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The Development of Multivariable Road Fatality Predictive Model for Provinces Region in Indonesia

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Abstract – This study investigated the development of multivariable road fatality predictive model for provinces region in Indonesia. It was carried out based on a consideration that Indonesia has still used Smeed (1949) and Andreassen (1985) models as road fatality predictive models, despite the fact that two variables in these models including population and motor vehicles numbers are not suitable with infrastructure and facilities characteristics of Indonesian road transportation. The sample used in this study was West Java Province as the representative of 34 other provinces in Indonesia with the highest numbers of populations and motor vehicles, the longest road infrastructure in Java Island and the third rank in the number of road fatality in Java as the most densely populated island in Indonesia. This study aimed to explore the use of Smeed/Andreassen variables, to develop these variables into multivariable and to develop Artificial Neural Netwok (ANN) model to forecast fatality based on road transportation infrastructure characteristics in the research site, West Java Province, Indonesia. The findings showed that (1) three-variable ANN model with two hidden layers (ANN3-2HL*S) is the best fatality predictive model in Indonesia province areas; (2) ANN3-2HL*S model is able to reveal 97.5% of data reported by RI National Police Department and hospitals survey fatality result; (3) Andreassen predictive model is unsuitable for Indonesia. This research recommends two following aspects: (1) ANN3-2HL*S predictive model can be used in Indonesia provinces with similar research site areas characteristics, and (2) ANN3-2HL*S can be used for completing RI National Police Department fatality data.

Keywords – Fatality model, Andreassen model, Artificial Neural Netwok, West Java-Indonesia.

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1. Introduction

Smeed (1949) and Andreassen (1985) models have still been used in Indonesia as predictive models for the number of road fatality. These two models are developed in Europe by using two main variables including numbers of population and of motor vehicles. Despite the fact, these two variables call into questions the suitable characteristics of both Indonesia road transportation facilities and infrastructure and areas. Compared to other ASEAN countries, Indonesia has the largest population, the highest number of motor vehicles, the longest road infrastructure, and the vastest land areas; however, fatality data reported by RI National Police Department is low in category. This condition is not in line with Smeed and Andreassen assumptions, stating that variables of population and motor vehicles numbers are two dominant aspects influencing actual fatality predictive numbers.

In Indonesia, fatality data accuracy has not been fully identified. RI Traffic Ordinance number 22 Year 2009 states that fatality data must be supplied with hospital's data; however, road safety researchers state that fatality data reported by RI National Police Department derive from those of accident scenes and has not yet provided with any data from victims died in hospital (hospital's data). Therefore, the data cannot be used as the primary data for road safety study. Consequently, the use of Smeed and Andreassen variables in Indonesian context hence is in need of review. The development of fatality predictive models from two variables into multivariable is required by suiting both characteristics of areas and facilities and infrastructure of Indonesian road transportation. Therefore, the main aim of this study is to find out the newest fatality predictive models so that it can be used widely to forecast actual fatality number in Indonesia.

1.1 Profile of Fatality Data in Indonesia

TABLE 1
NUMBER OF FATALITY IN ASIAN COUNTRIES WHO (2009, 2013)

Countries	Number of Population	Number of vehicles		Number of fatality (year)	
		Four wheels or more	Two wheels	2007	2010
Brunei	398.920	349.279	--	54	46
Cambodia	14.138.256	1.652.534	1.372.525	1.545	1.816
Indonesia	239.870.944	72.692.957	60.152.752	16.548	31.234
Laos	6.200.894	1.008.788	812.629	608	790
Malaysia	28.401.017	20.188.565	9.441.907	6.282	6.872
Myanmar	47.963.010	2.326.639	1.911.040	1.638	2.464
Philipina	93.260.800	6.634.855	3.482.149	1.185	6.941
Singapore	5.086.418	945.829	--	214	193
Thailand	69.122.232	28.484.829	17.322.538	12.492	13.766
Vietnam	87.848.460	33.166.411	31.452.503	12.800	11.029

Results of study and analysis of some transportation researchers in both Indonesian and international institution settings report that Indonesia faces serious problem regarding the number of traffic accidents record. It is estimated that there have been many traffic accident victims are not recorded and reported. ADB (2005) reported that Indonesia fatalities actually occurred four times as many as those data recorded in RI National Police Department, leading to a condition of under-reporting. WHO (2009, 2013) in Global Status on Road Safety has reported Indonesia fatality data compared to 10 countries in Asian as can be seen in Table 1.

