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A Review of the 1985 Andreassen Model to Predict the Fatality Rate of Traffic Accident Victims in Indonesia

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Abstract : In Indonesia, the 1985 Andreassen equation has been used in road safety studies to predict the number of actual fatality in traffic accidents, by examining the correlation between the number of vehicle and the number of population variables. The relationship between the formula/equation of the two variables needs to be analyzed in the light of the characteristic of Indonesia which is a vast area with huge amount of vehicles and great number of population. With the sample area of West Java Province, and using the test criteria of Mean Absolute Percent Errors, Mean Absolute Errors, and Root Mean Square Errors, the study finds that (1) the Andreassen equation formula is not suitable for predicting the number of actual fatality in Indonesia because the variable of population (P) does not have significant effect on the number of fatality; and (2) by formulating the data input from every area of the study, an updated equation is developed; *i.e.* $F = e^{-1,335} V^{0,509}$. This single-variable equation can predict the number of actual fatality of 176.8% greater than the data reported by the Indonesian National Police. It is recommended that the researchers of road safety in Indonesia implement the primary data of fatality as stated in Indonesian Law No 22/2009 on Traffic and Road Transportation, as well as the recommendation of International Road Traffic and Accident Database of 1998 and 2004. In Indonesia, a model needs to be developed to predict the updated fatality, based on the regional characteristics and road traffic infrastructures.

Keywords : Andreassen's prediction model analysis, variable of prediction model, Indonesia.

1. INTRODUCTION

In Indonesia, to predict the number of fatality (death victims) of traffic accident, the Andreassen's prediction model (1985) has been used for a long time. The results of studies using Andreassen's prediction model have been implemented in various road safety researches, including in the development of strategic policies and traffic safety programs. On national level, the results of such studies are used in the formulation of policies concerning the obligation to wear seatbelts for drivers, the obligation to wear helmet for motorcycle riders, and the age limit for drivers and riders of vehicles, as well as other rules and regulations concerning traffic safety in Indonesia. Agus S (2013) states that the results of studies on fatality using Andreassen's prediction model (1985) are not feasible for use in Indonesia since they are not compatible with Indonesia's regional characteristics and road transportation infrastructures. The accuracy of primary data used in road safety studies and the resulting findings do not meet researchers' expectations to develop better system of road safety for the future. Therefore, Agus S (2014) argues that the results of studies on primary data using Andreassen's two-variables prediction model (1985) are questionable, and do not provide expected result to develop better road safety management system and for *projustia* purposes in Indonesia.

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2. OVERVIEW OF TRAFFIC ACCIDENT FATALITY IN INDONESIA

In Indonesia, the fatality data reported by the National Police of Indonesia is an assumption based on occurrences in the sites of the traffic accident (DPRI, 2004). The number of actual fatality is unknown because the police report does not include the fatality data from hospitals as regulated by Indonesian Traffic Law No 22/2009 on Road Traffic and Transportation (Agus S, 2014). World Health Organization (WHO, 2013) in *Modified from the Global Safety Status Report* notes that the estimated number of fatality in Indonesia is twice the number reported by Indonesian National Police in 2007. Asian Development Bank (ADB, 2005) also reports that the number of actual fatality in Indonesia is almost four times the number recorded in Indonesian National Police data. Similar condition is also reported by WHO (2009), which states that Indonesia ranks the third among the ASEAN countries in terms of traffic accident fatality.

Currently, the researchers of road safety in Indonesia implement the equation model developed by Smeed (1949) and Andrassen (1985) to predict the number of actual fatality; *i.e*. using the formula of correlation between the number of vehicles (V) and the number of population (P). In Indonesia, there is no fatality prediction model that suits the regional characteristics and transportation infrastructure of Indonesia; which is a vast area with the greatest number of population and vehicles and the longest road infrastructure in ASEAN.

