American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-3, pp-310-316
www.ajer.org
Research Paper Open Access

Analysis of Traffic Accident Severity by Age Using Ordered Probit Model in Korean Highway

Sunyoung Ahn[1], Sanghyup Lee[2]
[1](*Korea Institute of Civil Engineering and Building Technology, Korea)*
[2]*Korea Institute of Civil Engineering and Building Technology, Korea)*
Corresponding author: Sunyoung Ahn

ABSTRACT: *Generally, traffic accident severity appear differently by human characteristics such as physical co mpetence, cognitive competence and coping competence, etc. Driver's age has correlation with these human cha racteristics. Furthermore, these competences have correlation with driver's characteristics, such as driving expe rience and social economy status. Thus, the objective of this study is to develope traffic accident severity forecas ting model which would analyze the traffic accident data according age group, whereby estimating influential fa ctors of traffic accident severity affecting differently by driver's age is confirmed. Also ordered probit model was employed for analyzing traffic accident severity based on traffic accident severity data which is originally from t raffic accident management systems(TAMS). As a result of the comparison with traffic accidents by age group, t he traffic accident severity was affected differently according to age group. And under 30s group of traffic accid ent severity is affected by speeding, drowsy driving, negligence of watching, vehicle-facility accident and road s urface condition, and up to 40s group of traffic accident severity was affected by locations of accident, drowsy d riving, vehicle-facility accident and longitudinal slope.*

Keywords -*Accident of Highway, Accident Severity, Age, OrderedProbit Model*

Date of Submission: 15-03-2018 Date of acceptance: 30-03-2018

I. INTRODUCTION

1.1 Background and Purpose of the Study

Traffic accidents are caused by various factors, including human, environmental, and physical factors, and such factors influence accident severity, which is the degree of damage of a traffic accident. Therefore, it is possible to decrease traffic accidents and improve safety by understanding factors affecting the number or severity of traffic accidents and their relationships with each other.

In this study, it was considered that physical ability such as cognitive response ability and driving skills, all of which may be different according to the age, would influence traffic accident severity, and the severity by age was analyzed. In addition, the analysis by age can be used not only as useful data for examining traffic safety measures and desirable road traffic facility plans to prevent accidents caused by elderly drivers in an aging society but also as basic data for implementing policies for young drivers with relatively less driving experience. Therefore, in this study, factors affecting traffic accident severity in highways are identified by age and different factors are derived by model.

1.2 Contents and Methods of the Study

In this study, the severity of nationwide accidents was classified into property damage, injuries, and deaths using the data provided by the traffic accident management system (TAMS) and the influence of each variable on accident severity was analyzed.

Factors affecting traffic accident severity were identified using previous studies and variables required for analysis were selected. The selected variables corresponded to environmental and driver factors. In addition, the ordered probit model was used in this study considering the characteristics of accident data, and accident severity models were developed for each age group.

Fig 1 shows the contents and methods of this study.

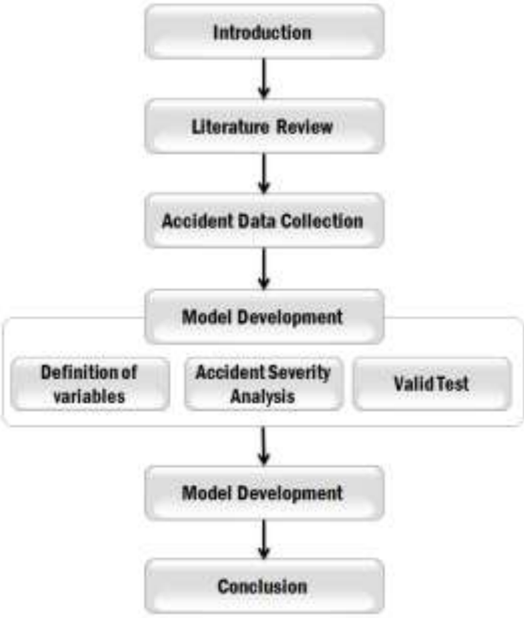

Fig 1 Process of the Study

II. LITERATURE REVIEW

2.1 Theoretical Background

The ordered probability model can be used when dependent variables are arranged in order. It is used when dependent variables have a sequence (e.g. y=0, y=1, y=2, and so on). In other words, the model can be utilized when ordered data, such as traffic accident severity analysis, are used.