In 2011, RI National Police Department reported that the average of fatality number in Indonesia was 50 persons/day or 17843 people died per year. Figure 1 shows the ratio of fatality and traffic accidents occurred in Indonesia in 2007 – 2010.

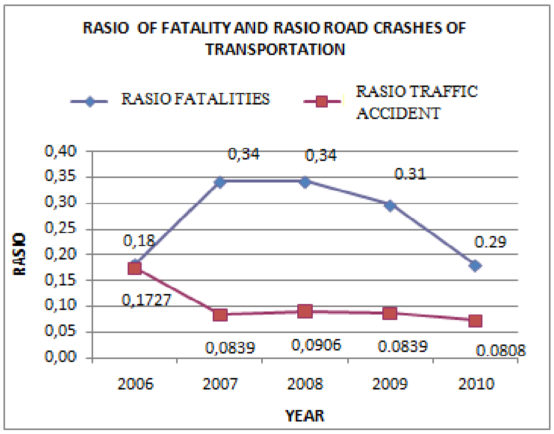

Figure 1. The ratio of fatality and traffic accidents (RI National Police Department, 2011)

1.2 Record of Victim Data of Traffic Accidents in Indonesia

Police of Republic of Indonesia is mandated by RI Traffic Ordinance number 22 Year 2009 section 233 stating that every traffic accident must be recorded in traffic accident form that constitutes a forensic data. Traffic accidents victim data processing has been conducted by RI National Police Department based on SOP by conducting investigation in the accident scenes including the activity of recording road fatality, serious injury, and slight injury victims. These data are managed by RI National Police Department and are required to be completed by the data deriving from the hospitals; nevertheless, road safety researchers declare that fatality data reported by RI National Police Department are those from the accident scenes only and have not been completed by the data of the victims died in the hospital, as also suggested by International Road Traffic and Accident Database (IRTAD, 1998). The collaboration between two institutions can be seen in Figure 2.

In Indonesia, Nations Association Resolution regarding Improving Global Road Safety has been implemented by RI National Police Department since 2011 through a program called Decade of Action for Road Safety 2011-2020. The program includes the implementation of Integrated Road Safety Management System (IRSMS) in two provinces of 34 provinces as field project areas in Indonesia. The purposes of this project are to increase the actual program of road fatality data management to attain more valid or accurate data, to identify the causes of traffic accidents, to recognize black spot (traffic vulnerable areas) and to investigate traffic accidents cases in detail. Apart from that, valid or accurate data fatality can be used by road safety researchers not only for the interest of projustia but also for the sake of strategic policy setting in order to maintain road safety management system in Indonesia.

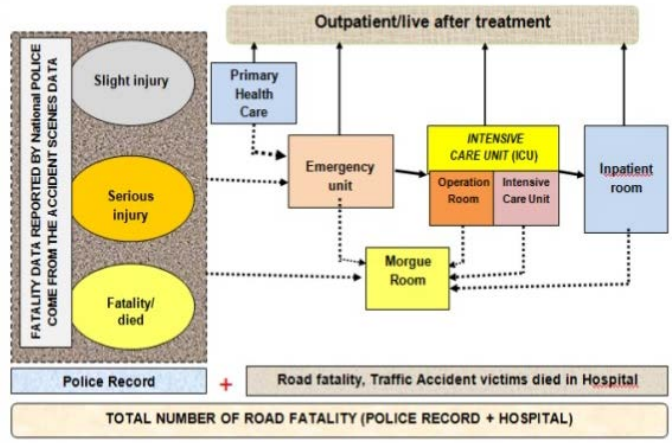

Figure 2. Fatality data recording based on RI traffic ordinance Law Number 22 Year 2009