2.1. The Role of Fatality Data in Road Safety Study

Data on traffic accident is one of the important aspects recommended by ADB (1999) to improve traffic safety management system. The accuracy of traffic accident and factual traffic fatality data is necessary in road safety study since the findings of the study will be used in the formulation of strategic policies and road safety programs. ADB (2004) recommends that the role of fatality data is one of the 14 aspects to be used for intervention to reduce the number of fatality and the risk of road accident. The 14 aspects recommended by ADB are:

- Road safety coordination and management
- Road (traffic) accident data system
- Road accident funding and role of insurance industry
- Road safety planning and design
- Improvement of dangerous sites
- Road safety education for children
- Drivers' and riders' training and testing
- Road safety campaign and socialization
- Driving/riding safety standard
- Traffic rules and regulations
- Traffic police and law enforcement
- First-aid for victims of road (traffic) accident
- Road safety study
- Road accident cost

The above has been taken from (ADB, 2004). Traffic accident data is preliminary information needed to describe the actual condition in the field; in terms of the road, the vehicles, the environment, or the drivers/riders. In road safety study, the data plays significant role as the primary data for various purposes; it is needed by researchers, police, road planners, educators, statistic experts, communication experts, lawyers, and other related organization/institution. Therefore, an accurate data is required, as close as possible to the actual condition in the field, to allow the result of the study to be useful as expected by the researchers. Should the data input be inaccurate, both quantitatively and qualitatively, the result of the study will not be feasible for use and will not be able to improve safety management system to reduce the risk of traffic fatality. Thus, the availability of highly accurate fatality data will meet the great expectation to improve and develop a good road safety management system, to determine excellent road safety program, and to predict future traffic fatality in Indonesia.

2.2. Fatality Data Recording System in Indonesia

The resulting effects of road (traffic) accident are slight injury, serious injury, and fatality. Based on the definition from International Road Traffic and Accident Database (IRTAD, 1998, 2004), fatality is an occurance of a person injured dies within 30 days of the crash (and as a result of the crash). The number of fatality includes those who died at the site of road accident, who died on the way to hospital/healthcare facilities, and who died during treatment in hospital/healthcare facilities.

In developed countries that prioritize road safety, the data on traffic accidents and victims is considered an important database priority. With unquestionable accuracy of traffic accident data, the study on certain sites or certain parts of a road represents the description of factual data. Therefore, the result of such study can and will be used as the basis to develop and implement intervention efforts concerning various aspects of road (traffic) safety.

In Indonesia, the Traffic Law No 22/2009 stipulates that road (traffic) accident data is managed by the National Police as part of its forensic data. The data should be completed with reports from hospitals and should be used by road and traffic regulation bodies. The National Police of Indonesia is given authority and responsibility to record and report the data of road/traffic accident victims (both injuries and fatality), and to manage road accident information system for public. The same authority is also given to the Indonesian Ministry of Health, delegated to hospitals, to record the data of fatality after 30 days of treatment (at most) following a traffic accident. The data of traffic accident includes data on: (1) accident number, (2) fatality, (3) serious injury, and (4) slight injury.

With such authority and responsibility, the National Police of Indonesia may conduct investigation of every traffic accident at the site of the accident based on the existing Standard Operational Procedure (SOP) of Investigation; *i.e*. (1) Secure the Scene quickly and accurately, and check the identity of the driver and personnel of the vehicle, (2) create a sketch of the traffic accident site (the scene), (3) Handling and providing first aid for the victims of traffic accident properly, and quickly transporting them to the nearest hospital for further medical treatment, (4) Developing an investigation report that contains the data on accident number, *visum etrepertum* requests, and coordination with Insurance companies to facilitate faster claim for the victims (KNRI, 2010).

Indonesia Ministry of Health, in this case is the hospital, plays important role in providing first aid treatment for traffic accident victims to reduce the number and risk of fatality by performing emergency procedures on the victims of traffic accident, and by providing hospital stay and health control facilities with quick response and gradual handling, in accordance with the hospital classification based on its facility and medical service capability (Indonesia Law on Hospital No 44/2009).