This ordered probability model is divided into the ordered probit model and the ordered logit model. In this study, the ordered probit model, in which it was assumed that the probability distribution of ε_i(error term) followed a normal distribution with the same variance and the zero covariance, was used.

The basic theory of the ordered probit model is as follows. In the data of the ordered probit model, y typically has the data of 0, 1, 2, 3, … y_i , and can be expressed as follows.

$$y = \beta X_i + \varepsilon, \ \varepsilon_i \sim N[0, 1]$$
$$y = 0 \ \text{if} \ y \le 0$$
$$y = 1 \ \text{if} \ 0 < y \le \mu_1$$
$$y = 1 \ \text{if} \ \mu_1 < y \le \mu_2$$
$$\vdots$$
$$y = y_1 \ \text{if} \ \mu_{y-1} < y$$

Where, y is the latent utility that cannot be measured, and can be expressed using the measurable utility (βx_i) and the unmeasurable utility (ε_i). In addition, $\mu$is called a threshold that is estimated along with the estimation factor $\beta$of each explanatory variable, and can be used to calculate the selection probability for selection alternatives. The selection probability for each alternative (following the order) can be expressed as follows.

$$Prob(y = 0) = \Phi(-\beta' x)$$
$$Prob(y = 1) = \Phi(\mu_1 - \beta' x) - \Phi(-\beta' x)$$
$$Prob(y = 2) = \Phi(\mu_2 - \beta' x) - \Phi(\mu_1 - \beta' x)$$
$$\vdots$$
$$Prob(y = y_i) = 1 - \Phi(\mu_{y_i - 1} - \beta' x)$$

The marginal effect that represents the influence of each explanatory variable on accident severity can be expressed by applying partial differentiation to each explanatory variable. For example, in the case of a dummy variable (x=0 or 1), the marginal effect means the difference between the selection probability when the explanatory variable is 1 and that when it is zero ($= Prob(1) - Prob(0)$) while the other explanatory variables are fixed. Therefore, the sum of the marginal effects for each explanatory variable becomes zero

$$\frac{\partial Prob[y = 0]}{\partial x} = -\Phi(\beta' x)\beta$$

$$\frac{\partial Prob[y=1]}{\partial x} = [\Phi(-\beta' x)\beta - \Phi(\mu - \beta' x)]\beta$$
$$\frac{\partial Prob[y=2]}{\partial x} = -\Phi(\mu - \beta' x)\beta$$

The finally derived model can be verified using ρ^2(likelihood), which represents the explanatory power of the model, and the χ^2(Chi-square) value, which tests the suitability of the model. ρ^2(likelihood), also known as McFadden's coefficient of determination, has a value between zero and 1. As it is closer to 1, the suitability of the model is considered high. Unlike the coefficient of determination of regression analysis, the value between 0.2 and 0.4 indicates sufficiently high suitability. In addition, the χ^2 (Chi-square) value is used to verify the independence of each variable during the development of a model. The suitability of a model can be verified by comparing the threshold values using the χ^2 statistics and the χ^2 distribution table (Oh-geun HA, 2005).

2.2 Previous Studies

2.2.1Studies on traffic accident severity

Se-heumBaek (2018) analyzed factors affecting accident severity before and during expansion construction using the ordered probit model. The factors affecting traffic accidents before the start of construction were found to be day and night, the vehicle type, and road surface condition, and those after the start of construction were the crash type, longitudinal slope, barricade facility, and vehicle type.

