Impacts of accident severity factors and loss values of crashes on expressways in Thailand

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ABSTRACT

The number of road accidents and the level of accident severity have been extensively applied as the indicators for measuring the efficiency of service provision in road network systems of each country. This research utilized accident data on expressway networks during B.E.2550 (2007) to B.E.2553 (2010) (updated data was collected), in which Expressway Authority of Thailand (EXAT) as legislatively mandated unit has taken responsibility for the execution of nine expressway routes covering distances totaling over 207 km with a record of 2194 crashes. The chief objective of the study aims to forecast the accident severity through formulating Multiple Logistic Regression Model to analyze the probability of injury accident and fatal accident in comparison with property damage only accident. Its measurement comprehensively considers statistical relationship among variables such as average speed on road section, average traffic volume per day, period of time, weather conditions, physical characteristics of accident area, and causes of accident. Together, the research question is to verify whether these variables affect the opportunity or probability of three levels of accidents and investigate impacts of accident loss values due to the reduction in crash severity measures.

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1. Introduction

Road accidents are a major world economic and social problem as shown by the report of loss of lives and properties in many countries around the world. Reporting indicated the number of fatalities from road accidents per year of about 1.3 million and 50 million injuries were recorded [1] or an average of 3000 deaths/day and 30,000 injuries/day. Furthermore, its consequences have an impact on economic and social conditions in terms of health care costs of injuries and disabilities. The World Health Organization (WHO) [2] estimated the economic costs derived from road accidents reached 518 billion USD per year in high income countries and 65 billion USD per year in medium and low income countries.

In addition, Peden and Organization 2004 reported that 90% of road crash fatalities were found in the group of medium and low income countries such as Africa and southeast Asia. Thailand is one of the southeast Asian countries where there was a significant number of traffic accident problems. According to a worldwide comparison of traffic accident mortalities, it was found that Thailand ranked 70th among 178 countries in the world in the total number of deaths as calculated approximately 19.6 deaths/100,000 people [1]. The report of Department of Health, Thailand B.E.2554 (2011) illustrated that traffic accident is the second leading cause of death in Thailand, 2nd only to cancer disease, and is the primary cause of injuries [3]. The total cost of traffic accidents in Thailand for the year 2004 was estimated at 153,755 million baht [4]. Although the government has issued some policies to prevent and control accidents, the numbers of injuries and deaths have continued to increase.

The Expressway Authority of Thailand (EXAT). a division of the Ministry of Transport, takes responsibility for the management and execution of the expressways. The EXAT has a consolidated vision of expressway safety and provides regular road safety audits and black spot treatment. However, the number of accidents on the expressways is still too high as indicated from the record in B.E.2553 (2010) of 1878 crashes with 20 deaths and 573 injuries [5]. Nevertheless, road accident prediction is quite difficult because the causes of accidents are generally brought on by various factors such as road user behaviors, vehicle conditions, physical road characteristics, and the environment [6], even with the improvement of physical road conditions. Therefore, it is vital to obtain accident data to formulate a statistical model for the purpose of providing an explanation for and forecasting the probability of crashes, as well as finding the factors that might affect the accident severity. This effort will benefit the responsible authorities in well-considered black spot improvement and road safety audit consequence to prevent or reduce any damages caused by accidents.

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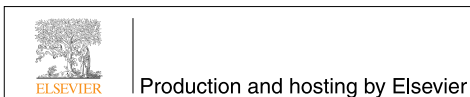
According to the reviews, we found various studies relating to the accident severity factors and [7] prediction of levels of severity of crash using nested logit model. Some influential factors were indicated by the study such as environmental conditions, highway design, accident type, driver characteristics and vehicle attributes. Kelvin [8] examined factors causing accident severity of three vehicle types in Hong Kong including private vehicles, goods vehicles and motorcycles via logistic regression models. The research found that each vehicle type significantly exhibited different accident severity factors. In the case of private vehicle type, severity levels of crashes were mainly influenced by district board, gender of driver, age of vehicle, time of the accident and street light condition factors. While the accident severity factors of goods vehicles are seat belt usage and weekday occurrence. In addition, age of vehicle, day of week and time of the accident factors showed a significant relationship with accident severity levels of motorcycle type. O'Donnell and Connor and Kockelman and Kweon [9,10] analysed the traffic accident data using an ordered multiple choice model consisting of ordered logit and ordered probit models. O'Donnell and Connor [9] found that slight increases in the probabilities of fatal or serious injuries were influenced by several factors including the victim's age and vehicle speed. Other factors that may have some influence on different types of injuries include seating position, blood alcohol level, vehicle type, vehicle make and type of collision. Kockelman and Kweon [10] found that the vehicles such as pickups and sport utility vehicles were less safe than passenger cars, especially for accidents involving a single vehicle. However, for accidents with two-vehicle collisions, it was reported that there are less severe injuries for the drivers and more severe injuries for occupants. Ali [11] investigated the influence of accident factors on fatal and non-fatal accidents in Saudi Arabia. The study findings showed that accident location and cause of accident are significantly associated with a fatal accident. Accident factors used in the study include accident location, accident type, collision type, time of accident, cause of accident, age of driver at fault, vehicle type, nationality and license status. Some of the accident factor classifications of that study are used as the independent (predictor) variables in the analysis.

