International Research Council on Biomechanics of Injury – IRCOBI 2018

Athens, Greece, 12 September 2018

A preliminary analysis of in-depth accident data for powered two-wheelers and bicycles in Europe

Ziakopoulos A., Theofilatos A., Yannis G., Margaritis D., Thomas P., Morris A., Brown L., Robibaro M., Usami, D. S., Phan, V., Davidse R., Buttler, I.

National Technical University of Athens

HELLENIC INSTITUTE OF TRANSPORT CERTH / HIT

Loughborough University

CENTRO DI RICERCA PER IL TRASPORTO E LA LOGISTICA

ceesar Centre Européen d'Etudes de Sécurité et d'Analyse des Risques

SWOV INSTITUTE FOR ROAD SAFETY RESEARCH

Instytut Transportu Samochodowego

Introduction and scope

Despite progress, road safety remains a major issue worldwide:

- Road traffic deaths have globally plateaued at 1.25 million a year. Identifying the causes of accident occurrence is a crucial step.
- Especially concerning vulnerable road users such as two-wheeler (PTW and bicycle) occupants.
- Demand to move past general trends and investigating detailed in-depth microscopic accident data.
- This study involves examining such data from across several countries for two-wheelers.

Data collection and processing

- Data originated from two-wheeler accidents by investigator teams after an accident.

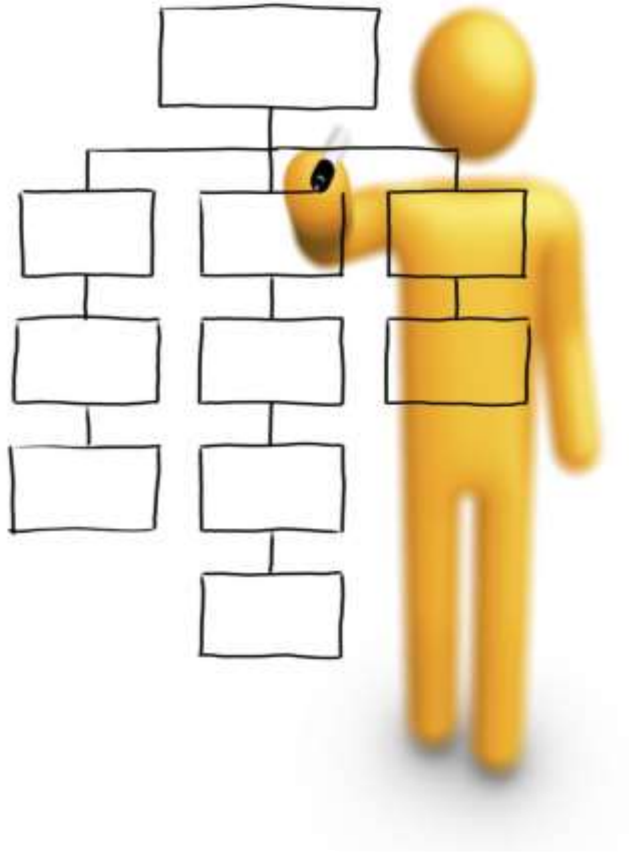
- 6 sample regions across Europe (France, Greece, Italy, The Netherlands, Poland, United Kingdom).
  - Adjusted by national populations and determined by the distribution of accidents in each area

- Methodology followed the DaCoTa protocol
  - Over 100 parameters for each accident
  - Adjusted to focus on two-wheelers

- Important information for:
  - road environment
  - involved vehicles and persons
  - circumstances & causes for each accident etc

Stages of technical analyses

1. Initial analysis: Descriptive statistics, cross-tabulation of data, including multiple layers, provides initial insight
2. Two-step clustering analysis for accidents
   – Provide results based on continuous and categorical variables
   – Works based on a distance measure (Log-Likelihood for both variable categories)
   – Step 1: pre-clustering (distances of all possible case pairs)
   – Step 2: hierarchical clustering algorithm (cluster formation)
3. Random Forest analysis
   – Involves ranking of accident causes per contribution
   – Classifier containing a collection of decision-tree structured classifiers
   – Variable importance rankings when examining injury severity of accidents (distinction between fatal-nonfatal accidents)