Sang-hyeok Lee (2012) identified the causes of traffic accidents for the elderly group and the non-elderly group using traffic accident data, and defined traffic facilities, road environment, and individual characteristics as independent variables to analyze factors affecting traffic accident severity by group. The ordered logit model was used for the analysis. As a result, the types and sizes of factors affecting traffic accident severity were different between the elderly group and the non-elderly group.

Ji-yeon Hong (2011) analyzed traffic accident severity in construction sites using the data provided by TAMS, and the ordered probit model was utilized. As a result, traffic accident severity was affected by the road surface condition, horizontal alignment of the accident location, and the test status of the vehicle that caused an accident.

Kara Maria Kockelman (2002) classified traffic accident severity into property damage, light injuries, severe injuries, and deaths; selected explanatory variables for driver, vehicle, and accident characteristics; and developed a model accordingly. This study revealed that the safety of heavy vehicles was lower than that of passenger cars in single-vehicle crashes and that the accident severity of the driver was lower than that of the passenger car while the accident severity of the person seated in the passenger seat was higher in vehicle-to-vehicle crashes. Furthermore, accident severity was lower as the driver was younger and the driving speed was lower.

Oh-geun Ha (2005) analyzed factors affecting the accident severity of intersection traffic accidents using the ordered probit model, and found that factors affecting traffic accident severity in intersections were the traffic on minor roads, heavy vehicle proportion on major roads, right-turn proportion on major roads, right-turn proportion on minor roads, lighting facilities on major roads, restriction facilities on major roads, and left-turn guidelines on minor roads.

Zhang (2000) analyzed factors affecting accident severity according to the driver age using the accident data of Canada, and found that accident severity was higher for older drivers.

2.2.2Limits of previous studies and research direction establishment

The examination of the results of previous studies revealed that domestic studies on the analysis of traffic accident severity by age group were not sufficient other than those on elderly and non-elderly drivers. The analysis data of elderly drivers can be used as basic data for preparing traffic safety measures to reduce the risk of accidents caused by unsafe driving of elderly drivers while the analysis data of young drivers can be utilized as basic data for preparing policies related to driver's license testing and training. As such, this study aims to provide data required for implementing traffic-safety-related policies and to derive a severity model of highway traffic accidents based on the methodologies of previous studies.

III. MODEL ESTIMATION

3.1 Accident data collection

This study conducted analysis using only highway traffic accidents among traffic accidents in South Korea in 2009. In addition, the traffic accident data were classified into all ages, ages less than 30, ages between 30 and 40, ages between 40 and 50, and ages over 50 for analysis by age. Table 1 shows the definition of each variable for developing accident severity models for each age group.

Property-damage, injury, and death accidents, which correspond to dependent variables, were defined as indicators capable of representing accident severity. 19 factors considered affecting accident severity, including the location of the accident, cause of the accident, crash type, accident time, and road surface condition, were defined as explanatory variables.

Table 1 Definition of variables

Classification	indication method
severity	no injury=0; injury=1; fatal=2
locations of accident	mainline=1; others=0
	tunnel=1; others=0
	ramp=1; others=0
cause of accident	speeding=1; others=0
	alcohol=1; others=0
	drowsy driving=1; others=0
	negligence of watching=1; others=0
	wheel over control=1; others=0
	vehicle defects=1; others=0
crash type	single-vehicle crash=1; others=0
	vehicle-facility=1; others=0
	rear-ender=1; others=0
day and night	night=1; daytime=0
road surface condition	dry=1; wet/slippery=0
horizontal alignment	curve=1; straight=0
longitudinal slope	slope=0; surface=1
vehicle type	heavy vehicle=1; others=0
number of car involved	1=0; more than 2=1
gender	male=1; female=0

The number of traffic accidents by age group shown in Table 2 revealed that, out of total 2,374 traffic accidents, 418 were caused by ages under 30, 628 by ages between 30 and 40, 738 by ages between 40 and 50, and 590 by ages over 50, indicating that ages between 40 and 50 caused the largest number of traffic accidents. In addition, in the case of total traffic accidents, the number of property-damage accidents with no injury was 1,637 (69.0%), while the number of injury accidents was 523 (22.0%) and the number of death accidents was 214 (9.0%). The proportions of property-damage, injury, and death accidents were similar for all age groups, but drivers aged between 40 and 50 exhibited death accidents accounting for more than 10% of the total accidents in the age group, resulting in relatively higher proportion of death accidents than other age groups.