Based on the review of traffic safety literature in Thailand, most research on factors influencing accidents on highways have used several methods, such as application of statistical models and multi-factors to provide an illustration of accident conditions. None of the past research has specifically considered the issue of accident severity on the expressways which has well-designed and safety control systems serving as accident prevention which is the focus of this study. The analysis of factors influencing accident severity on Thai expressways was performed together with the development of a model for predicting the probability of crash severity following significant factors obtained by the analysis. Moreover, the study applied multinomial logistic regression to assess accident loss values according to the reduced accident numbers resulting from the revision of accident reduction policies and measures. The outcomes of the study would benefit the responsible agencies in identifying accident reduction interventions.

2. Methodology

2.1. Data description

This study proposes to investigate the severity of accidents on all expressways in Thailand by using secondary data obtained from the Expressway Authority of Thailand (EXAT), which has taken responsibility of collecting traffic accident data on each of the 9 expressway routes covering a total area of 207 km. The data includes time and location (e.g., accident time, accident management time, and accident location), environment (e.g., traffic lanes, weather condition, and physical characteristics of the accident location), accident severity (e.g., number of injuries or deaths and number of damaged cars), and characteristics and causes of the accident. This study gathered data from the past 3 years from B.E.2550 (2007) to B.E.2553 (2009) by classifying the severity of accidents following the accident factors as shown in Table 1.

According to Table 1, there were a total of 2194 accidents recorded in 3 categories including 1455 property damage-only accidents (66.32%), 700 injury accidents (31.90%), and 39 fatal accidents (1.78%).The average speed on the expressway section at which the accident occurred was around 70 km/h; while an average traffic volume of 3385 PCU/day was addressed. Considering the time of accidents, most accidents usually occur during the day (1106 times); however a high level of accident severity being recognized as a fatal accident always occurs at night (25 times). For weather conditions, the largest number of accidents occurs in clear weather (2013 times) and most occurred on a straight segment (1327 times). Furthermore, a greater number of crashes occur on one-lane roads (1606 times), in which inconsiderate drivers are a major cause of accidents (1910 times).

Table 1
The number of accidents disaggregated by accident severity.

Variables		Unit	Property damage-only	Injury accident	Fatal accident	Total
Accident occurred		Number of accidents	1,455	700	39	2194
Speed		km./hr.	70	71	76	70
Traffic volume		PCU/day	3,391	3,402	2,862	3385
Time of day	Day time	Number of accidents	769	323	14	1106
	Night time	Number of accidents	686	377	25	1088
Weather conditions	Normal	Number of accidents	1,341	637	35	2013
	Rainy	Number of accidents	114	63	4	181
Number of lane	1-lane	Number of accidents	1,112	467	27	1606
	2-lane	Number of accidents	236	178	11	425
	3-lane	Number of accidents	106	51	1	158
	4-lane	Number of accidents	1	4		5
Cause of accident	Slow driving/unusual	Number of accidents	12	5	1	18
	reckless driving	Number of accidents	1,279	601	30	1910
	Sudden lane change	Number of accidents	71	41	1	113
	Drunk	Number of accidents	17	9	3	29
	Personal diseases/driver sleepiness	Number of accidents	38	32	4	74
	Equipment failure	Number of accidents	38	12		50
Type of location	Toll station	Number of accidents	181	12	1	194
	Curve	Number of accidents	249	132	6	387
	Straight	Number of accidents	853	448	26	1327
	Intersection	Number of accidents	46	25	2	73
	Junction	Number of accidents	21	11	1	33
	Upgrade	Number of accidents	36	32	2	70
	Downgrade	Number of accidents	69	40	1	110