In the effort to realize road safety in Indonesia, hospitals play important role to act out the Law on Traffic No 22/2009, by recording the data of fatality (i.e. the number of injured person who died in hospital after a medical treatment for 30 days (at most) after the accident). In Indonesia, not all hospital have performed this function effectively. To identify the victim of traffic accident, some hospitals have installed International Classification of Diseases (ICD) system in their Emergency Response Unit. However, in Indonesia, there is no surveilance injury database available that meets the recommendation of Indonesia's Traffic Law No 22/2009.

2.3. Andreassen's Prediction Model

Andreassen's prediction model (1985) is a development or improvement of Smeed's prediction model (1949, 1955) to make the model more universally applicable based on the socio-economic condition of the local society. Andreassen's model uses the same variables as Smeed's model (1949, 1955); *i.e*. the number of vehicles and the number of population. Both variables are still considered the most influential variable on the number of predicted fatality. Smeed's equation is reformulated using log-linear regression model as follow:

$$(F/V) = \alpha\, x\, (V/P)^{\beta} \tag{1}$$

F = Fatality,

P = Population

V = Vehicle,

α and β = constants

Andreassen (1985) argues that Smeed's prediction model has a weakness. It cannot be used in all countries in the world based on one year worth of data. Every country has unique socio-economic condition, which significantly affect the condition of traffic vehicle. Furthermore, Broughton (1988) and Oppe (1991) note that Smeed's equation is not universal because the parameters of α and β in the equation always change, depending on the location and time. A comparison study of Smeed's prediction model is performed by Jacobs and Cutting (1986) in several developed and developing countries to determine the correlation between death due to traffic accident (fatality) and the socio-economic characteristics of the nation. The result of the study shows that Smeed's equation model cannot be implemented in all country because it depends on various road safety aspects of each nation, including the road condition and the behavior of road users. Considering this weakness, Andreassen improved Smeed's prediction model by adjusting the intercept parameter and the gradient parameter. The general equation of Andreassen's prediction model is:

$$F = C \cdot V^{M1} \cdot P^{M2} \tag{2}$$

F = Prediction of fatality

C = Constant

V = Number of vehicle

P = Number of population

M_1 = Square coefficient of the number of vehicle

M_2 = Square coefficient of the number of population

The equation shows that both Smeed and Andreassen use independent variables of the number of vehicles (V) and the number of population (P) as the main variables. To predict the number of actual fatality, Andreassen requires a constant C and coefficients of M_1 and M_2, calculated as follows:

$$\ln F = \ln C + M_1 \ln V + M_2 P \tag{3}$$

On equation 2.2, assume that:

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

$$Y = \alpha + \beta x_1 + \gamma x_2 \tag{4}$$

The values of α, β, and γ are calculated using multiple-linear regression analysis with the dependent variable of Y and the independent variables of x_1 and x_2. When α, β and γ are known, the values are implemented in the equation (2.1) with $C = e^{\alpha}$, $M_1 = \beta$, $M_2 = \gamma$, resulting in the number of predicted fatality (F) of:

$$F = e^{\alpha} V^{\beta} P^{\gamma} \tag{5}$$

2.4. Study of Fatality Number in Indonesia

In Indonesia, the study on data accuracy of fatality number is rare. However, various road safety studies have been performed using the fatality data from the National Police of Indonesia's report as its primary data. The fatality data has not met the requirement of Indonesia' Traffic Law No 22/2009 because it is not completed with fatality data from hospitals. The data from National Police of Indonesia also fails to satisfy the recommendation of International Road Traffic and Accident Database (IRTAD, 1998, 2004), issued by the UN, that fatality is an occurence of a person injured died in 30 days, at most, after traffic accident (and as a result of the accident).

In Indonesia, road safety researchers are merely users of data reported by the National Police of Indonesia. The researchers have not considered the need for accurate fatality data as the primary data in road safety study. However, by using inadequate and unfit fatality primary data, various studies have been performed for various purposes. Among many purposes of road safety study are:

- To improve road traffic safety management system and its needs of facilities and equipments
- To design various road traffic safety programs (action plans).
- To justify the planning and improvement of roads' geometrical aspect.
- To plan and design road traffic safety education and training programs.
- To justify the demand of law enforcement.
- To plan and provide road safety insurance.
- To investigate black spots of road accident.