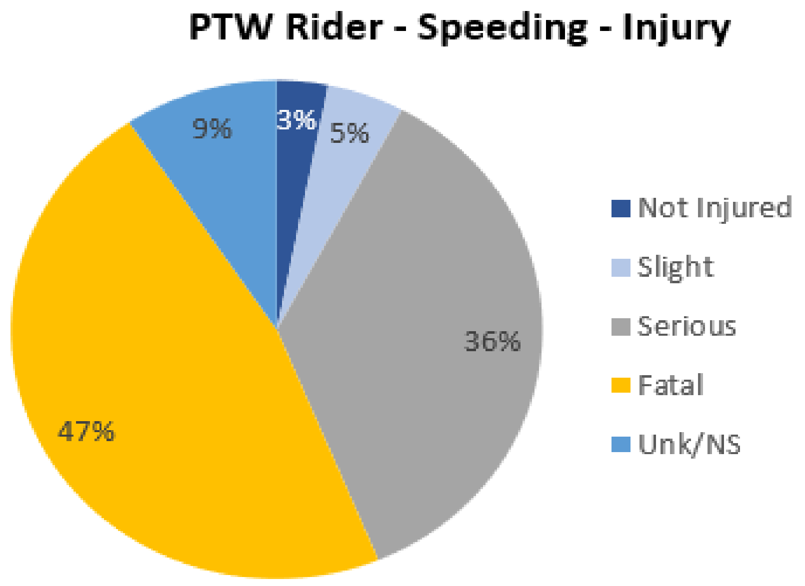
Descriptive statistics – accident occurrence

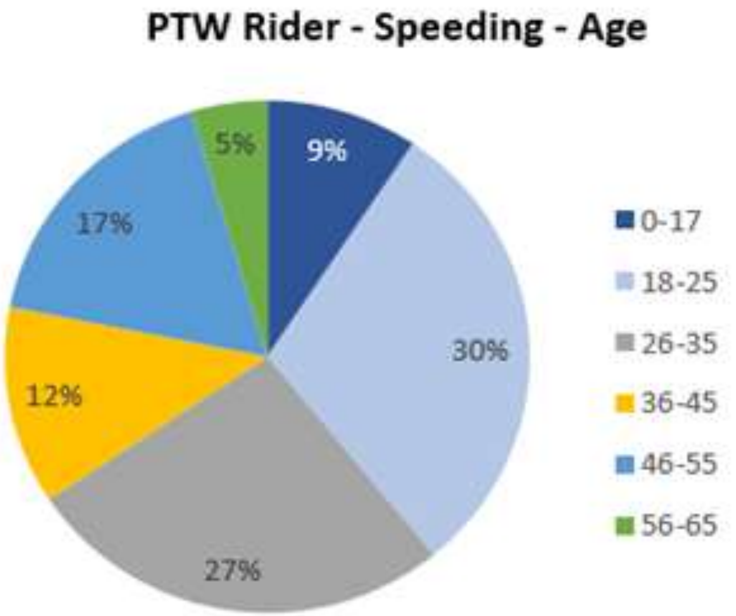
- 500 collected two-wheeler accidents overall
- All injury severity categories represented
- Most accidents occur from May to September and on working days (possibly affected by sampling period)
- Approximate normal distribution throughout the day,
  - 80% during daylight hours
  - least amount of accidents between 20:00 – 03:00

Country	Not Injured	Slight	Serious	Fatal	Unknown	Total
France	2	43	32	7	3	86
Greece	-	59	11	15	-	85
Italy	16	-	-	2	57	75
The Netherlands	2	-	84	1	-	87
Poland	-	59	19	7	2	87
United Kingdom	-	16	10	54	-	80
Total	**20**	**177**	**156**	**86**	**62**	**500**
Percentages	4%	35%	31%	17%	12%	100%

Descriptive statistics – road user personal factors

- Database contained 951 road users:
  - 780 riders/drivers
  - 55 passengers
  - 10 pedestrians
- Majority of accidents (>80%) did not involve alcohol consumption from riders
- Most riders (>90%) did not have a pre-existing medical condition
- In cases where speeding was recorded as prime accident cause, PTW riders were above the speed limit, while bicyclists were not
  - Speed once again found to increase injuries
  - Young riders speed more frequently