Note:
- Victimsare referred to get assistance/ treatment
- Recording of number of victims died in hospitals
- Victims go home after getting assistance/ treatment

On the other hand, The Ministry of Health of Republic of Indonesia, especially hospitals has just started using International Classification of Diseases (ICD-10) since 2008 for medical record services management containing the classification of patient illnesses diagnostics. The use of ICD-10 program for fatality victim record is still in the process of development and has been trialled to several government hospitals in limited number. MTI (Indonesia Transportation Society) in 2007 reported that Indonesia institutions recording road fatality could not be able to cooperate well, each works in solitude, resulting in low quality of traffic safety management system and increasing traffic accidents number. Data of road fatality reported by RI National Police Department are not precise because it is low in number and it does not reflect the real situation.

1.3 Role of Fatality Data in the Study of Road Safety

In road safety study, traffic accidents data accuracy is primary data. Fatality data accuracy is required to obtain the results of the study in line with the actual condition in the field. Data of these road fatalities are crucial for many sides, including researchers, police, road planner, educators, statisticians, communication experts, lawyers and

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stakeholders used for many purposes and goals. The results of the accurate primary data are beneficial for the setting of strategic policies; for the setting of law enforcement strategy; for the development of road safety management system in order to reduce the risks of road fatalities; for the maintenance of black spots; for the arrangement of road safety action planning program and for the implementation of evaluation including to fully implemented projects, ongoing programs and programs that will be conducted in years to come.

1.4 Review of Fatality Predictive Models of Road Crashes

Forecasting models used in the study of development of fatality predictive models are Andreassen (1985) and ANN (Artificial Neural Network) methods. Both are reviewed as follows.

A. Andreassen Model

Andreassen model (1985) is a model derived from Smeed predictive model (1949, 1955) intended for universal use. The form of Smeed equation is formulated by using regression log-linier model as follows.

$$(F/V) = \alpha \times (V/P)^{\beta} \qquad (1)$$

Note:
F = Fatality
P = Population
V = Vehicle
α and β = constanta

The Smeed model was later perfected by Jacobs and Cutting (1986) in particular to that low and average income developing countries by investigating the relation between traffic accidents related death and social and economy characteristics of society. It was resulted from Smeed predictive model comparative study conducted to some developed and developing countries. Further, Andreassen also developed Smeed predictive models (1949) with the same purposes, covering obtaining actual fatality predictive numbers in line with social and economy conditions of society. Andreassen (1985) states that Smeed predictive model has several weak points and it includes inflexible application to all countries. Each country has different social economy condition that influences on traffic vehicle condition. Broughton (1988), Oppe (1991), and Jamal, R.M. Ameen, and Jamil A. Naji (2001) argued that Smeed equation models cannot be used in general because the equation parameter of α and β that keeps changing when those are applied to the data in different time and location. Having these shortcomings on Smeed model, Andreassen developed Smeed predictive model by adjusting intercept parameter to gradient parameter. General form of Andreassen predictive model can be seen below.

$$F = C \cdot V^{M_1} \cdot P^{M_2} \qquad (2)$$

Note:
F = fatality predictive number
C = constanta
V = number of motor vehicles
P = number of population
M_1 = coefficient degree of number of motor vehicles
M_2 = coefficient degree of number of population

Andreassen predictive model constitutes two independent variables, consisting of number of motor vehicles (V) and number of population (P) and one dependent variable, namely fatality predictive number (F). In order to obtain Andreassen predictive model, the calculation on constanta C as well as coefficient M1 and M2 is required and can be seen in the following.

