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Ranking of Road Traffic Accident Blackspots Based on Economic Criteria: A Study from Indian Cites

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Short abstract: Road safety improvement measures imposing a significant financial burden certainly explain the need of a tool for the prioritization of expenditure on improvement works at crash prone areas to channelize the limited financial resources effectively; especially in developing countries like India. In this study the cost of road crashes is used as a key parameter in ranking the blackspots for improvement. Stated Choice Method (SCM) is adopted here to find out people's Willingness to Pay (WTP) to reduce the probability of involvement in a crash and this value is used to evaluate the total cost of crashes in different blackspot areas; based on which, the blackspots can be ranked for improvement. It is expected that this study will fill the gaps in the traditional criterion followed in blackspot ranking, which are based on dominant pattern of crashes characterized by an over-representation of particular type of crashes.

Keywords: Stated Choice Method (SCM), Willingness to Pay (WTP), crash costs, ranking of blackspots.

1. INTRODUCTION

Road traffic crashes also termed as 'accidents' are the unfortunate incidents occurring in a road network resulting in human and property loss. The impact of crashes to the person or to the family and finally to the society will vary according to the type of the crashes whether it is minor, major or fatal. Each category of crashes will be resulting into different financial loses to the victims and dependents. Similarly, each hazardous location will be different in terms of the category and number of crashes occurring at that location and so the total financial implication to the society will be varying from zone to zone. Thus, it is very essential to identify and rank the hazardous crash locations from a group under consideration for effective improvement based on the total economic loss involved.

Several blackspots identification methods which are in use have deficiencies in conveying the actual severity of the site. The current methods used in the country to list the hazardous locations for improvement are not so effective as sets of sites identified by various methods are not identical. Some locations have high frequency of crashes but fatality rate is very less and on the other hand there are locations with very few crashes but resulting high fatality rates. As a result, it is not quite clear to use which method for prioritizing the improvement works. So, in order to create a better ranking criterion, it will be useful to think of the economic burden that these crashes are creating to the society. We have to identify the blackspots where the remedial actions would be more cost effective. In view of this, in this study, a method is formulated to rank or prioritize the high-risk zones based on an economic criterion for improvements. This paper will highlight an economical based approach to produce an alternative ranking method to select the promised crash locations for treatment. Cost of fatality and injury crashes are arrived through WTP method and the cost of PDO is obtained from direct expense details and aggregating these values with the number of different category of crashes at a spot, the total financial implication of that spot is calculated. Then based on this total cost at each location, they are ranked for improvisation.

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This paper represents an attempt made in Indian scenario on the evaluation of costs of road crashes and ranking of crash prone areas for improvement based on economic impact. The remainder of the paper is arranged as follows. Next section describes some literature reviews on this study area followed by methodologies underlying the experiment. The data analysis is described later part and continued to the discussion and conclusion.

2. LITERATURE REVIEW

For evaluation of safety improvement measures, advanced economic practice tries to take into account the individual willingness to pay for an averted death or injury. Stated choice (SC) experiments has emerged as a better alternative to evaluate casualty risk changes during the last decade [1]. The WTP method has been adopted since ancient days in arriving the value of lost quality of life by many researchers. This approach actually indicates the cost that users are willing to pay for a reduced risk of being involved in crashes. Superiority of SC method has been explained by many researchers in finding WTP values for road safety appraisal projects [1]

Many studies have used different forms of the rate and number of crashes to identify blackspots. Sites that are experiencing an unusual high number of crashes or an unusual crash rates are usually considered for analysis. In some methods crashes are often weighted according to the severity.

3. MATERIALS AND METHODS

The overall concept of the project methodology and the execution procedure is explained in this topic.

3.1. Value of Crashes

The WTP values can be interpreted as an implicit value for own life and averaging it over all individuals travelling on the route yields a value of avoiding one expected fatality per unit of time [2]. This value, also known as Value of Statistical Casualty (*VSC*) is equivalent to

$$VSC = \sum_{j=1}^{N} WTP_j$$

where N represents the average total number of passengers travelling on a route in a given year.