Table 2 Number of Traffic Accident by Age Group and Characteristics of Accident

(Unit: Number, %)

Classification		All		under 30		30s		40s		over 50	
		accidents	ratio	accidents	ratio	accidents	ratio	accidents	ratio	accidents	ratio
Number of accident		2,374	100.0	418	17.6	628	26.5	738	31.1	590	24.9
severity	no injury	1,637	69.0	286	68.4	439	69.9	507	68.7	405	68.6
	injury	523	22.0	97	23.2	140	22.3	152	20.6	134	22.7
	fatal	214	9.0	35	8.4	49	7.8	79	10.7	51	8.6
locations of accident	mainline	1,793	75.5	332	79.4	479	76.3	563	76.3	419	71.0
	tunnel	64	2.7	14	3.3	12	1.9	16	2.2	22	3.7
	ramp	325	13.7	49	11.7	88	14.0	112	15.2	76	12.9
	others	192	8.1	23	5.5	49	7.8	47	6.4	73	12.4
cause of accident	speeding	548	23.1	104	24.9	148	23.6	173	23.4	123	20.8
	alcohol	67	2.8	12	2.9	27	4.3	24	3.3	4	0.7
	drowsy driving	541	22.8	94	22.5	149	23.7	168	22.8	130	22.0
	negligence of watching	304	12.8	45	10.8	68	10.8	102	13.8	89	15.1
	wheel over control	372	15.7	83	19.9	102	16.2	105	14.2	82	13.9

	vehicle defects	253	10.7	41	9.8	56	8.9	74	10.0	82	13.9
	others	289	12.2	39	9.3	78	12.4	92	12.5	80	13.6
crash type	single-vehicle	359	15.1	65	15.6	96	15.3	109	14.8	89	15.1
	vehicle-facility	1,454	61.2	263	62.9	391	62.3	449	60.8	351	59.5
	rear-ender	368	15.5	56	13.4	93	14.8	113	15.3	106	18.0
	others	193	8.1	34	8.1	48	7.6	67	9.1	44	7.5
day and night	day	1,412	59.5	228	54.5	359	57.2	438	59.3	387	65.6
	night	962	40.5	190	45.5	269	42.8	300	40.7	203	34.4
road surface condition	dry	1,757	74.0	331	79.2	479	76.3	523	70.9	424	71.9
	wet/slippery	617	26.0	87	20.8	149	23.7	215	29.1	166	28.1
horizontal alignment	straight	1,425	60.0	237	56.7	372	59.2	440	59.6	376	63.7
	curve	949	40.0	181	43.3	256	40.8	298	40.4	214	36.3
longitudinal slope	surface	901	38.0	142	34.0	233	37.1	283	38.3	243	41.2
	slope	1,473	62.0	276	66.0	395	62.9	455	61.7	347	58.8
vehicle type	non heavy vehicle	1,376	58.0	340	81.3	404	64.3	365	49.5	267	45.3
	heavy	998	42.0	78	18.7	224	35.7	373	50.5	323	54.7
number of car involved	one	1,626	68.5	295	70.6	430	68.5	508	68.8	393	66.6
	more than two	748	31.5	123	29.4	198	31.5	230	31.2	197	33.4
gender	male	2,120	89.3	359	85.9	556	88.5	655	88.8	550	93.2
	female	254	10.7	59	14.1	72	11.5	83	11.2	40	6.8

3.2Estimation and Results of the Model

In this study, LIMDEP (Limited Dependent Variables, ver 8.0), a statistical package, was used to develop traffic accident severity models for each age group.