$$\ln F = \ln C + M_1 \ln V + M_2 \ln P \qquad (3)$$

On the equation 2, for example:

$$\ln F = Y,\ \ln C = \alpha,\ \ln V = x_1,\ \ln P = x_2,\ M_1 = \beta,\ M_2 = \gamma,$$

therefore,

$$Y = \alpha + \beta x_1 + \gamma x_2 \qquad (4)$$

In order to obtain the value of α, β, and γ, analysis of double linier regression with dependent variable of Y and independent variable of x1 and x2 is used. After the values of α, β, and γ are obtained, these values are then applied to the equation (1) using $C = e^{\alpha},\ M_1 = \beta,\ M_2 = \gamma$ so that the general form of Andreassen predictive model (1985) can be obtained as follows:

$$F = e^{\alpha} V^{\beta} P^{\gamma} \qquad (5)$$

B. Artificial Neural Network Model*:*

Artificial Neural Network (ANN) can be used to model complex relation between input and output so that patterns can be recognized. ANN constitutes a network of small units group, modeled based on human nerves network as adaptive system by changing its structure for solving the problem based on either external and internal problems flowing through one network. ANN model has been implemented in many fields of science for forecasting work (William and L. Yan, 2008) recommends that ANN has strong points in terms of segmentation and classification problems, especially those with big and varying numbers of data. In this present study, ANN model used is *Multi Layer Perceptron (MLP)* to map out a set of input data into a set of output data by using non-linear activation function. In MLP, both independent and dependent variables contain metric and non-metric measurement degrees. Generally, ANN consists of three layers, namely *input layer*, *hidden layer* and *output layer* (see Figure 3). Input layer comprises several neurons that can accept input data of one problem. Hidden layer consists of neurons that are able to accept inputs from input layer and later brings them to the the output layer containing neurons receiving outputs from hidden layer and send them to users.

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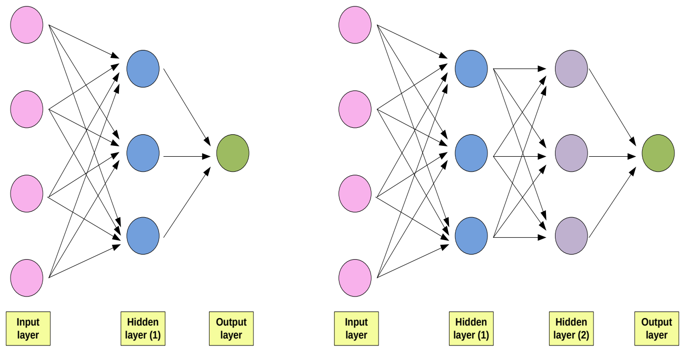

Figure 3. Multi layer ANN model with one or two hidden layer

Activation function of hidden layer is as follows:

- Hyperbolic tangent : $Y(c) = \tanh(c) = \dfrac{e^{c} - e^{-c}}{e^{c} + e^{-c}}$ (6)
- Sigmoid : $Y(c) = \dfrac{1}{1+e^{-c}}$ (7)

Activation function of output layer can be seen below:

- Identity : $Y(c) = c$ (8)
- Softmax : $Y(c_k) = \dfrac{e^{c_k}}{\sum_j e^{c_j}}$ (9)
- Hyperbolic tangent : $Y(c) = \tanh(c) = \dfrac{e^{c} - e^{-c}}{e^{c} + e^{-c}}$ (10)
- Sigmoid : $Y(c) = \dfrac{1}{1+e^{-c}}$ (11)

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1.5 Model Validity Test

Model validity test on forecasting study is conducted by finding out the best predictive model which is realized by looking at the element containing the smallest difference on actual fatality data. Validity test is conducted using three types of error model tests, namely *Mean Absolute Percent Errors* (MAPE), *Mean Absolute Errors* (MAE), and *Root Mean Square Errors* (RMSE).

