x}$</td>
<td>0.9656</td>
</tr>
<tr>
<td>Workday &amp; Weekend</td>
<td>$y = 15,589e^{-0.337x}$</td>
<td>0.9718</td>
</tr>
</tbody>
</table>

Austrian average rain likeability vs. Accidents/Day
### Weather Conditions

- 95% of variance can be explained by variation of weather conditions
- Mission completed!
- Exposure data needed to proceed

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Days</th>
<th>Accidents</th>
<th>Statistical values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td>0%-15%</td>
<td>210</td>
<td>245</td>
<td>196</td>
</tr>
<tr>
<td>15%-30%</td>
<td>55</td>
<td>60</td>
<td>61</td>
</tr>
<tr>
<td>30%-45%</td>
<td>47</td>
<td>35</td>
<td>57</td>
</tr>
<tr>
<td>45%-60%</td>
<td>35</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>60%-75%</td>
<td>14</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>75%-100%</td>
<td>4</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>365</strong></td>
<td><strong>365</strong></td>
<td><strong>366</strong></td>
</tr>
</tbody>
</table>
# Summary of critical PTW risk factors

<table>
<thead>
<tr>
<th>Element</th>
<th>Macroscopic Analysis</th>
<th>Microscopic Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rider/Driver Behavior</td>
<td>Prevailing PTW accident scenarios with respect to:</td>
<td>moped riders:</td>
</tr>
<tr>
<td></td>
<td>• the number of vehicles (including pedestrians) involved in the accident.</td>
<td>• age, experience</td>
</tr>
<tr>
<td></td>
<td>• the area of the accident (outside or inside urban area),</td>
<td>• riding frequency</td>
</tr>
<tr>
<td></td>
<td>• accident occurring at a junction or not and the type of the opponent (vehicle) in</td>
<td>• state of moped</td>
</tr>
<tr>
<td></td>
<td>the accident</td>
<td>• PTW apparel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Human errors (looking but not seeing, failure in perceiving the moped)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• voluntary risk taking behavior conspicuity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• lack skills and knowledge about riding.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motorcycle riders:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• age, experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• human functional failures (loss of control when experiencing a guidance problem or</td>
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<tr>
<td></td>
<td></td>
<td>the poor reaction to an external distraction due to excessive speeds, risk taking)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• the lack of perception (from the passenger car driver and of the motorcyclists)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• conspicuity (the driver fails to see the motorcyclist)</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>The type of area</td>
<td>Crossfall and curve radius (radii smaller than 200m)</td>
</tr>
<tr>
<td></td>
<td>Carriageway type</td>
<td>curvature change rate</td>
</tr>
<tr>
<td></td>
<td>Road Installations and stationary objects</td>
<td>Black spots for passenger cars</td>
</tr>
<tr>
<td></td>
<td>Pavement surface conditions</td>
<td>Deficits (general unevenness for example are road surface waves as well as potholes)</td>
</tr>
<tr>
<td></td>
<td>Junction type</td>
<td>friction value</td>
</tr>
<tr>
<td></td>
<td>Geometry specifications</td>
<td>accumulation of bituminous binders and ruts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not-predictable road geometry</td>
</tr>
<tr>
<td>Weather Conditions</td>
<td>Meteoroosensitivity</td>
<td>PTW accidents correlate with weather conditions. This correlation can be described</td>
</tr>
<tr>
<td></td>
<td>Precipitation intensity</td>
<td>in mathematical terms.</td>
</tr>
<tr>
<td></td>
<td>Snowfall</td>
<td>The accident record of a year can be normalized using a correlation between accidents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and weather conditions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The correlations between weather and accident numbers differ for weekends and workdays</td>
</tr>
</tbody>
</table>
Concluding Remarks

• The synthesis of the results from the macroscopic and in-depth studies reveals the complete size and the characteristics of the road accidents phenomenon.

• The use of different accident configurations adds value to the analysis results.
Concluding Remarks

• Exposure disaggregate data (veh-kms etc) are necessary for the identification of accident risk.

• Datasets should be reliable, compatible and comparable across Europe through the use of common collection forms.
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