Table 3shows factors affecting highway traffic accident severity by age group and Table 4 represents the marginal effect that represents the influence of each explanatory variable on accident severity. As for the models estimated in this study, χ^2, which represents the overall goodness of fit, was higher than 27.20, the threshold value, in the 90% confidence interval for all the models, indicating that the models were significant. The likelihood (ρ^2), which represents the explanatory power of a model, was also higher than 0.1 for all the models, showing that the models were fit to a certain degree.

First, the model for the total traffic accidents showed that traffic accident severity was affected by speeding, drowsy driving, and negligence of watching among the causes of the accident; vehicle-facility accidents and rear-enders among the crash types; as well as road surface condition, longitudinal slopes, and the number of cars involved. The model for ages between 40 and 50 and the one for ages less than 30 were almost similar to the model for the total traffic accidents. Among the factors that were found to affect traffic accident severity in the model for the total traffic accidents, rear-enders in the model for ages between 40 and 50 and rear-enders as well as longitudinal slopes in the model for ages less than 30 appeared not to affect traffic accident severity. In addition, in the model for ages between 30 and 40, traffic accident severity was found to be affected by ramps, vehicle-facility accidents, drowsy driving, and longitudinal slopes. In the model for ages over 50, drowsy driving and the number of cars involved were found to affect traffic accident severity.

Table 3 Model Results

Classification		All			under 30			30s			40s			over 50		
		Coe.	t	P	Coe.	t	P	Coe.	t	P	Coe.	t	P	Coe.	t	P
Constant		-0.87	-4.59	0.00	-1.92	-3.80	0.00	0.19	0.48	0.63	-1.20	-3.60	0.00	-0.91	-2.28	0.02
locations of accident	mainline	0.02	0.21	0.84	0.08	0.27	0.79	-0.34	-1.66	0.10	0.33	1.71	0.09	0.01	0.05	0.96
	tunnel	0.12	0.68	0.50	-0.15	-0.33	0.74	0.03	0.09	0.93	0.31	0.84	0.40	0.11	0.35	0.73
	ramp	-0.26	-1.95	0.05	-0.22	-0.60	0.55	-0.76	-2.87	0.00	0.08	0.35	0.73	-0.27	-1.01	0.31
cause of accident	speeding	0.53	5.00	0.00	1.11	3.79	0.00	0.37	1.72	0.09	0.57	3.01	0.00	0.35	1.61	0.11
	alcohol	0.27	1.53	0.13	0.70	1.54	0.12	0.39	1.31	0.19	0.12	0.40	0.69	-6.13	0.00	1.00
	drowsy driving	0.50	5.08	0.00	1.10	3.81	0.00	0.49	2.52	0.01	0.38	2.22	0.03	0.38	2.00	0.05
	negligence of watching	0.43	4.04	0.00	1.05	3.40	0.00	0.24	1.10	0.27	0.41	2.22	0.03	0.38	1.91	0.06
	wheel over control	0.09	0.79	0.43	0.58	1.91	0.06	-0.02	-0.08	0.93	0.10	0.46	0.65	0.00	0.00	1.00
	vehicle defects	-0.04	-0.31	0.76	0.62	1.78	0.08	0.09	0.37	0.71	-0.40	-1.68	0.09	-0.16	-0.67	0.50
crash type	single-vehicle	-0.18	-1.48	0.14	-0.47	-1.47	0.14	-0.22	-0.90	0.37	-0.36	-1.57	0.12	0.08	0.32	0.75
	vehicle-facility	-0.49	-4.74	0.00	-0.63	-2.41	0.02	-0.70	-3.35	0.00	-0.41	-2.26	0.02	-0.42	-1.91	0.06

