Powered Two Wheeler critical risk factors
Behaviour - Infrastructure - Weather

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Phan Vuthy, CEESAR - Peter Saleh, AIT – Martin Winkelbauer, KfV
Objectives and Activities

- Describe the interactions between PTW accidents and...

Diagram:
- Road Infrastructure (AIT)
- Rider/Driver Behavior (CEESAR)
- Weather Conditions (KfV)

PTW Road Safety
Description of Work

- **Duration:**
  - January 2009 to June 2010

- **Partners:**
  - INRETS, CEESAR, TUD, BAST, UNIFI, TRL, AIT, KfV, UNIVIE, NTUA, CIDAUT, VTT

- **Reporting – Deliverables**
  - State-of-the-Art Report (M5 internal)
  - D1 - Rider/driver behaviours and PTW safety
  - D2 - Road infrastructure and PTW safety
  - D3 - Weather conditions and PTW safety

Available at [www.2besafe.eu](http://www.2besafe.eu)
Methodology

Research Questions

1. What knowledge has already been obtained for each road user?
   → Literature Review

2. What are the most relevant accident configurations at EU level?
   → Descriptive Analysis

3. Why accidents of those configurations take place?
   → In-depth Analysis

Common methodological framework to all activities
<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Interaction</th>
<th>Magnitude</th>
<th>Need for Further Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway design defects</td>
<td>Infrastructure</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Roadway maintenance defects</td>
<td>Infrastructure</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Road surface condition</td>
<td>Infrastructure</td>
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<tr>
<td>Collision with road side barriers in a run-off accident</td>
<td>Infrastructure</td>
<td>High</td>
<td>Low</td>
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<td>Critical curve radii</td>
<td>Infrastructure</td>
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<td>Low</td>
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<tr>
<td>“Negative” crossfall</td>
<td>Infrastructure</td>
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<td>Low</td>
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<tr>
<td>Combined effect of crossfall, gradient and direction of curve</td>
<td>Infrastructure</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Intersections</td>
<td>Infrastructure</td>
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<tr>
<td>Road surface condition</td>
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<td>Low</td>
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<tr>
<td>Speeding</td>
<td>Rider/Driver Behavior</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Riding/Driving Attitudes and Patterns</td>
<td>Rider/Driver Behavior</td>
<td>High</td>
<td>High</td>
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<tr>
<td>Age, Gender and experience</td>
<td>Rider/Driver Behavior</td>
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<td>Low</td>
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<tr>
<td>Licensing, Education and Training</td>
<td>Rider/Driver Behavior</td>
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<td>Low</td>
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<tr>
<td>Perception of drivers/riders and human errors</td>
<td>Rider/Driver Behavior</td>
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<td>High</td>
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<tr>
<td>Drivers’ Perception of motorcycles</td>
<td>Infrastructure/vehicle</td>
<td>Low</td>
<td>Low</td>
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<tr>
<td>Alcohol and other impairments</td>
<td>Rider/Driver Behavior</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Personal Protective Equipment</td>
<td>Rider/Driver Behavior</td>
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<td>Low</td>
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<tr>
<td>Sociological considerations</td>
<td>Rider/Driver Behavior</td>
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<tr>
<td>In vehicle design elements and systems</td>
<td>Vehicle</td>
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<tr>
<td>Conspicuity</td>
<td>Vehicle</td>
<td>Low</td>
<td>High</td>
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<tr>
<td>Braking</td>
<td>Vehicle</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Type of PTW</td>
<td>Vehicle</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Engine performance</td>
<td>Vehicle</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Precipitation</td>
<td>Weather</td>
<td>High</td>
<td>High</td>
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<tr>
<td>snowfall</td>
<td>Weather</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>
Interactions between PTW accidents and …

RIDER/DRIVER BEHAVIOR

LEADER: CEESAR
Rider/Driver Behavior – Analysis Framework

MACRO ANALYSIS LEVEL

National databases

Scenario 1
Scenario 2
Scenario 3
Scenario ...

MICRO ANALYSIS LEVEL

In-depth databases

Scenario 1
Scenario 2
Scenario 3
Scenario ...

M 1, 2, 3, 4 = Model 1, 2, 3, 4

M 1, M 2, M 3, M 4

2BESAFE User Forum - December 14, 2011, Paris
Prevailing PTW accident scenarios

- Main accident configurations for the five countries (FR, GR, UK, FI, IT)
- Common or not to the five countries involved
- 20 PTW accident configurations

Only 9 accident scenarios for in-depth analysis

- E.g. single moped/motorcycle accidents inside/outside urban area, accidents with more than one vehicle involved
Rider/Driver Behavior – Microscopic Analysis

- Analysis framework:
  - Who is involved in such accidents?
  - Where did the accidents occur and which type of vehicles were involved?
  - How the accidents evolved (from pre-crash to crash and immediately after the crash)?
  - When did the rider or the driver fail? → What is the degree of influence of an accident factor?
  - What are the blunt end failures, the latent and sharp end ones?
4 different models (conceptual approaches)

Each model
- Has a different approach to the understanding and classification of the causation factors
- Acts complementary to provide an overall summary of causation factors.