Although there are findings of road safety study, none of them optimally meets the expectations of researchers; the findings are unable to decrease the amount of traffic accident and the risk of fatality, as well as unable to improve drivers' discipline in traffic in Indonesia. The studies to predict the accurate actual fatality have been performed only by few researchers, including:

- A study that gradually compared the fatality data from Police of Bandung City with the fatality data from five hospital in the same city. The finding showed that the conversion score of fatality is ± 25% more than the data reported by the National Police of Indonesia (Susilo et al., 1996).
- A study that used Capture-Recapture method with web-based computer program to obtain an estimation of prevalence fatality data from the Police and hospitals in Yogyakarta city, Indonesia, in 2006. The finding showed that the estimation of prevalence of traffic accident was 369 per 100.000 people; 229% greater than the data from hospitals and 724% greater than the data from the Police (Utama S.U., 2007).
- A uniformity study of fatality data in 2002-2007 using gradual conversion method in several research sites: (1) fatality data from Bandung City Police to fatality data from each work area of Police Resort in Bandung City; (2) conversion of fatality data in Bandung City to fatality data of the Police in West Java Province; (3) conversion of fatality data from the Police of West Java Province to fatality data from the National Police of Indonesia. The findings showed that the conversion of average fatality data in each area in Bandung city is 1.12; the conversion to fatality data in the province is 0.98; and the converstion to fatality data in National level is 1.07 (Susilo, 2009).
- An estimation study of traffic accidents in six provinces in Java Island, Indonesia. The aim of the study was to predict the rate of traffic accident using Smeet's equation (1949) and to identify the factors affecting traffic accident based on the pyramid theory using the data inpot from the Central Bureau of Statistics. The study found that (1) the higher the number of vehicle increase, the lower the number of traffic accident and (2) the difference of fatality estimation is quite big in some provinces of Indonesia (Najib, 2013).
- A comparison study of Andreassen's model (1985) to the Artificial Neural Network (ANN) model to predict fatality based on low, medium, and high population density in West Java Province. Using population data in 2007-2010 on the variables of number of population,

number of vehicle, length of the road, and number of Driving License holders, it was found that the 2-variables ANN prediction model (ANN2) and the 4-variables ANN prediction model (ANN4) were better than the 1985 Andreassen's model with validation criteria of MAPE, MAE, and RMSE (Agus S, 2012).

These studies indicate that there is no study that analyzes the suitability of Andreassen's prediction model to forecast the number of actual fatality in Indonesia. It implies that road safety researchers in Indonesia are merely users of fatality data from the National Police of Indonesia.

Other study that relates with Andreassen's prediction model is the Variable Analysis Study to Predict Traffic Accident Fatality Based on Regional Characteristics and Transportation Infrastructure in Indonesia. The aim of this study was to discover several selected variables from the 8 variables being studied: (1) number of population, (2) length of the road, (3) number of vehicles, (5) number of Driving License holders, (6) width of the area, (7) accessibility, and (8) mobility. The finding showed that the variables selected as the most influential and significant on the prediction of actual fatality in Indonesia were: (1) population, (2) vehicles, and (3) accessibility (Agus S., 2015).

3. METHODOLOGY

3.1. Sample of research site

In the present study, West Java Province is selected as the representation of the other 34 provinces of Indonesia because West Java has the most number of population and vehicles. According to KNRI (2010) the number of traffic accidents in West Java is quite high. Agus S (2014) notes that the ratio of fatality in traffic accident in West Java is 26.1%, ranking the third in Java (the most populated island in Indonesia). Compared with developed countries, Indonesia's ratio of fatality is high. Therefore, West Java province is selected as the sample to be studied, representing other provinces in Indonesia. The findings of this study can be used as a reference to develop updated fatality prediction model for Indonesia.

