Abstract

Pedestrian fatalities often represent the highest share of road traffic crash-related fatalities in developing countries. However, a thorough assessment of pedestrian safety using sophisticated statistical analysis and modelling to gain a complete understanding of the risk factors is still in a nascent stage in developing nations. In this background, the foremost goal of this thesis is to develop a systematic approach to identify and estimate the major sources of risk factors for fatal pedestrian crashes related to the (a) traffic exposure and operational characteristics, roadway factors and infrastructure, land use type, (b) pedestrian behavior and perception, and (c) spatial characteristics of the road network level in the context of an urban setup in a developing country. The fatal pedestrian crash data for 2011 to 2016 of Kolkata City, India, have been utilized to demonstrate the research methodology. To start with, to develop an understanding of the risk factors associated with pedestrian fatalities, a set of safety performance functions (SPF) are developed. In these SPFs several attempts are made to identify a host of risk factors ranging from the road infrastructure to land use, traffic volume, operational characteristics, pedestrian level attributes, and spatial features of the road network level. Based on the model outcomes, there is strong evidence that high approaching speed of vehicles, wider road width, on-street parking, inadequate sight distance, the encroachment of footpath, certain land-use type, pedestrian risk-taking attitude (e.g., signal violation, pedestrians are not using designated path, etc.), crossing difficulty, distraction, postencroachment time, and several spatial characteristics such as slum population, population density, etc. significantly affect fatal pedestrian crashes at the road network level. In the second stage of the thesis, the pedestrian risk of road traffic crashes is assessed based on three proactive measures, namely (a) examining pedestrian signal violation behavior, (b) studying pedestrian risk perception, and (c) analyzing pedestrian-vehicular post encroachment time. In the third stage of the thesis, the current study formulates and presents a modelling methodology that accounts for multiple sources of pedestrian risk as described previously (i.e., i. traffic exposure and operational characteristics, roadway factors, and infrastructure, land use type; ii. pedestrian behavior and perception; and iii. spatial characteristics of the road network level) to develop an SPF to assess pedestrian safety at the road network level in a developing country. Afterward, the present study also estimates and evaluates the approximate share of these three major sources of pedestrian risk across sites. The model outcomes indicate that in Kolkata City at the road network level, nearly 40% of the overall fatal pedestrian crashes occur due to pedestrians' unsafe crossing behavior and poor risk perception; almost 50% of the overall fatal pedestrian crashes occur due to the absence of pedestrian-friendly infrastructure and inefficient traffic operations, and remaining 10% of the overall fatal pedestrian crashes occur due to unobserved spatial factors.

To end, based on the present research findings suitable countermeasures are formulated and three specific countermeasures are implemented at three major junctions in Kolkata city. Subsequently, the effectiveness of countermeasures is also evaluated. Overall, this thesis presents an inclusive analysis of identification and estimation of pedestrian risk factors associated with (a) traffic exposure and operational characteristics, roadway factors and infrastructure, land use type (b) pedestrians' behavior and perception, and (c) spatial characteristics of the road network, in the context of an urban area in a developing country. The study outcomes indicate that while road infrastructure and traffic exposure-related risk factors are very similar to the findings from the developed countries, the present thesis provides several new insights about risk factors that may be unique to Kolkata or other Indian metropolitans or cities of other developing countries. Subsequently, the present thesis also provides a systematic modelling approach to estimate and evaluate the share of three major sources of pedestrian risk. The knowledge of risk factors and modelling approach established in this thesis are extremely helpful for the incorporation and/or modification of the particular planning and design elements to reduce pedestrian risk.