$$MAPE = \frac{1}{n}\sum\left(\left|\frac{o_j - t_j}{o_j}\right| \times 100\right) \quad (12)$$

$$MAE = \frac{1}{n}\sum\left|t_j - o_j\right| \quad (13)$$

$$RMSE = \sqrt{\frac{1}{n}\sum\left|t_j - o_j\right|^2} \quad (14)$$

2. METHODOLOGY

2.1 Sample and Population of the Research Site

Sample of the research site was West Java Province as the representative of 34 provinces in Indonesia. This province has the largest population, the longest road infrastructure and the highest number of motor vehicles in Indonesia. West Java Province is in the third rank in terms of fatality road crashes number in Java Island which is also the most densely populated island in Indonesia. Figure 4 shows the location of the research site that consists of 18 areas of regencies and 8 big cities. Table 2 illustrates the comparison between potential sample of the research site and other provinces in Java Island.

TABLE 2
THE COMPARISON BETWEEN THE RESEARCH SAMPLE SITE AND OTHER PROVINCES IN WEST JAVA (National Statistics Bureau, Province Communication and Revenue Directorate, 2010)

No	Types of Data	Potential Research Site		
		West Java Province	Central Java Province	East Java Province
1.	Number of Population	42.194.869	30.775.846	37.694.836
2.	Number of Motor Vehicles	7.291.817	5.582.696	6.557.246
3.	Length of the road (km)	37.731,760	26.300,420	27.392,110
4.	Number of Road Crashes	6.215	11.370	5.277
	Slight Injury victims	6.850	15.325	5.569
	Serious Injury victims	1.908	2.071	1428
	Road fatalities	1.596	1.812	1.790
5.	Landmass (km²	34.816,96	32.540,20	47.922

In order that the results of predictive models can be used in all provinces in Indonesia, some characteristics of the research sites were set as follows.

1) Research site (province) has two statuses of administrative areas, namely regencies and cities.
2) Each research site has class A hospitals in the level of province. Areas of regencies/ cities or the integration of several nearest regencies/ cities should at least have reference class B hospital for medical services to serious injury road crashes victims.
3) Each area of regency/ city or the integration of several nearest regencies/ cities should have center for administrative services regarding legality of vehicles documents (resort police/ city resort police) such as for the issues of driver license, of motor vehicles number document and of motor vehicles tax services.
4) Each area of regency/ city or the integration of several nearest regencies/ cities should have center for recording services of road crashes victims (resort police/ city resort police).

Table 3 shows the standard ability of hospital medical services in Indonesia and Table 4 shows the sample of a number of hospitals used in this study.

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Figure 4. Map of Research Sample Site

TABLE 3
THE STANDARD OF HOSPITAL MEDICAL SERVICE FACILITIES IN INDONESIA

No	Types of medical services facilities	General hospitals classification based on the ability of medical services facilities			
		A	B	C	D
1.	Emergency care unit	√	√	√	√
2.	General services	√	√	√	√
3.	Basic specialist services	min 4	min 4	min 4	min 2
4.	Medical supporting specialist	5	4	4	---
5.	Sub-specialist	12	8	---	---
6.	Other specialist	13	2	---	---

TABLE 4
HOSPITALS SAMPLE, NUMBER AND SPECIFICATIONS

Research Site	Hospitals Sample, Number and Specifications	
	Hospital Standard	Number of Sample
City of Bandung	Class A	1
	Class B	5
City of Depok	Class B	1
City of Banjar	Class B	1
City of Cimahi	Class B	1
City and Regency of Bekasi	Class B	2
City and Regency of Bogor	Class B	2
City and Regency of Sukabumi	Class B	1
City and Regency of Tasikmalaya	Class B	1
City and Regency of Cirebon	Class B	1
Regency of Western Bandung	Class B	1
Regency of Cianjur	Class B	1
Regency of Garut	Class B	1
Regency of Ciamis	Class B	1
Regency of Kuningan	Class B	1
Regency of Karawang	Class B	1
Total Number		22 hospitals

2.2 Research Variables

Dependent variable used in this study was the result of variable correlation test analysis and of the test among 8variables investigated in this study. Those variables were the ones that had significant relation and strong influence on road crashes fatality victims in Indonesia. Table 5 describes the chosen research variables as well as input data used in the model development in this study.