3.2. Population and data input

The data input in the present study comes from the population data of 2007-2010 for each variable in all regencies and big cities in West Java Province (18 regencies/cities and 8 big cities) as shown in Table 1.

Table 1
Data source institution for each variable of the study

No.	*Variables of Data Population*	*Population*	
		Year (Population Data)	*Each Regency/ Big City*
1.	Total number of population (*)	2007, 2008, 2009, 2010	√
2.	Total number of all vehicle (+)	2007, 2008, 2009, 2010	√
3.	Total number of fatality (National Police) (**)	2007, 2008, 2009, 2010	√
3.	Total number of fatality (survey in provincial and regional hospitals) ++	2007, 2008, 2009, 2010	√

(*) BPSPJABAR, 2008-2011

(+) KPRI-DJPD, 2008-2011

(**) KNRI, 2008-2011

(++) Source: Personal Data (2008-2011) Survey in Provincial hospitals and regional hospitals

3.3. Sources of Data

Data on the number of fatality is obtained from two sources of data; *i.e*. the National Police of Indonesia and Public Hospitals. The population of fatality data from the Police is obtained based on the operational jurisdiction of Resort Police/City Police that is authorized to process the data on traffic accident fatality. The population of fatality data from hospitals is gathered based on the operational work area of Class A and Class B hospitals as regulated in Law No 44/2009 on hospitals. Based on the operatonal work area of the Police and the hospitals, the 26 regencies and big cities in West Java Province are grouped into 18 areas of fatality data source (Table 2).

Table 2
Source of data and Institutions in each area

No.	*Fatality Data Survey Area*	*Number of Fatality Data Source*	
		Police	*Class A and B Hospitals*
1.	Bandung City	1	6
2.	Depok City	1	-
3.	Cimahi City	1	1
4.	Bekasi City/Regency	1	2
5.	Bogor City/Regency	1	2
6.	Sukabumi City/Regency	1	1
7.	Tasikmalaya City/Regency	1	1
8.	Cirebon City/Regency	1	1
9.	Bandung/Bandung Barat Regency	1	1
10.	Indramayu Regency	1	-
11.	Cianjur Regency	1	1
12.	Ciamis Regency	1	1
13.	Majalengka Regency	1	-
14.	Subang and Purwakarta Regency	1	-
15.	Sumedang Regency	1	1
16.	Garut Regency	1	1
17.	Kuningan Regency	1	-
18.	Karawang Regency	1	1
Total		18	20