Instead of valuing separately fatal risk reductions and serious injury risk reductions because of the difficulty of the participants in understanding the minute differences in valuing their life against a death or a serious injury, we value the casualty risk reduction (VSC) which is inclusive of both fatalities and serious injuries. And, from this value we derive the values of serious injury risk reductions (VSI) using the death-risk equivalent (DRE) which equals the relative value of preventing a serious injury with respect to preventing a fatality; $DRE = VSI/VSL$ [3]. Jones-Lee et al. [2] estimated values of DRE between 0.1 and 0.15, while Swedish studies have estimated DRE between 0.15 and 0.2 [4]. Based on this we apply DRE equal to 0.2 in our calculations. Here the Value of Statistical Life (VSL) is first obtained from VSC and then the VSI is obtained as per the following formulae.

$$VSL = \frac{VSC}{DRE \times \delta_{SI} + \delta_f}$$

$$VSI = DRE \times VSL$$

where and δ_{SI} and δ_f represents, respectively, the actual shares of serious injuries and fatalities [5]. Relative shares of 0.85 injuries and 0.15 fatalities follow from the official figures from 2009 to 2019 obtained from Kerala Police Records.

Knowing the cost of various severity levels, they can be clubbed together according to the severity distribution to calculate cost of different categories of crashes. Once the average classified crashes occurring at a blackspot is known, the total financial implication by that particular blackspot due to these crashes can be calculated. Thus, financial burden of all the blackspots can be worked out and a prioritisation of these blackspots for improvement can be easily arrived at comparing these total costs.

3.2. Experimental Setup

A hypothetical binary route choice stated preference (SP) questionnaire-based survey was designed for various road users such as two wheelers, three wheelers, cars and bus passengers. Attributes such as travel time (minutes), travel cost (rupees) and fatality per year was included to decide upon the choice sets. Data was collected across northern part of the state of Kerala (Calicut, Kannur and Manjeri), India. A total of 3600 persons were contacted for the data collection, inclusive of different category of road users such as two-wheelers, three wheelers, car users and bus passengers.

4. RESULTS AND DISCUSSION

The average severity distribution obtained from the police records is given in the Table 1 below:

Table 1: Severity Distribution in Road Traffic Crashes (RTC)

Type of crash	Fatality	Injury	PDO
Fatal RTC	1.12	1.62	1.42
Injury RTC		1.67	1.62
PDO			0.92

Table 2 presents the Mixed Logit (ML) model estimation results based on random parameter approach and heterogeneity in means and variances. The WTP value of avoiding a road crash is obtained is 0.68/person/trip. The value of avoiding a traffic crash is calculated using the Average Daily Traffic (ADT) count and number of persons travelled per day. Average urban daily personal trip is obtained as 215,000 based on ADT and average vehicle occupancy in an urban corridor.

Based on this, the Value of Statistical Casualty (*VSC*) is obtained as
VSC = 0.68 x 365 x 215000 = Rs. 53,363,000
The *VSL* value is obtained as

$$VSL = \frac{53,363,000}{0.2 \times 0.85 + 0.15} = Rs.\ 17,076,160,\ and$$

VSI = 17,076,160 x 0.20 = Rs. 3,415,232.

Cost of various categories of crashes calculated based on these values is shown in Table 3.

Table 3: Category-wise Crash Costs

	Fatality	Injury	PDO		Total cost in Rupees
	(Rs. 53,363,000)	(Rs. 3,415,232)	Rate in Rupees	Involvement	
Fatal RTC	1.12	1.62	59,255	1.42	65,383,378
Injury RTC		1.67		1.62	5,799,431
PDO			25,180	0.92	23,166

Data regarding number of fatalities, injuries and property damage only crashes will be available in the blackspot identification list. Then these cost values can be used to find out the total financial implications of the blackspots. Immediate priority for improvement works should be given to that spot which shows the highest financial loss and other spots can be selected for safety improvisation works based on their position in the rank list based on these total cost values. This method of prioritisation is more live and will be more acceptable as the real-life burden of traffic crashes to the society is taken into consideration in this method.

5. CONCLUSIONS

The methodology used in this study provides a framework for the determination of cost of traffic crashes which can be used to prioritize the crash prone areas for improvement works to channelize the limited financial resources effectively in developing countries like India. Evidence herein can be disaggregated to provide inputs for various types of analysis like benefit-cost analysis. The model proposed in this study was from a specific region of the country and so should be very careful while applying these findings in local, regional and national level projects. Also, in future research, separate procedure can be developed for getting the willingness to pay values to prevent various levels of injuries.

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