TABLE 5
RESEARCH VARIABLES AND INPUT DATA IN THE STUDY OF MODEL DEVELOPMENT

Research Variables	Total Input Data in the research site (per-year)				Input variable	
	2007	2008	2009	2010	Andreassen	ANN
Population (Million)	40,65	41,39	42,01	43,8	√	√
Vehicles (Million/Unit)	6,12	6,89	7,73	9,07	√	√
Accessibility	0,64	0,67	0,67	0,69	×	√
Actual Fatality*	3158	3399	3429	3927	√	√

*) Fatality Data from State Police and Survey Results in Hospital

2.3 Method of Fatality Data Survey in Hospital

Fatality data victims died in hospital were conducted based on the method of document analysis study of each patient medical record. This is done by referring to Law number 14 Year 1993 regarding road traffic and transportation, as well as International Road Traffic and Accident Database (IRTAD, 1998). Figure 5 illustrates the process of fatality data survey in hospital.

2.4 Procedure of Fatality Predictive Model Development

Fatality predictive model development was built based on the input data of each type of data from all research variables. Model development was done by using general equation of Andreassen (1985) and ANN model development from Multi Layer Perception (MLP) form. Figure 6 is the process of predictive model development.

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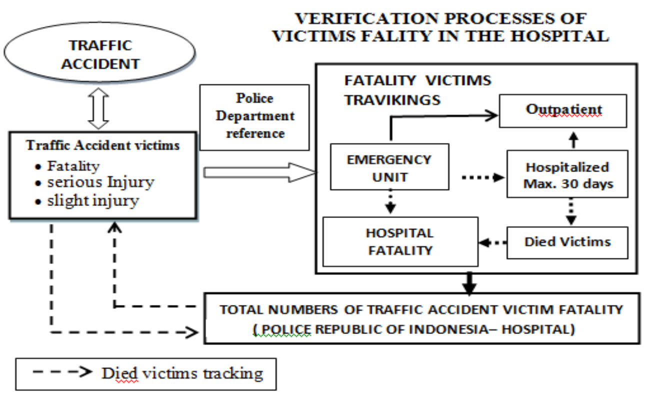

