ESTIMATING TRAFFIC CRASH RISK TO USERS IN URBAN AREAS AND ITS IMPACT ON MODE CHOICE: CASE STUDY VADODARA CITY, INDIA

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JANUARY 2016

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by

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Submitted
In fulfillment of the requirements of the degree of
Doctor of Philosophy

to the

Indian Institute of Technology Delhi

JANUARY 2016

CERTIFICATE

This is to certify that the thesis titled **Estimating Traffic Crash Risk to Users in Urban Areas and its Impact on Mode Choice: Case Study Vadodara City, India** being submitted by Mr. Prajapati Pankaj Shankarlal to Indian Institute of Technology Delhi for the award of the degree of Doctor of Philosophy is a record of the original bona fide research work carried out by him under my guidance and supervision and guidance. The thesis work, in my opinion, has reached the requisite standard fulfilling the requirements for the degree of Doctor of Philosophy. The results contained in this thesis have not been submitted in part or in full, to any other university or Institute for the award of any degree or diploma.

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ACKNOWLEDGEMENTS

At the outset I convey my heartiest thanks to my PhD supervisor Prof. Geetam Tiwari for her continuous inspiring support during my research work. It was due to her I could accomplish the work in a meaningful way. Because of her visionary directives this entire process became journey towards enlightenment.

I am grateful to Continuing Education Programme (CEP-QIP), IIT (Delhi), the premier institute of our country, for accepting my candidature and providing me an opportunity to carry out research work leading to highest degree. I had wonderful time here and could avail all resources most vital for research.

I am indeed highly obliged to my mother institute The Maharaja Sayajirao University of Baroda for sponsoring me under QIP Program for this PhD research. The University authority generously and timely processed all correspondences and paved a path towards my bright future.

How can I forget my family who has sacrificed the most without uttering a single word during the period of my research? I recall I had tough situations to face at family level but due to loving support of my beloved wife and children I could successfully withstand during hard days of my struggle.

I understand it's because of support and help of all above mentioned persons and institute and above all blessings of almighty I am able to complete my research.

Mr. Pankaj Prajapati

Abstract

Urban infrastructure improvement; intersection improvement, flyover construction and road widening projects are implemented to improve the transportation system. However, often these improvements focus on system of motorised vehicles and address problems like vehicular congestion and focus to improve the convenience of car (motorised vehicle) users, but ignore the safety and convenience of bicyclists and pedestrians. These strategies result in increased risk to bicyclists, pedestrians and motorised two-wheeler (M2W) riders and subsequently reduction in the use of these travel modes. It is necessary to measure traffic crash risk to different road users and to identify the factors imposing crash risk. If real traffic crash risk can be identified and addressed scientifically, potential pedestrians and bicycle users may be encouraged to walk and to use bicycle for their short trips. It is necessary to study safety consideration of road users in the travel mode choice along with travel time, convenience and other factors.

In this study traffic crash risk to different road users in Vadodara city has been estimated. Traffic police data shows that the proportion of vulnerable road users (pedestrian, bicyclists and motorised two-wheeler riders) observed as a victim in fatal crashes is 41%, 13% and 33% for M2W riders, bicyclists and pedestrians respectively. Safety Performance Functions (SPFs) have been developed to predict number of fatal crashes per year on different road locations, which identifies factors affecting these crashes. The important factors includes traffic volume, presence of heavy vehicle on urban roads, land use type, length of road segment, street intersection density, volume to capacity ratio, type of road and presence of median. Separate models have been developed to predict number of fatal crashes per year for pedestrian, bicyclists and motorised two-wheeler riders. These findings have important

bearing on the design of urban arterial roads. In the absence of facilities for pedestrians and bicyclists, arterial roads with wider carriageway and higher number of lanes increase the risk of fatal crash for pedestrians and bicyclists.

This study quantifies real and perceived traffic crash risk to urban road users of medium size city. An average fatality per million persons is 84 for an urban area of Vadodara city. Truck as impacting vehicle is involved in 35% of the fatal crashes which shows the high risk imposed by heavy vehicles to vulnerable road users. High number of crashes with M2W and pedestrian at roundabout shows the need to improve geometric design of roundabouts. Real fatal crash risks to common travel modes on different road facilities have been quantified using real fatal crash data and exposure level. Different road facilities on order of real crash risk level from highest to lowest are mid-block, signalised intersection, roundabout and un-signalised intersection. Pedestrians have highest real crash risk on mid-block followed by M2W riders and bicyclists. M2W riders have highest risk on signalised intersection followed by pedestrians and bicyclists. Roundabouts impose highest risk to M2W riders, followed by bicyclists and pedestrians.

Self-reported perceived crash risks to road users on different road locations have been compared to real crash risk. The ranking correlation by Spearman's rho has established that there is no correlation between real and perceived crash risk.

The influence of perceived traffic risk on different modes at mid-block, signalised intersection, un-signalised intersection and roundabout has been assessed by two multinomial logit mode choice models; one for people of ages up to 25 years and other for above 25 years. The impact of perceived crash risk for age below 25 years is insignificant for all modes. The probability of choosing auto-rickshaw, car, bus and bicycle mode is less for the road users who perceive high traffic crash risk at signalised intersection with respect to road users who

perceive no crash risk. On the other hand, probability of choosing these modes is high at an un-signalised intersection even if the perceived crash risk is high. The perceived crash risk at roundabout is not significant for any mode.

An attempt has been made for the first time to evaluate and quantify the perceived risk on different road locations like mid-block, signalised intersection, un-signalised intersection and roundabout of urban area for all modes available; walk, cycling, motorised two-wheeler, auto-rickshaw, car, and bus. The relations between real and perceived traffic crash risk to different modes on above road locations have been established.

As the travel behaviour is governed by perceived crash risk, the influence of perceived crash risk on different modes has been modeled in this study. The mode choice depends on perception about crash risk associated with particular mode and not based on real risk. While to address the road safety issue, the real risk should be addressed. Thus, both the real and perceived crash risks are very important in policy framework.

Table of Contents

List of Figures

List of Tables