7ο Πανελλήνιο Συνέδριο Οδικής Ασφάλειας
Λάρισα, 11-12 Οκτωβρίου 2018

Exploration of real-time crash likelihood of Powered-Two Wheelers in Greece

Theofilatos Athanasios[1], Yannis George[1], Kopelias Pantelis[2], Papadimitriou Fanis[3]

[1]1National Technical University of Athens, Department of Transportation Planning and Engineering, 5 Heroon Polytechniou, Athens, GR15773, Greece

[2]University of Thessaly, Department of Civil Engineering, Pedion Areos, Volos, GR38334, Greece

[3]Attica Tollway Operations Authority – Attikes Diadromes S.A., 41.9 km Attiki Odos Motorway, Paiania, GR19002, Greece

Summary

The incorporation of real-time traffic and weather data has proven to be a very fruitful approach when analysing crash likelihood. A major limitation is that there is no specific focus on vulnerable road users such as Powered-Two-Wheelers (PTWs). This paper aims to analyse PTW crash likelihood in the motorway of Attica Tollway ("Attiki Odos") by using real-time traffic and weather data and applying Bayesian Logistic Regression. The results of the paper attempt to contribute to the understanding of accident probability and severity on motorways, by having a special consideration of PTWs for one of the first times for safety evaluation of motorways.

Data collection and processing

- The required crash, traffic and weather data were extracted from Attica Tollway Only basic freeway segments (BFS) were considered and not ramp areas.
- The raw motorway dataset, includes 387 cases, from 2006 to 2011. In order to explore the probability of PTW crash involvement, a subset had to be created.
- All crash cases had to be defined (and not the injured persons). Each row of this subset corresponds to a crash, resulting in 285 crash cases, where a new binary variable was defined, namely "PTW crash involvement".
- Real-time traffic data for the Attica Tollway were collected from the Traffic Management and Motorway Maintenance. Traffic flow, occupancy, speed and truck proportion were considered and were measure in 5-min intervals and each crash was assigned to the closest upstream loop detector.
- Real-time weather data were extracted from the website of the Hydrological Observatory of Athens (www.hoa.ntua.gr), measuring various environmental parameters.
- In our study, each crash was assigned to the closest meteorological station and rainfall, relative humidity and wind speed were utilized.

Methodology

- Bayesian logistic regression models were developed to estimate crash probability with focus on PTWs. The likelihood function for Bayesian logistic regression is the same as in the frequentist inference. More specifically,

$$likelihood_i = \pi(x_i)^{y_i}(1-\pi(x_i))^{(1-y_i)} \quad \text{(Eq. 1)}$$

where $\pi(x_i)$ is the probability of the event for the i^{th}subject which has covariate vector x_i. The logistic regression equation is:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n \quad \text{(Eq. 2)}$$