Figure 5. Process of Fatality Data Survey in Hospital

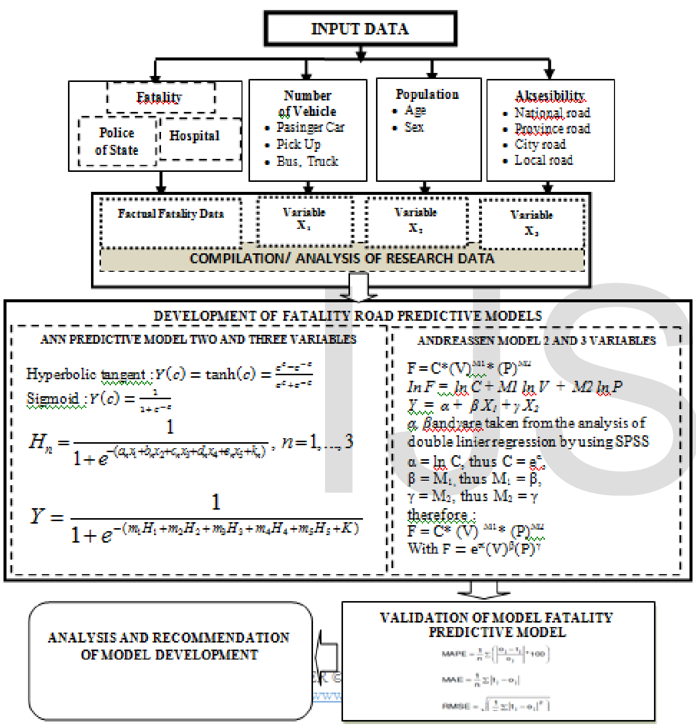

Figure 6. Fatality Predictive Model Development Process

3. RESULTS AND DISCUSSION

3.1 Result of Correlation Test among Variables

There were 8 variables analyzed in order to find out the significance of correlation among variables used as the input data in this study. Those variables included number of population; length of road; number of motor vehicles; number of driver license owner; landmass; accessibility; mobility aspect and drivers driving attitude. All were correlated towards number of fatality and the relation among variables. The scatter plot and Pearson Coefficient showed that there were some variables having strong correlation towards fatality number and relation among variables including; (1) number of vehicles; (2) number of population; and (3) accessibility. Meanwhile, the correlation of other variables encompassing driver license owners towards drivers driving attitude, drivers' attitude towards number of vehicles, drivers' attitude towards fatality number and mobility variable towards fatality number have weak correlation.

3.2 Result of Calculation and Analysis of Fatality Predictive Model Development

Fatality predictive models developed in this study were Andreassen (1985) and Artificial Neural Netwok (ANN) models with variables of input data in line with characteristics of both areas and facilities and road transportation infrastructure in Indonesia. In Andreassen model, there were two activities conducted, covering; (1) the application of Andreassen model with two variables P and V and (2) the developmet of Andreassen model into multivariable (3 variables). The development of ANN Multivariable model (3 variables) was carried out by using one and two hidden layers. The result of calculation/ analysis of Andreassen model development and implementation is presented in Table 6.

TABLE 6
DESCRIPTION OF ANDREASSEN MODEL DEVELOPMENT AND IMPLEMENTATION

Input Variables	Result of Study of Andreassen Model Development and Implementation	Calculation Result	Discussion
Population (P) Vehicles (V)	$F = e^{-1,228} V^{0,516} P^{-0,013}$ $F = e^{-1,228} V^{0,516}$	ln (V) = 0,000 < 0,05. ln(P) = 0,915 > 0,05	Andreassen Equation with two variables canot be used
Population (P) Vehicles (V) Accessibility (A)	$F = e^{-1,408} V^{0,443} P^{0,064} A^{-0,052}$ $F = e^{-1,408} V^{0,443}$	ln(V) = 0,04 <0,05, ln(P) = 0,716 >0,05, ln(A) = 0,536>0,05	Andreassen Equation with three variables cannot be used
Summary : Variables P and A did not significantly influence fatality predictive number			

3.3 The Result of Calculation of Multivariable ANN Model Development

A. ANN3-1HL Predictive Model

$$F = 37 + 743 * F'$$
$$F' = 1.395 - 2.067 * H(1{:}1) + 1.001 * H(1{:}2)$$

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$$H(1{:}1) = \frac{1}{1 + e^{-(2.575 - 0.437*V' - 0.125*P' - 1.533*A')}}$$

$$H(1{:}2) = \frac{1}{1 + e^{-(0.442 + 0.216*V' + 0.409*P' + 0.356*A')}}$$

$$V' = \frac{V-95864}{1155402}\ ;\quad P' = \frac{P-536743}{5175532}\ ;\quad A' = \frac{A-0.1249}{8.2148}$$

B. ANN3-2HL Predictive Model

$$F = 37 + 743 * F'$$
$$F' = 1.395 - 2.067 * H(1{:}1) + 1.001 * H(1{:}2)$$

$$H(1{:}1) = \frac{1}{1 + e^{-(2.575 - 0.437*V' - 0.125*P' - 1.533*A')}}$$

$$H(1{:}2) = \frac{1}{1 + e^{-(0.442 + 0.216*V' + 0.409*P' + 0.356*A')}}$$

$$V' = \frac{V-95864}{1155402}\ ;\quad P' = \frac{P-536743}{5175532}\ ;\quad A' = \frac{A-0.1249}{8.2148}$$

Note:
F = Fatality prediction
P = Population
V = Total Vehicles
A = Accessibility
F′ = Number fatality data that has been normalized

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3.4 Result of Validation Test of Model Development and Actual Fatality Number Prediction

Table 7 presents the results of model validation test using error test MAE, MAPE and RMSE towards each model developed in this study. The table also shows actual fatality number prediction of the result of the study taken based on input data of all variables in the research site of West Java Province in 2010.