3.4. Data collection technique from Hospitals

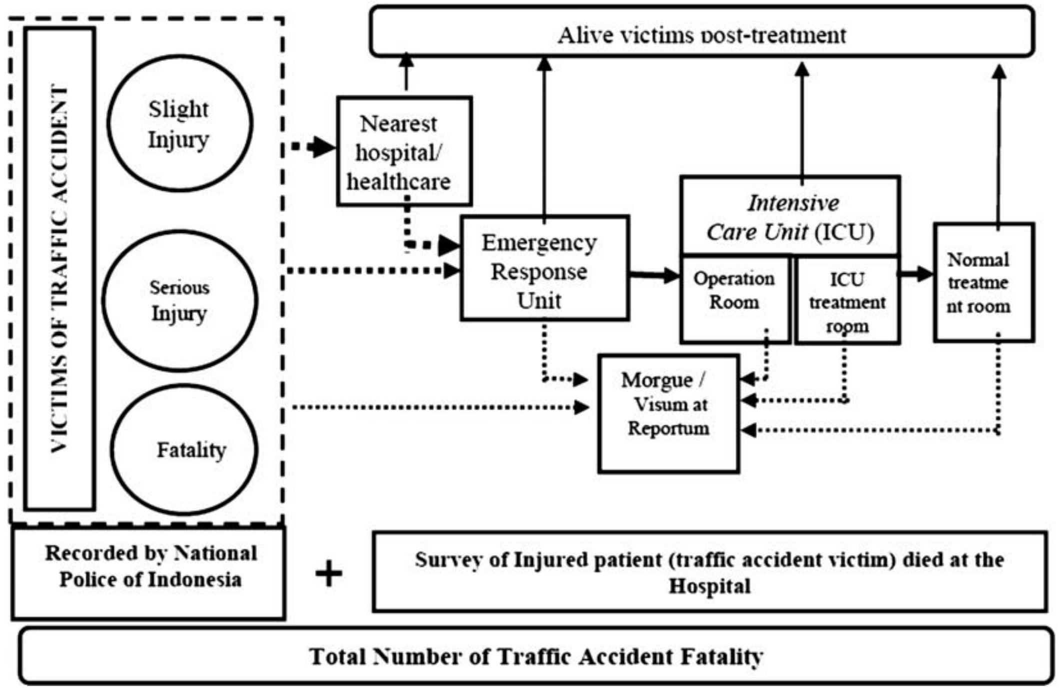

Figure 1: The process of survey and verification of fatality data in hospital (Agus S. 2013)