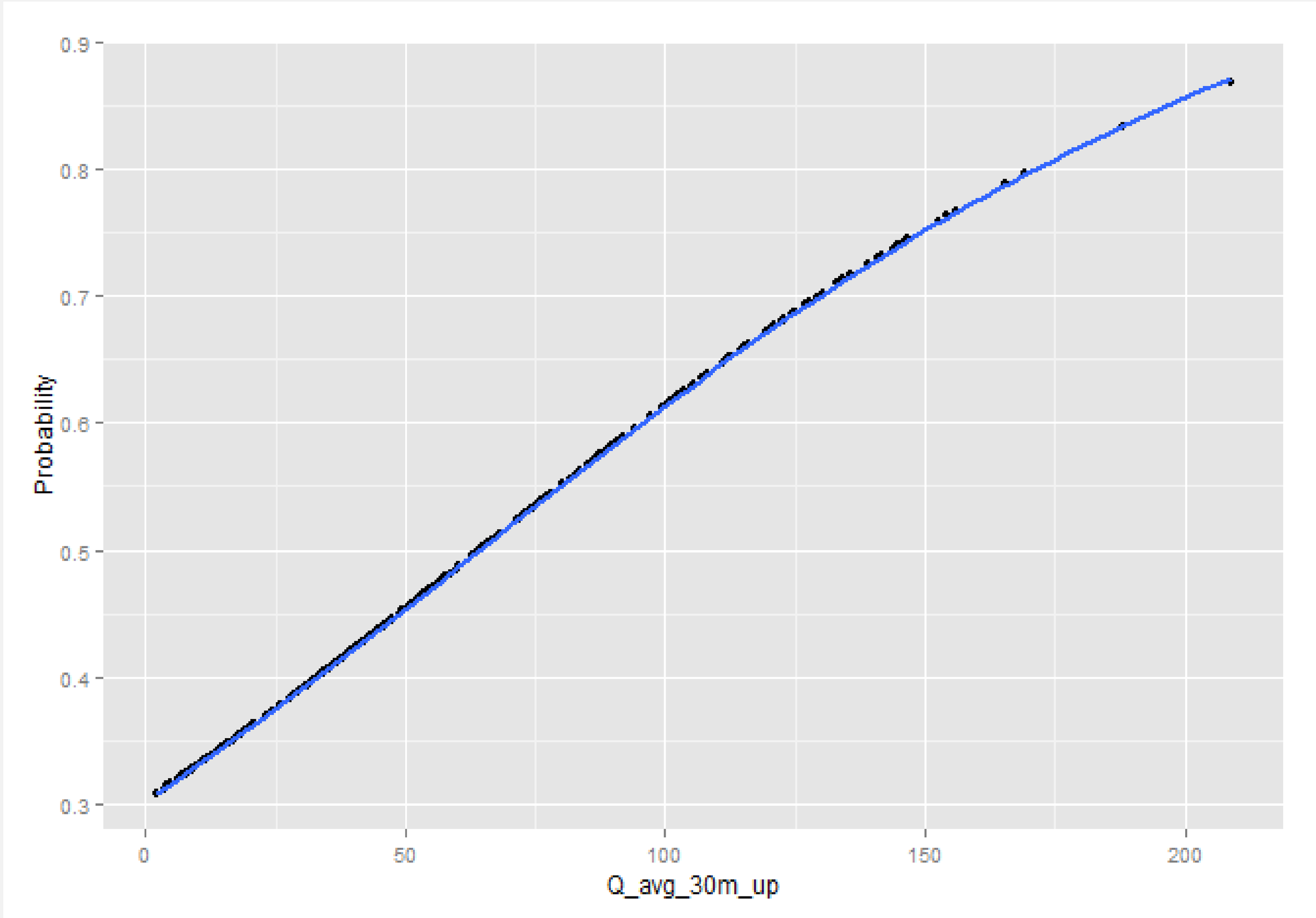
where β_0 is the intercept, β_i is a coefficient for the explanatory variable x_i.

- Any prior distribution can be used for unknown parametersThe distribution of the aforementioned example is transformed to $\beta_j \sim normal(0, 0.0001)$. The posterior distribution is derived if the prior distribution over all parameters is multiplied by the full likelihood function. Thus,