Comparative study of the results
Rider/Driver Behavior – Critical Factors

- Perception of drivers/riders and human errors
  - Failure in perceiving the PTW by another vehicle driver
  - Loss of control when experiencing direction choice problems
  - 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
In accidents involving mopeds

- Licensing and riding experience
- Type of activities
- Protective PTW clothes
- Errors
  - Moped rider often incorrectly positioned on the road or he/she voluntarily takes risks.
  - The passenger car driver fails to look, he looks but does not see.
- Night Riding
In accidents involving motorcycles

- Frequency of riding
- Daylight and alignment (curvature or not)
- Area type

Errors
- for single motorcycle accidents, a poor/loss of control because of excessive or non adapted speeds, risk taking, etc.
- lack of perception (from the passenger car driver and of the motorcyclists)
Interactions between PTW accidents and …

ROAD INFRASTRUCTURE

LEADER: AIT
**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”
Critical Factors

- Area type
  - Increased number of PTW accidents inside urban areas and at intersections
  - Increased severity outside urban areas
  - Outside urban areas the most frequent is run-off road accident

- Curves and descending gradients (GR)

- Roundabouts (GB)
  - Less front to side accidents at roundabouts (ES)

- Pavement conditions
  - Accidents on wet and slippery roads are less severe than on dry roads (IT)
Road Infrastructure – Microscopic analysis

- **Methodology**
  - In-depth accident data analysis (CIDAUT)
    - Analysed and reconstructed accident data from a special investigation team
    - 67 motorcycle accidents (2003-2009)
  - Linkage of crash data, road geometry data and road surface data using special measurement vehicle and software tools (BASt, AIT)
    - Crash data of injury motorcycle driving (IMD) accidents outside urban areas (2002-2006) and measurement data on road geometry (2009)
    - Austrian PTW accident data and infrastructure data (2000-2007)
Critical Risk factors

- Negative 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 100ma
- Unbalanced ratio of successive radii
- Curvature change rate [gon/km]
Road Infrastructure – Microscopic analysis

Critical Risk factors

- Deficits
  - Longitudinal or transversal unevenness have significant impact
  - Continuous deficits concerning the skid resistance have no impact
  - Rut depth and texture seem to have a low impact

- Barriers

- Roundabouts
RECOMMENDATIONS

- Safe/forgiving roadside or protection from obstacle with motorcycle friendly protective devices

- Road surface improvements

- Improvement of conspicuity at roundabouts outside urban areas (e.g. electric lighting, retro reflecting materials)

- PTW safety as part of Road Safety Audit, Inspection and Impact Assessment (RSA, RSI, RSIA)
Interactions between PTW accidents and ...

WEATHER CONDITIONS

LEADER: KfV
Problem:
- Accident statistics biased by weather conditions

Literature:
- Hardly anything controlled for exposure
- Nothing about PTWs

Macroscopic Analysis:
- Executed, but with limited results
Weather Conditions - Methodology

Weather impact by

Exposure  Intrinsic risk  Risk compensation

Riders  Riders on the road  Riders in danger  Rider risk

OVERALL RISK
"VERA" (vienna enhanced resolution analysis) model
Institute for Meteorology and Geodynamics
University of Vienna
Weather Conditions - Findings

Regression Curve | Function | $R^2$
--- | --- | ---
Weekend | $y = 26.109 e^{-0.474x}$ | 0.9061
Workday | $y = 18.298 e^{-0.378x}$ | 0.9656
Workday & Weekend | $y = 15.589 e^{-0.337x}$ | 0.9718
Weather effect on road accidents was found significant

However, exposure data are needed for a more complete and accurate analysis

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Days</th>
<th>Accidents</th>
<th>Statistical values</th>
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<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>
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<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>Total</td>
<td>365</td>
<td>365</td>
<td>366</td>
</tr>
</tbody>
</table>
Correlation of Weather and Collisions

- On sunny weekends, 8 times more motorcycle collisions occur than on rainy weekend days.
- On sunny workdays, 5 times more motorcycle collisions occur than on rainy workdays.

However, detailed exposure data (traffic volume, composition, speed) should be co-considered before valid conclusions can be drawn.
Concluding Remarks

- PTW Accident Factors from three different aspects
  - Ride/Driver
  - Road Infrastructure
  - Weather Conditions

- Interactions were revealed based on both macroscopic and in-depth analyses
Concluding Remarks

Issues of interest

- Study the accident configurations rather than entire accident datasets.
- Some accident scenarios are more relevant regarding accident frequency and/or accident severity.
- Acquire complete accident data in a homogeneous format (across countries)
Limitations

- Few data available from PTW in-depth studies
- Lack of exposure data
  - systematic data collection (pan-European studies)
  - reliable data collection procedure
  - sufficiently disaggregated
  - comparable with other traffic data
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