Exploring Weather Effects on Powered-Two-Wheeler Safety on Urban Arterials in Athens

Abstract

The effective treatment of road crashes constitutes a major concern to societies due to the losses in human lives and also the economic and social costs. Despite the efforts, the total number of road fatalities worldwide remains at 1.24 million per year, while almost half of worldwide fatalities correspond to "vulnerable road users": pedestrians, cyclists and motorcyclists. Recently, there is a growing trend to record and collect real-time traffic and weather data from freeways. Such data were mainly utilized in order to analyse crash likelihood and severity. A few studies investigate crash likelihood in urban expressways. Moreover, the number of studies exploring the impact of real-time weather characteristics on crashes taking place on urban arterials is relatively few. Despite the fact that freeway safety has been extensively explored, there is very little research regarding on urban arterials internationally. Moreover, there is no specific focus on Powered-Two-Wheelers (PTWs) which constitute a vulnerable type of road users and therefore the investigation of the impact of risk factors measured real-time could be of great importance. In this study, we focus on Powered-Two-Wheeler (PTW) crash likelihood and severity on two similar major urban arterials in Athens, Greece, by utilizing real-time weather parameters. Moreover, studies with focus on Powered-Two-Wheelers (PTWs) are even fewer. The present paper aims to investigate the weather effects on crash likelihood and severity trends of Powered-Two-Wheelers.

For that reason, crash data from two urban arterials of Athens, Greece were collected for the 2006-2011 period to explore weather effects on road crashes. The chosen areas for analysis are the Kifisias and Mesogeion avenues in Athens, which are two major urban arterials with similar traffic and geometrical characteristics. The required crash data were collected from the Greek crash database SANTRA, which is provided by the Department of Transportation Planning and Engineering of the National Technical University of Athens. Crashes were classified as severe (crash including at least one seriously injured or killed person-KSI) or slight (crash including only slightly injured persons-SI). Moreover, it was examined whether the likelihood of Powered-Two-Wheeler (PTW) to be involved in a crash is influenced by weather conditions. Therefore, another binary variable is created with values 0 (crash without a PTW) and 1 (crash involving a PTW). Other crash characteristics include crash location (intersection/no intersection) and time (day/night). Weather data for each crash case were collected from the website created by the Hydrological Observatory of Athens (HOA). It provides access to an open-access single database of more than 10 stations located in the greater Athens area, measuring various environmental parameters. In this study rainfall, temperature, humidity, solar radiation and wind speed from the closest meteorological station are considered. Various related weather parameters measured on the 1-hour interval prior to the time of the crash were considered such as temperature, rainfall, relative humidity, wind speed and solar radiation.

In this study, a mesoscopic analysis approach was followed, where the raw 10-min raw weather data were aggregated in order to obtain averages in the 1-hour interval prior to the crash occurrence. It is expected that weather conditions prior to a crash occurrence would cover the hazardous conditions and therefore only data in the time interval 0-1h

hour prior to a crash were analysed. For example, if a crash occurred in Kifisias Avenue on 26 August 2011 at 17:00 weather data on the same day and location from 16:00 to 17:00 are considered. It is noted that a time lag of 20 minutes was used (i.e. the time of the crash was recalculated by subtracting 20 minutes) in order to compensate for any inaccuracies in the exact time of the crash. Similar time lags have been applied in other similar studies in the past.

To achieve the aims of the study, Bayesian t-tests are carried out in order to compare the means of two different groups. In this study, the mean values of weather parameters are tested a) between crashes with or without Powered-Two-Wheeler involvement and b) between slight and severe crashes with Powered-Two-Wheelers. The comparison is conducted simply by dividing the marginal likelihoods, producing a parameter called a Bayes Factor (BF). The BF is a very good alternative to the traditional t-test and shows the extent to which the data support the H1 hypothesis over H2 hypothesis. Values of Bayes Factor higher than 10 indicate a strong evidence for the H1 hypothesis.

Bayesian t-tests were carried out to compare the means of the two different groups. The mean values of weather parameters are tested between crashes with or without Powered-Two-Wheeler involvement. Humidity and Temperature appear to be significantly correlated with the type of crash (BF>10). On the other hand, the Bayes Factors show no statistically significant differences between crashes with and without PTWs, in terms of rainfall, wind speed and solar radiation.

On the other hand, the mean values of weather parameters are tested between slight and severe crashes with Powered-Two-Wheelers. Bayesian t-tests of independent sample is rejected for all weather parameters implying that none of them is significantly correlated with PTW crash severity, since the Bayes Factors are below the critical value of 10. The results showed that humidity and temperature play a significant role in PTW involvement in crashes, but no weather parameter seems to affect PTW crash severity. The findings of study can contribute to the further understanding of Powered-Two-Wheeler critical safety issues on urban arterials regarding real-time weather effects.

As a suggestion for further research, the correlation between accidents with or without PTW involvement and precipitation should be further investigated in order to conclude whether or not rainfall can significantly influence PTW road crashes. The findings of this study can contribute to the further understanding of Powered-Two-Wheeler critical safety issues on urban arterials regarding real-time weather effects.