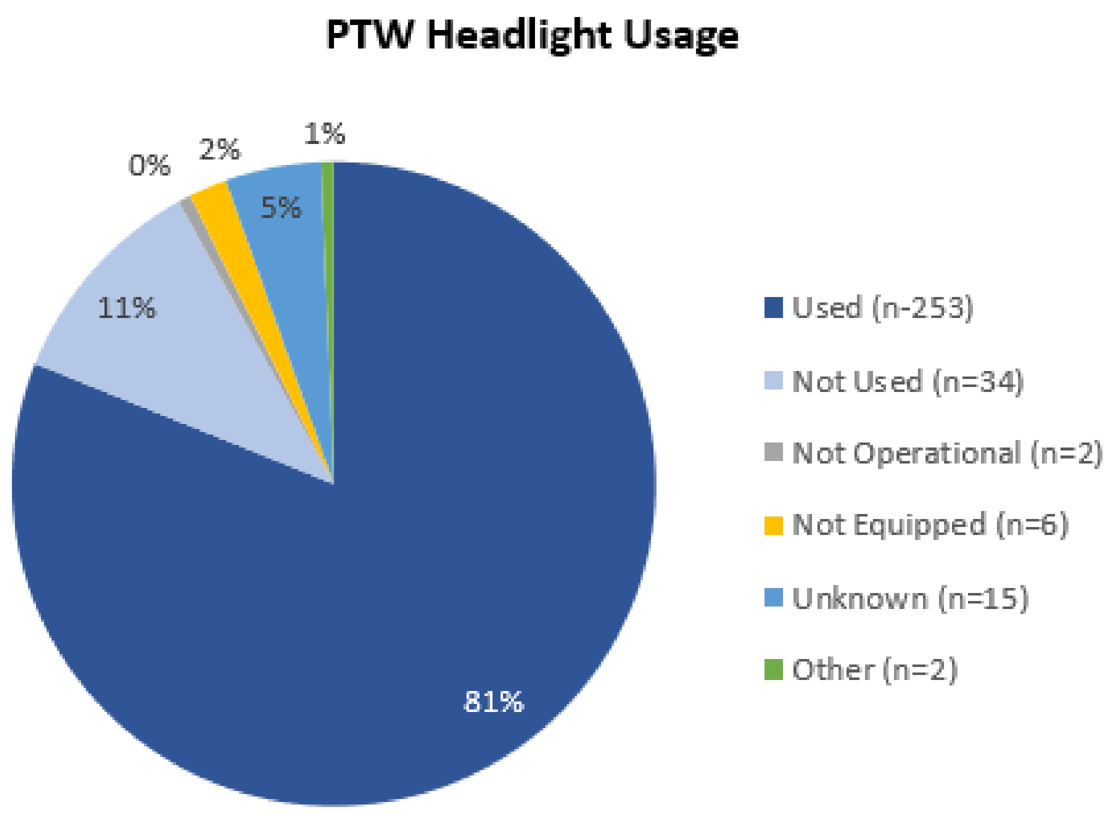


Descriptive statistics – road user equipment

- Protective equipment examined for PTW riders:
  - 15% did not wear a helmet (margin for awareness raising)
  - From those that wore, helmets prove effective (stayed on during accident)

- Protective equipment examined for bicyclists:
  - 36% of riders were wearing a helmet and had it fastened
  - 17% of riders were wearing a helmet and did not have it fastened
  - 39% were not wearing one at all

- Most two-wheeler riders do not wear reflective clothing (PTWs >60% and cyclists >50%) but do use headlights (PTWs >80% and cyclists >20%)