rear-ender	0.24	2.05	0.04	0.35	1.24	0.22	0.20	0.90	0.37	0.23	1.08	0.28	0.28	1.13	0.26
day and night	0.10	1.78	0.08	0.11	0.78	0.44	0.10	0.95	0.34	0.08	0.75	0.45	0.12	1.03	0.30
road surface condition	0.28	3.91	0.00	0.45	2.38	0.02	0.07	0.48	0.63	0.46	3.48	0.00	0.16	1.13	0.26
horizontal alignment	-0.01	-0.15	0.88	0.07	0.52	0.60	0.08	0.70	0.48	-0.09	-0.84	0.40	-0.03	-0.24	0.81
longitudinal slope	-0.20	-3.32	0.00	0.08	0.54	0.59	-0.37	-3.02	0.00	-0.26	-2.37	0.02	-0.17	-1.36	0.17
vehicle type	-0.08	-1.37	0.17	-0.16	-0.86	0.39	-0.10	-0.80	0.42	-0.18	-1.72	0.09	0.03	0.25	0.80
number of car involved	0.46	5.91	0.00	0.56	2.93	0.00	0.23	1.47	0.10	0.43	3.08	0.00	0.55	3.36	0.00
gender	0.04	0.39	0.69	0.38	1.80	0.07	-0.28	-1.61	0.11	0.16	0.96	0.34	0.10	0.40	0.69
μ(1)	0.99	25.30	0.00	1.16	10.73	0.00	1.03	13.02	0.00	0.89	13.67	0.00	1.05	12.89	0.00
LL(0)	-1914.6190			-337.0334			-492.2908			-607.0392			-475.8644		
LL(b)	-1700.1240			-281.6873			-442.5443			-536.3589			-410.7332		
ρ^2	0.1120			0.1642			0.1011			0.1164			0.1369		
χ^2	428.9905			110.6924			99.4931			141.3607			130.2624		
Degrees of Freedom	19			19			19			19			19		

note: t value is significant at the 0.05 level.

Table 4 Marginal Effect

Classification		All			under 30			30s			40s			over 50		
		Y=0	Y=1	Y=2	Y=0	Y=1	Y=2	Y=0	Y=1	Y=2	Y=0	Y=1	Y=2	Y=0	Y=1	Y=2
locations of accident	mainline	-0.01	0.01	0.00	-0.03	0.02	0.01	0.12	-0.08	-0.04	-0.11	0.07	0.04	0.00	0.00	0.00
	tunnel	-0.04	0.03	0.02	0.05	-0.04	-0.01	-0.01	0.01	0.00	-0.11	0.06	0.05	-0.04	0.03	0.01
	ramp	0.08	-0.06	-0.03	0.07	-0.06	-0.02	0.21	-0.16	-0.05	-0.03	0.02	0.01	0.08	-0.06	-0.02
cause of accident	speeding	-0.19	0.11	0.08	-0.41	0.24	0.17	-0.13	0.08	0.05	-0.21	0.11	0.10	-0.12	0.08	0.04
	alcohol	-0.10	0.06	0.04	-0.27	0.16	0.11	-0.14	0.09	0.06	-0.04	0.03	0.02	0.29	-0.23	-0.05
	drowsy driving	-0.18	0.11	0.08	-0.41	0.24	0.17	-0.17	0.11	0.07	-0.14	0.07	0.06	-0.14	0.09	0.05
	negligence of watching	-0.16	0.09	0.07	-0.40	0.21	0.19	-0.08	0.05	0.03	-0.15	0.08	0.07	-0.14	0.09	0.05
	wheel over control	-0.03	0.02	0.01	-0.21	0.14	0.07	0.01	0.00	0.00	-0.03	0.02	0.01	0.00	0.00	0.00
	vehicle defects	0.01	-0.01	-0.01	-0.23	0.15	0.09	-0.03	0.02	0.01	0.12	-0.08	-0.04	0.05	-0.04	-0.02
crash type	single-vehicle	0.06	-0.04	-0.02	0.14	-0.11	-0.03	0.07	-0.05	-0.02	0.11	-0.07	-0.04	-0.03	0.02	0.01
	vehicle-facility	0.17	-0.11	-0.07	0.22	-0.15	-0.07	0.24	-0.16	-0.09	0.15	-0.08	-0.06	0.14	-0.10	-0.05
	rear-ender	-0.08	0.05	0.03	-0.13	0.09	0.04	-0.07	0.05	0.03	-0.08	0.05	0.04	-0.10	0.06	0.03
day and night		-0.03	0.02	0.01	-0.04	0.03	0.01	-0.04	0.02	0.01	-0.03	0.02	0.01	-0.04	0.03	0.01
road surface condition		-0.09	0.06	0.03	-0.14	0.11	0.03	-0.02	0.02	0.01	-0.15	0.09	0.06	-0.05	0.04	0.02
horizontal alignment		0.00	0.00	0.00	-0.03	0.02	0.01	-0.03	0.02	0.01	0.03	-0.02	-0.01	0.01	-0.01	0.00
longitudinal slope		0.07	-0.04	-0.02	-0.03	0.02	0.01	0.12	-0.08	-0.04	0.09	-0.05	-0.04	0.06	-0.04	-0.02
vehicle type		0.03	-0.02	-0.01	0.05	-0.04	-0.01	0.03	-0.02	-0.01	0.06	-0.04	-0.03	-0.01	0.01	0.00
number of car involved		-0.16	0.10	0.07	-0.20	0.14	0.07	-0.08	0.05	0.03	-0.15	0.08	0.07	-0.19	0.13	0.07
gender		-0.01	0.01	0.00	-0.12	0.09	0.03	0.10	-0.06	-0.04	-0.05	0.03	0.02	-0.03	0.02	0.01

