REPORT OF RESEARCH RESULTS

(a) **Title**: Impact of Branch office of highway on Traffic accidents and fatalities: Multilevel models approach.

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(c) **Summary**

The purpose of this study is to focus on factors affecting accident frequency and severity of fatal accidents. The mentioned factors will be considered into two levels including accident case level and highway level which were analyzed by applying multivariate models and multi-level analysis. The results of the mentioned model will be able to predict accident risks occurring in each area under the responsibility of Highway Districts as well as propose the policy potentially decreasing the number and severity of accidents.

(d) **Aim of Research**

To analyze the factors resulting in accident occurrences and their severities, the factors will be divided into two levels: 1) Accident case level including driver factor (sex, age, safety equipment); Road factor (physical characteristics of roads), Environmental factors (conditions or vision) etc. ; and 2) Highway District level in which the factors will be considered in differently general characteristics and particular characteristics including traffic quantity under the responsibility of highway districts, congestion index, budget, and district responsibility etc. The accident model results would be developed two models including: 1) modeling of crash frequency and 2) modeling of fatal crash.

(e) **Method of Research and Progression**

This study will investigate the factors resulting in accidents and their severities by multi-level model analysis which is able to seek for factors affecting accident risks in two levels of Accident case level and Highway Districts of which operational sub areas of responsibility are throughout the country. The procedures and process of study are as follows;

1) Study related research involving with the accident analysis in Thailand and abroad by dividing into 3 groups including 1) Factors resulting in accident risks, 2) Factors affecting accident death rates, and 3) Multi-level models such as Poisson regression models, Negative binomial models, Fixed-Random effected models, Mixed model, Logistics models etc.

2) Gather information from Internet system and request data from the involved departments as well as actual data collection. The details are as follows;

2.1) Department of Highways includes details of accidents such as driver characteristics (sex, age, alcohol usage / drug use), environment characteristics (Visibility, visibility, lighting, time of accident, etc.), road characteristics in case of accident occurrences (accidents at crossroads or not, curve / straight routes / number of traffic lanes, etc.)

2.2) Office of Highways and Highway Districts countrywide such as the operational areas of responsibility, the details of characteristics under the responsibilities, annual traffic quantity etc., travel size quantity, congestion index on roads under the responsibility.

2.3) Survey additionally actual accident data to analyze the model realism by exploring the accident scene to collect factors and accident occurrence traits, as well as every victim's injury levels.

3) Select the model and variables suitable for the acquired data. Then, the model will be developed to seek for risk factors affecting both accident frequency and fatality rate caused by accidents. The R program will be used for developing the model.

4) The results of model will be interpreted with respect to empirical data and variables affecting the dependent variables at a level of statistical significance. They will be taken to analyze for creating guidelines for reducing accident frequency and their severities.

(f) Results of Research

1. Modeling of crash frequencies

The overall picture of crash frequencies model as shown in Table 1 shows the road segment data which were divided according to the road physical characteristics. It was found that the number of accidents occurring had mean value of 6.39 times, segment length 3.08 kilometers, lane width 3.47 meters, and road with medians 33%. For the traffic volume, it was found that the average was 14,465 vehicles per day and the proportion of trucks was16.33%.

For the model results (Table 2), they were presented in three parts: 1) random effect conditional model referring to allowing the prediction of the relationship between the independent and the dependent variables which were grouped according to the areas under the supervision of Department of Highways, 2) Conditional model was the factors affecting the accident number to be non-zero state, and 3) zero state which was the factor causing no accidents.

For the random effect, it was found insignificant. In other words, the parameter estimation values were lower than those of standard errors. For result interpretation, these variables did not differently affect the accident number in the regulatory area of Department of Highways. Therefore, the policy management to reduce the number of accidents can be similarly done throughout the country.

As for the condition model, there were several significant factors including constant value (-5.097) which indicated that when not considering other factors, the accident number will not occur. For the factors resulting in accident occurrence was traffic volume, followed by the existence of medians. The reason is because these two variables were clearly related. In other words, the roads with a lot of traffic are often built with medians subsequently causing higher chances of accidents.

For Zero-states, most negative values showed that significant factors often caused the accident number, for example, the increasing distance of road segments causing the non-zero state, followed by the existence of medians and increasing traffic. Volume. This is consistent with the conditional model.