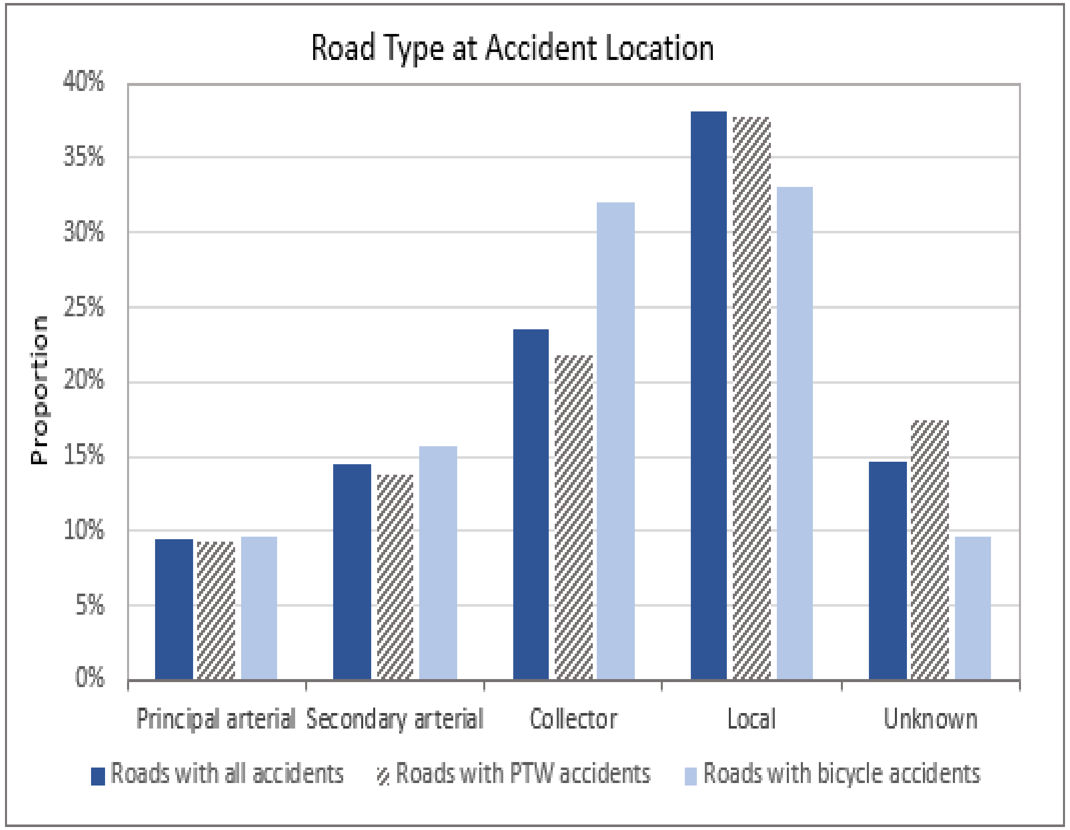


Descriptive statistics – vehicle condition factors

- Considerable variation in the PTW condition; however brake levers are operational overall
- Front and rear sprocket conditions are usually good when PTW condition is good
  - If they are worn, PTWs are classified as poor
- In the majority of PTW cases, right and left mirrors are operational
- Throttle condition does not affect vehicle characterization
- Steering stem adjustments mainly in correct form

Descriptive statistics – road environment

- 715 examined roads from the 500 cases
- Across all accident types, the majority occurred in urban areas (as opposed to rural areas)
  - 50% of PTW accidents in residential areas
  - 40% of bicycle accidents in commercial areas
- 50% of accidents occur in single roads
  - >35% of total & PTW accidents in local roads
  - >30% of bicycle accidents in collector roads
- Overall good weather conditions
  - No rain, snow or fog for >90% of accidents
  - Light wind present in 10% of accidents (10-15 km/h)



Two Step Cluster analysis results

- The 500 accidents were split into two clusters:
  - Cluster 1: 398 cases
  - Cluster 2: 99 cases
  - 3 excluded cases (statistically uncertain)

Characteristics		N	Percentage of Combined	Percentage of Total
	1	398	80.1%	79.6%
Cluster	2	99	19.9%	19.8%
	Combined	497	100.0%	99.4%
Excluded cases		3	-	0.6%
Total		**500**	**-**	100.0%

- Good overall cluster quality

Model Summary

Algorithm	TwoStep
Inputs	5
Clusters	2

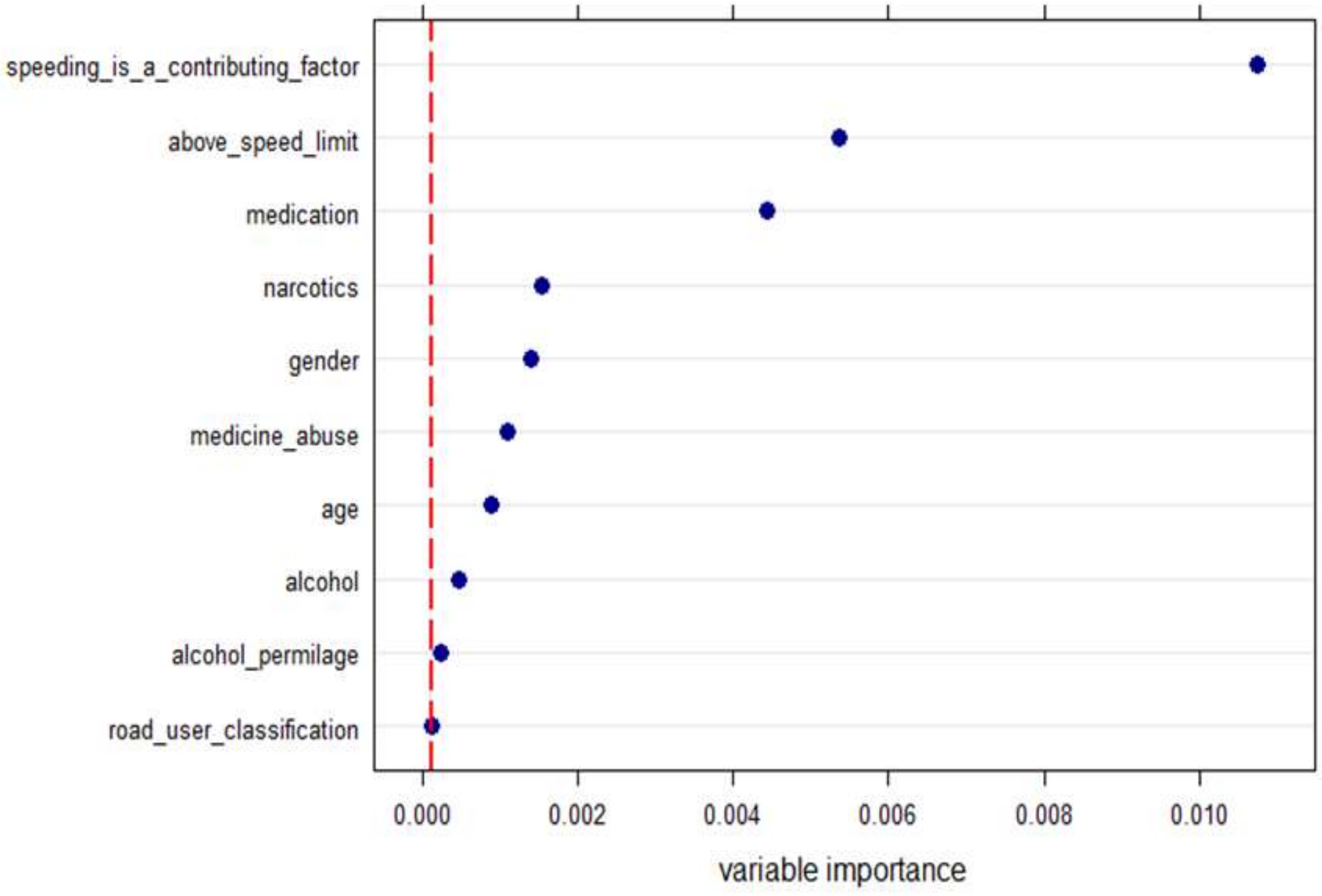
- Cluster 1: “No wind, no drugs, lighting”
  - mainly consists of cases of all countries except for Netherlands

