Several statistical methods are used to investigate the association between traffic crash frequency and contributing factors of crash data, which are characterized by 1) geographical reference (i.e., observed at specific locations) or spatially varying over geographic units when modeled; 2) correlation between different response variables (e.g., crash counts by severity or type levels); and 3) temporally correlated. One main interest in crash frequency modeling is to predict crash count over a spatial domain of interest (e.g., traffic analysis zones (TAZs)). The macro-level crash prediction models can assist transportation planners with a comprehensive perspective to consider safety in the long-range transportation planning process. The majority of the previous studies that have examined traffic crashes at the macroscopic level are related to high-income countries, whereas there is a lack of similar studies among lower- and middle-income countries where most road traffic deaths (90%) occur. This includes Middle Eastern countries, necessitating a thorough investigation and diagnosis of the issues and factors instigating traffic crashes in the region in order to reduce these serious traffic crashes. Since pedestrians are more vulnerable to traffic crashes compared to other road users, especially in this region, this research explores the association between traffic volume, land-use, socio-demographic and roadway characteristics factors, and the frequency of pedestrian crashes. The results show that the factors that affect total pedestrian crash occurrences are different from those affecting severe pedestrian crashes. Then, a Bayesian multivariate spatial model was developed for predicting crash counts by severity and type at the macro-level. The results reveal that significant variable sets for different severity levels of crashes are not consistent for different types of crashes. Therefore, based on the findings of this study, policy makers would be able to suggest appropriate safety countermeasures for each type of crash in each zone.