Table 1 Data description of crash frequency model

	Description	n	mean	sd	min	max
Crash number	Crash number	16933	6.39	33.89	0	1329
Length	Length of segment	16933	3.08	5.02	0	63.16
NoLane	Number of lane	16933	3.19	1.78	1	14
Concrete*	Pavement type (1=Concrete, 0=Otherwise)	16933	0.10	0.3	1	2
LaneWidth	Lane width (m)	16933	3.47	0.21	2.5	6
Footpath*	Shoulder type (1=Footpath, 0=otherwise)	16933	0.05	0.21	1	2
ShoulderWidth	Shoulder width (m)	16933	1.74	0.88	0	7.2
Median*	Divided road (1=Yes, 0=Otherwise)	16933	0.33	0.47	1	2
Median_Width	Median width (m)	16933	0.84	3.27	0	15
AADT	Average annual traffic volume (vehicle)	16933	14465.51	24286.45	58	339248
Percent_Truck	Percentage of truck volume	16933	16.33	11.77	0	72.51
LN_AADT	AADT in term of natural logarithm	16933	8.88	1.18	4.06	12.73

Table 2 Crash frequency model results

	Conditional model				**Zero-state**			
Variable	**Estimate**	**Std. Error**	**P-value**	**Sig. sign**	**Estimate**	**Std. Error**	**P-value**	**Sig. sign**
Fixed effect								
(Intercept)	-5.097	0.521	<0.000	***	2.460	0.898	0.006	**
lenght	0.100	0.006	<0.000	***	-1.755	0.171	<0.000	***
NoLane	0.110	0.019	<0.000	***	-0.032	0.024	0.191	
Concrete1	-0.171	0.099	0.083	.	-0.252	0.123	0.040	*
LaneWidth	0.115	0.127	0.362		-0.056	0.235	0.813	
Footbath1	0.217	0.121	0.074	.	-0.358	0.178	0.044	*
ShoulderWidth	0.226	0.035	<0.000	***	0.002	0.053	0.968	
Median1	0.524	0.093	<0.000	***	-0.446	0.125	<0.000	***
Median_Width	0.028	0.013	0.028	*	0.026	0.017	0.116	
LN_AADT	0.544	0.036	<0.000	***	-0.125	0.045	0.006	**
Percent_Truck	-0.002	0.003	0.423		0.000	0.004	0.981	
Random effect: Group = DOH_CODE								
(Intercept)	2.238	1.496						
Distance	0.001	0.027						
LN_AADT	0.033	0.182						
Percent_Truck	0.000	0.013						

*Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

2. Modeling of fatal/non-fatal crash

The accident data showing the number of road accident victims are shown in Table 3. After screening the data, there were 37,685 victims (data from 2014-2018). For the driver factor, the driver age was mostly found in middle-aged people. Most of them do not use seat belts and helmets. Regarding the drunk driving factor, it is very rare, accounting for only 2%. As for the road factor, it was found that the overall picture showed the roads with medians 33% including raised median type (26%), followed by depressed median type (23%), and the smallest proportion which was the colored median type 5%. For environmental factors, most accidents occurred during the day (60%), while the accidents occurring at night and without illumination were 10%. For crash type factor, it was found that single crash had the highest proportion of 49%, followed by rear- end crashes by 25%, side rear-end crashes by13%, crashes against people traveling, and head-to head collisions respectively.

For the parameter estimation results as shown in Table 4, when considering the consistency data with the empirical data, it was found that the mixed effect model potentially predicted better than the fixed effect model. However, the overall number of factors affecting the deaths from accidents went in the same direction, but the mixed effect model was less significant. In terms of driver factor when comparing the car size, it was found that small cars such as motor vehicles had the greatest chance of fatality and females were more likely to die than males. Using a seat belt can cause a death chance. Drunken drivers were probable to die than those who did not drink. With regards to the driver age, it was found that the elderly was more likely to die. For environmental factors, it was found that collisions at night were very likely to cause fatality while collisions at night and without lights potentially increased the likelihood of death. For road factors, it was found that the main traffic lane caused a low death chance, and the accident at the median openings and intersections also brought about low deaths. For crash types, it was found that side -Rear-end crash and a single-car crash gave rise to a low death chance while rear-end and head--to-head collisions would increase the fatality chances.

Table 3 Data description of fatal crash model

Factor	Descriptions	n	mean	sd	min	max
Fatal_Injury	1=Fatal crash, 0=Otherwise	37685	0.14	0.35	0	1
Vehicle size*	1=Small, 2=Middle and 3=Large	37685	1.97	0.6	1	3
Driver_Age	Age of driver	37685	2.55	1.17	1	7
Gender*	1=Male, 0=Female	37685	0.15	0.36	0	1
safety_equip*	1=Use, 0=Otherwise	37685	0.36	0.48	0	1
Drunk_driver*	1=Yes, 0=Otherwise	37685	0.02	0.15	0	1
Main_Road*	1=Inner lane, 0=Otherwise	37685	0.13	0.34	0	1
Normal*	1=Normal status, 0=Otherwise	37685	0.97	0.17	0	1
Devided_Median*	1=Devided road, 0=Otherwise	37685	0.33	0.47	0	1
Flush*	1=Flush median, 0=Otherwise	37685	0.05	0.21	0	1
Riased*	1=Rasued median, 0=Otherwise	37685	0.26	0.44	0	1
Depressed*	1=Depressed median, 0=Otherwise	37685	0.23	0.42	0	1
Barrier*	1=Yes, 0=Otherwise	37685	0.12	0.33	0	1
Councrete*	1=Yes, 0=Otherwise	37685	0.11	0.32	0	1
Straight*	1=Yes, 0=Otherwise	37685	0.84	0.37	0	1
Slope*	1=Yes, 0=Otherwise	37685	0.06	0.24	0	1
Intersection*	1=Yes, 0=Otherwise	37685	0.14	0.35	0	1
Median_opening*	1=Yes, 0=Otherwise	37685	0.1	0.3	0	1
env_surfaces*	1=Dry, 0=Otherwise	37685	0.12	0.33	0	1
Weather*	1= Clean, 0=Otherwise	37685	0.13	0.33	0	1
Day*	1=Yes, 0=Otherwise	37685	0.6	0.49	0	1
Night_NoLight*	1=Nightime and non-lighting, 0=Otherwise	37685	0.1	0.29	0	1
Pedestrians	1= Pesdestrians crash, 0=Otherwise	37685	0.07	0.26	0	1
Rear-end	1=Rear-end crash, 0=Otherwise	37685	0.25	0.43	0	1
Sideswipe	1=Sideswipe crash, 0=Otherwise	37685	0.13	0.34	0	1
Single vehicle	1=Single vehcle crash, 0=Otherwise	37685	0.41	0.49	0	1
Head-on	1=Head-on crash, 0=Otherwise	37685	0.03	0.16	0	1
Other	1=Other crash type, 0=Otherwise	37685	0.08	0.27	0	1