4. ANALYSIS

Table 7 reveals the result of validation test that ANN3-2HL model has the lowest value of error test MAPE, namely 27.39, compared to ANN3-1HL model, which is 29.75. Makridakias S. Et al. (1995) suggested that the value of MAPE test of 27.39 is categorized good enough to forecast actual fatality number prediction in the research site of West Java Province, Indonesia. Table 7 also illustrates that accumulation of actual fatality number prediction occurred in each research site of regency-big cities in 2010 was 3872. Compared to fatality data reported by RI National Police Department, results of study fatality number prediction is bigger, that is, 90.9 % towards fatality data of RI National Police Department as well as the result of road fatality victims died in hospital, therefore, results of study of actual fatality number prediction can reveal 97.5% of 3927 factual fatality data.

TABLE 7
SUMMARY OF FATALITY PREDICTIVE MODEL DEVELOPMENT OF WEST JAVA PROVINCE

	Actual Fatality*	Prediction of Actual Fatality Number as the result of the study	
		ANN3-1HL	ANN3-2HL
City of Bandung	780	652	646
City of Depok	130	247	205
City of Cimahi	197	236	172
City of Bekasi	306	334	441
City of Bogor	337	288	327
City/ Regency of Sukabumi	172	167	165
City/ Regency of Tasikmalaya	146	165	160
City/ Regency of Cirebon	141	165	167
Regency of Bandung and Western Bandung	332	259	279
Regency of Indramayu	276	145	145
Regency of Cianjur	180	138	143
Regency of Ciamis	151	141	144
Regency of Majalengka	52	133	133
Regency of Subang and Purwakarta	192	167	163
Regency of Sumedang	129	128	130
Regency of Garut	168	144	149
Regency of Kuningan	119	120	126
Regency of Karawang	119	198	177
Prediction of Fatality of Study Results	3927*	3823	3872
Fatality Data of RI National Police Department	2028		
Error MAPE Test		29,75	27,39
Error MAE Test		46,89	47,17
Error RMSE Test		64,31	64,09

*) Fatality Data report of RI National Police Department + Results of Study Data in hospitals

5. CONCLUSION

The study concerns Andreassen model development and its implementation from two variables into multivariable as well as ANN model development by taking into considerations characteristics of both areas and road facilities and infrastructure in Indonesia. Based on the study, some conclusions can be drawn as follows.

1. Equation of Andreassen predictive model cannot be used for forecasting actual fatality number prediction in the provinces areas in Indonesia, especially in the research site of West Java Province.
2. Artificial Neural NetworkModel with three variables and two hidden layers (ANN3-2HL), later known as *ANN3-2HL*S Province Area model*is the best fatality predictive model to forecast actual fatality prediction number for

province areas in Indonesia, particularly for that of West Java Province. Predictive model of *ANN3-2HL*S Province Area model* is able to reveal actual fatality data that is 97.5% of the fatality data reported by RI National Police Department and the result of study of fatality data from hospitals.

ACKNOWLEDGMENT

1. Predictive model of *ANN3-2HL'S Province Area Model* can be used as one of the references for road safety researchers, especially those in Indonesia by, among others, completing fatality data reported by RI National Police Department.
2. Predictive model of *ANN3-2HL'S Province Area Model* as the result of the study can be used widely in Indonesia, especially in the provinces bearing similar characteristics of both areas and road transportation facilities and infrastructure with those in the research site.
3. Predictive model of *ANN3-2HL'S Province Area Model* as the result of the study is still in need of trialing, particularly to those other provinces in Indonesia

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