As for the effects of each explanatory variable on accident severity in the model for the total traffic accidents, speeding, drowsy driving, and negligence of watching among the causes of the accident as well as rear-enders among the crash types exhibited positive effects, indicating that traffic accidents caused by these factors led to higher traffic accident severity. Furthermore, road surface condition and the number of cars involved were also found to exhibit positive effects. As a result of analyzing the marginal effects of each explanatory variable on dependent variables, these factors with positive effects showed positive values for injury accidents (Y=1) and death accidents (Y=2). This means that if speeding, drowsy driving, or negligence of watching is the cause of an accident, injuries or deaths are more likely to occur, and that dry road surface condition rather than wet or icy condition or the involvement of more than two cars may cause severer accidents. Furthermore, the values of injury accidents (Y=1) were higher than those of death accidents (Y=2), revealing that injury accidents are more probable than death accidents.

The marginal effects of the models by age group exhibited similar trends. In the case of the marginal effects for accidents caused by vehicle defects among the factors analyzed to affect traffic accident severity at the 90% confidence level, the value of property-damage accidents (Y=0) was negative while those of injury accidents (Y=1) and death accidents (Y=2) were positive for ages less than 30, and ages between 40 and 50 showed the opposite values.This appears to be because drivers aged between 40 and 50 use vehicles with better performance in terms of safety than those used by drivers aged less than 30 because they have higher socioeconomic status. This was proved by the automobile purchase statistics by age in 2009. Drivers in the 20s and 30s mostly purchased compact and mid-size cars, while drivers in the 40s and 50s mostly purchased mid-size cars, RVs, and full-size cars.1Furthermore, the overall marginal effects for injury or death accidents of drivers aged less than 30 were the highest, indicating that severer traffic accidents may occur to this age group compared to the other age groups.This seems to be due to the difference in driving skills as well as the difference in vehicle performance.

Therefore, to reduce traffic accident severity, it is necessary to prevent accidents by prompting drivers to follow traffic regulations, such as avoiding speeding and drowsy driving, and to prepare appropriate countermeasures for factors affecting traffic accident severity, such as methods to reduce the risk of dry road surface accidents.

IV. CONCLUSION AND FUTURE RESEARCH

In this study, factors affecting traffic accident severity were analyzed using the data of highway traffic accidents. For this purpose, the ordered probit model was used, and factors affecting traffic accident severity were analyzed by age.