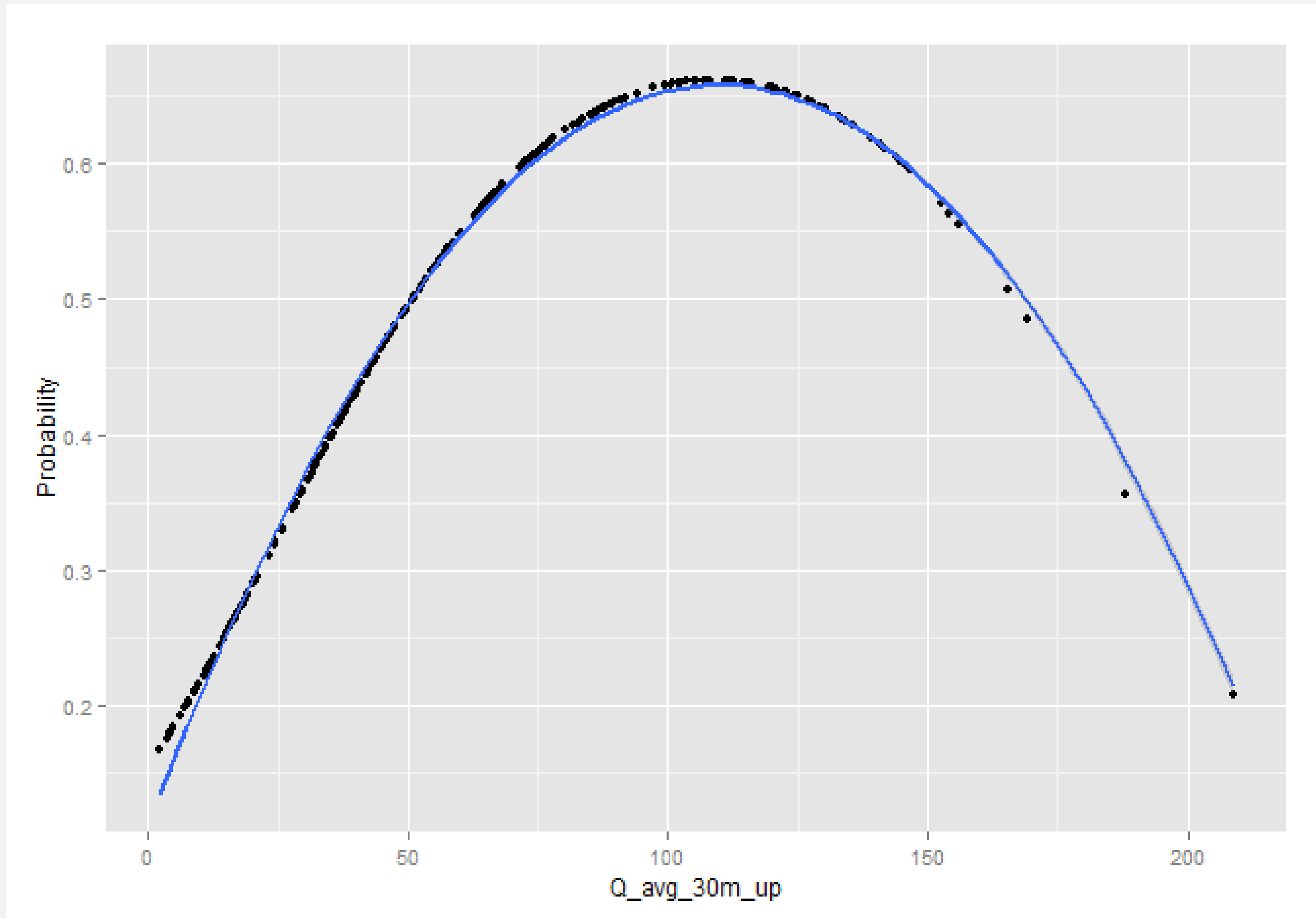
$$prior \times likelihood = posterior \quad \text{(Eq. 3)}$$

Results

- It is remarkable that PTWs are involved in almost half of the total crash cases (49.5%).
- Two models were developed; one linear and one non-linear.
- Traffic flow was the only significant predictor.
- Figure 1: Diagram of the relationship between the average flow probability of PTW crash likelihood (linear model).



- Figure 2: Diagram of the relationship between the average flow probability of PTW crash likelihood (non-linear model).



Conclusions

- PTW crash involvement (or PTW crash likelihood) was explored through Bayesian logistic regression models. It was found the only statistically significant variable is the average 30-min flow upstream of the accident location.
- Two models were developed: one linear and one non-linear. The fit of the non-linear was better indicating that a quadratic relationship exists, namely an inverse U-shape. It is interesting, that weather parameters were not found to significantly affect injury severity of occupants in motorways. The insignificance of weather parameters in the motorway, may be attributed to the fact that weather parameters may not be linearly related with road safety indicators such as PTW probability. It is expected that complex non-linear relations may exist and need further investigation.
- Overall, this paper contributes on the current knowledge, by having a specific consideration of PTW safety in motorways and also by developing models combined with real-time traffic and weather data.

Acknowledgements

This research is implemented through IKY scholarships programme and co-financed by the European Union (European Social Fund - ESF) and Greek national funds through the action entitled "Reinforcement of Postdoctoral Researchers", in the framework of the Operational Programme "Human Resources Development Program, Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) 2014 – 2020.