Table 4 Parameter estimation of fatal crash model

	Fixed effect model				Mixed effect model			
Variables	**Estimate**	**Std. Error**	**P-value**	**Sig. sign**	**Estimate**	**Std. Error**	**P-value**	**Sig. sign**
(Intercept)	0.550	0.177	0.002	**	-0.317	0.323	0.327	
`Vehicle size`2	-0.655	0.039	<0.000	***	-1.163	0.058	<0.000	***
`Vehicle size`3	-0.550	0.052	<0.001	***	-1.225	0.076	<0.000	***
Gender1	-0.359	0.048	<0.001	***	-0.422	0.069	<0.000	***
safety_equip1	-0.538	0.036	<0.001	***	-0.544	0.063	<0.000	***
Drunk_driver1	0.316	0.088	<0.001	***	0.390	0.122	0.001	**
Driver_Age	0.087	0.013	<0.001	***	0.090	0.018	<0.000	***
Day1	-0.223	0.037	<0.001	***	-0.317	0.054	<0.000	***
Night_NoLight1	0.653	0.051	<0.001	***	0.561	0.075	<0.000	***
env_surfaces1	0.000	0.107	0.997		-0.031	0.151	0.838	
Weather1	-0.076	0.104	0.462		-0.181	0.147	0.217	
Normal1	-0.116	0.091	0.202		-0.099	0.153	0.517	
Main_Road1	-0.184	0.065	0.005	**	-0.287	0.108	<0.000	**
Devided_Median1	-0.586	0.135	<0.001	***	-0.380	0.246	0.122	
road_lane	-0.099	0.011	<0.001	***	-0.055	0.021	0.008	**
Flush1	-0.338	0.147	0.021	*	-0.520	0.280	0.063	.
Riased1	-0.729	0.137	<0.001	***	-0.605	0.255	0.018	*
Depressed1	-0.469	0.137	0.001	***	-0.174	0.250	0.488	
Barrier1	-1.028	0.153	<0.001	***	-0.635	0.279	0.023	*
Intersection1	-0.307	0.047	<0.001	***	-1.747	0.155	<0.001	***
Median_opening1	0.217	0.054	<0.001	***	-0.813	0.145	<0.000	***
Straight1	-0.150	0.050	0.003	**	-0.105	0.073	0.149	
Councrete1	-0.182	0.058	0.002	**	-0.079	0.109	0.469	
Slope1	0.183	0.068	0.007	**	-0.286	0.131	0.029	*
Pedestrians	-0.634	0.076	<0.001	***	-0.012	0.146	0.934	
`Rear-end`	-0.353	0.048	<0.001	***	0.305	0.139	0.029	*
Sidewipe	-0.667	0.058	<0.001	***	-1.663	0.230	<0.000	***
`Single vehicle`	-1.050	0.049	<0.001	***	-0.488	0.126	<0.000	***
`Head-on`	0.509	0.079	<0.001	***	0.946	0.375	0.012	*

(g) Future Area to Take Note of, and Going Forward

1) Department of Highways can implement the same policy throughout the country and specially consider the policy for roads with medians and high traffic volume. In case of mentioned roads, road safety audit may be considered for safety assessment.

2) For reducing fatal crashes, the survey for the accident spots without light should be firstly conducted, followed by the increase in the signs promoting of non- drunk driving campaigns. the Department of Land Transport should help promote such campaigns. As for crash types, head-to- head collisions and rear-end crashes were the types mostly causing the fatality chances. Therefore, it is necessary to consider the point at which these crash types have often taken place, especially, illegally driving on the wrong side of the street.

(h) Means of Official Announcement of Research Results

We have already prepared our research to distribute our work to the wider audience in Traffic Injury and Prevention.