The results of the analysis showed that the traffic accident severity of drivers aged between 40 and 50 was affected by the most factors, such as alcohol, road surface condition, and horizontal alignment, while that of drivers aged over 50 was affected by the least factors. The marginal effect analysis revealed that drivers aged less than 30 are the most likely to suffer injury or death accidents. As such, it was found that factors affecting traffic accident severity and the degree of accident severity were different depending on the age group.

In addition, drowsy driving and the number of cars involved were found to affect traffic accident severity for all ages, indicating that safety measures are required to prevent drowsy driving and multiple-vehicle collisions such as two- or three-vehicle collisions.Furthermore, it is necessary to prepare measures to reduce accidents caused by drivers' traffic regulation violation and carelessness such as speeding and negligence of watching.

Future research for this study is as follows. First, a broader analysis is required by adding more explanatory variable, such as the traffic volume, heavy vehicle proportion, and vehicle type, to the identified 19 variables. Second, it is necessary to build a model with more explanatory power by securing more data because only the data of 2009 were utilized in this study.Finally, more models need to be applied, compared, and analyzed because only the ordered probit model was used in this study.

REFERENCES

[1] Ha O. K., Oh J. T., Won J. M., Sung N. M. (2005), The Study on the Accident Injury Severity Using Ordered Probit Model, Korean Society of Transportation, Vol.23, No.4, pp.47~55

[2] Hong J. Y., Kim K. T., Lee S. B. (2011), Analysis of Traffic Crash Severity on Freeway Using Hierarchical Binomial Logistic Model, Journal of the KOSOS, Vol.26, No.2, pp.89~98

[3] Ju M. Y. (2002), Probit and Ordered Probit Analysis and Its Application, Institute of Governmental Studies, Vol.6, No.1, pp.24~48

[4] Kara, M.K. (2001), Driver Injury Severty An Application of Ordered Probit Models, Accident Analysis & Prevention. Vol.28, pp 313~321.

[5] Back, S. H. (2018), A Study on the Traffic Accident Injury Severity- For the Road Widening Construction Sections of Expressways, Keimyung University

[6] Lee S. H., Jeung W. D., Woo Y. H. (2012), Comparative Analysis of Elderly’s and Non-elderly’s Human Traffic Accident Severity, The Journal of The Korea Institute of Intelligent Transport Systems, Vol.11, No.6, pp.133~144

[7] Lee J. Y., Chung J. H., Son B. S. (2008), Analysis of Traffic Accident Severity for Korean Highway Using Structural Equations Model, Korean Society of Transportation, Vol.26, No.2, pp.17~24

[8] Lee S. W. (2005), An Application of Logit and Probit Model, PARKYOUNGSA(Seoul, Korea)

[9] Mun S. R., Lee Y. I. (2011), Analysis of Traffic Crash Severity on Freeway Using Hierarchical Binomial Logistic Model, J. Korea Soc. Road Eng, Vol.13, No.4, pp.119~209

[10] Nataliya V. M, Fred M. (2009), Effect of Increases in Speed Limits on Severities of Injuries in Accidents, Transportation Research Record: Journal of the Transportation Research Board, No. 2083, TRB, National Research Council, Washington, D.C., 2008, pp.122~127

[11] Zhang, J., Lindsay, J., Clarke, L., Robbins, G., and Mao, Y. (2000), Factors affecting the severity of motor vehicle traffic crashes involving dlderly drivers in Onario, Accident Analysis & Prevention. Vol. 32, pp.117~115.

[12] Seoulauto. org corporation, http://www.seoulauto.org (March 9, 2018)

Sunyoung Ahn "Analysis of Traffic Accident Severity by Age Using Ordered Probit Model in Korean Highway.” American Journal of Engineering Research (AJER), vol. 7, no. 3, 2018, pp.310-316.

[1]Automobile purchase statistics by age using more than 50,000 vehicles sold by the traders under the Seoul Automobile Corporation (Seoul Automobile Corporation, 2009)