- Cluster 2: “Windy, lighting, unknown DUI condition”
  - mainly consists of Netherlands and some UK cases

Random Forest analysis results

- Variable importance rankings when examining injury severity:
  - Accidents were separated (Fatal vs non-Fatal).
  - However, magnitude of effect and sign of each variable are not identified

- Most important factors (variables):
  1. speeding
  2. driving above speed limit
  3. consumption of medication
  4. followed by use of narcotics and others



Conclusions (1/2)

- Regardless of origin, two-wheeler occupants remain vulnerable road users:
  - several serious and fatal injury accidents; indication that more severe accidents are more commonly and systematically collected for two-wheelers (especially in countries using retrospective methods)
- There seem to be more active periods of time in which more accidents occur.
- PTW speeding riders seem to be often younger & male; speeding caused accidents more frequently overall (in the examined accident sample).
- Most two-wheeler riders recognize the essentiality of helmet use but not for reflective clothing.

Conclusions (2/2)

- Two Step Cluster analysis hints at meaningful separation of two-wheeler accidents when the influence of outside factors is considerable.
- Several factors seem to affect accidents, most of them appear to originate from road user behaviour:
  - actively to the accident location (speeding)
  - preceding the accident (substance consumption)
  - high road user mortality increases under specific factor combinations.
- The inclusion of areas across Europe offers robustness and transferability to data and results.

Lessons learned

1. Interpretation of results should take into account the lack of exposure data (e.g. vehicle kilometers per each user, road, traffic and vehicle type).

2. Microscopic analyses can have drawbacks:
   – Each accident has unique configurations; careful consideration when assembling the database.
   – Complex decoding for some road users
   – Advanced modelling can be difficult

3. More effort is essential for systematic collection of data (unknown variable values).
   – Training of dedicated officials can be an initial solution.
   – Connected technology applications and big data need to be exploited.

International Research Council on Biomechanics of Injury – IRCOBI 2018

IRCOBI

Athens, Greece, 12 September 2018

A preliminary analysis of in-depth accident data for powered two-wheelers and bicycles in Europe

Ziakopoulos A., Theofilatos A., Yannis G., Margaritis D., Thomas P., Morris A., Brown L., Robibaro M., Usami, D. S., Phan, V., Davidse R., Buttler, I.

National Technical University of Athens

HELLENIC INSTITUTE OF TRANSPORT CERTH / HIT

Loughborough University

CENTRO DI RICERCA PER IL TRASPORTO E LA LOGISTICA

ceesar Centre Européen d'Etudes de Sécurité et d'Analyse des Risques

SWOV INSTITUTE FOR ROAD SAFETY RESEARCH

Instytut Transportu Samochodowego