3.5. Data Analysis Technique

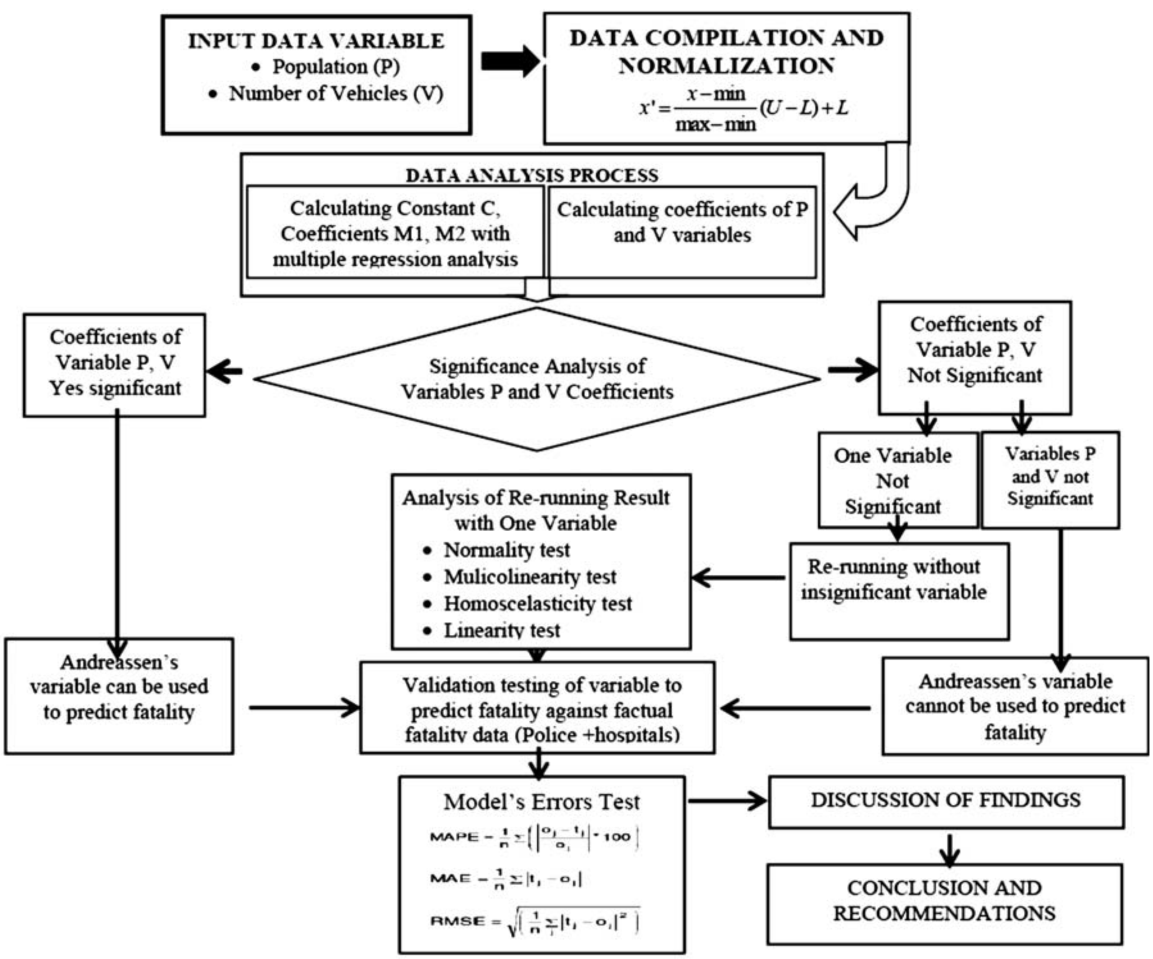

Figure 2: Stages of Andreassen's Variables Analysis

4. ANALYSIS OF ANDREASSEN'S MODEL TO PREDICT FATALITY IN INDONESIA

4.1. Andreassen's Model to Predict Fatality

General formula of Andreassen's Model:

$$F = CV^{M1} P^{M2} \tag{6}$$

C = Constant

V = Number of Vehicles

P = Number of Population

M_1 = Square Coefficeint of Vehicle

M_2 Square Coeffient of Population

To obtain the value of constant C, calculations of the values of M_1, M_2 coefficients and the values of α, β, γ are needed. The measurement is performed using SPSS, with multiple linear regression analysis, which results in $\ln F = \alpha + \beta \ln V + \gamma \ln P$, or in other form, $F = CV^{M_1} P^{M_2}$ is linear to $F = e^{\alpha}V^{\beta}P^{\gamma}$. Model summary of the measurement result of the regression model 1n(fatality) against 1n(population) and against 1n(vehicle) is as follow:

Table 3

Calculation Summary and Anova of Andreassen's Model Model Summary[a]

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of The Estimate*
1	.679	.461	.445	.41584

(*a*) Predictors: (Constant), of total population

ANOVA[b]

Model	*Sum of squares*	*df*	*Mean square*	*F*	*sig*
Regression Residual Total	10.197 11.932 22.129	2 69 71	5.099 .173	29.484	.000[a]

(*b*) Dependent variable: Total accidents

Based on the model summary in Table 3, it is found that $R^2 = 0.461$ and from the Anova table, it is found that the significance score is 0.000. The interpretation of these results is that in general, the model can explain 46.1% of variation of Ln (number of fatality), and the remaining 53.9% is affected by other factors. The significance score is 0.0000 < 0.05, indicating that at 95% reliability level, the model is good. To find out the coeffient values of each variables, the measurement result is displayed in Table 4.

Result of Andreassen's Model Coefficient Measurement.

Cefficients[b]

Model	*Unstanderdised Coefficients*		*Standardized Coefficients*	*t*	*sig*
	B	*Std. Error*	*Beta*		
(Constant)	-1.228	1.308		-.939	.351
Total of Car	.516	.090	.689	5.735	.000
Total Population	-.013	.122	-.013	-.108	.915

(*b*) Dependent variable: Total accidents

On Table 4, it can be seen that the result of coefficient value is formulated in equation of Andreassen's model for fatality prediction study in Indonesia, as follow:

$$F = e^{-1.228} V^{0.516} P^{-0.013} \tag{7}$$

Based on the coefficient value in Table 4, it is found that the significance score of variable ln(number of population) is 0.915 > 0.05, indicating that ln(number of population) has no significant effect on ln(number of fatality), or, the coefficient of population variable is considered as Zero.

To find out the distribution and correlation of dependent variables and independent variable (number of fatality), Regression Test is performed, including Normality Test, Multicolinearity Test, Homoscedasticity Test, Auto Correlation Test, and Linearity Test. The result of regression assumption tests on the 1985 Andreassen's prediction model is as follow:

4.1.1. *Normality Test*

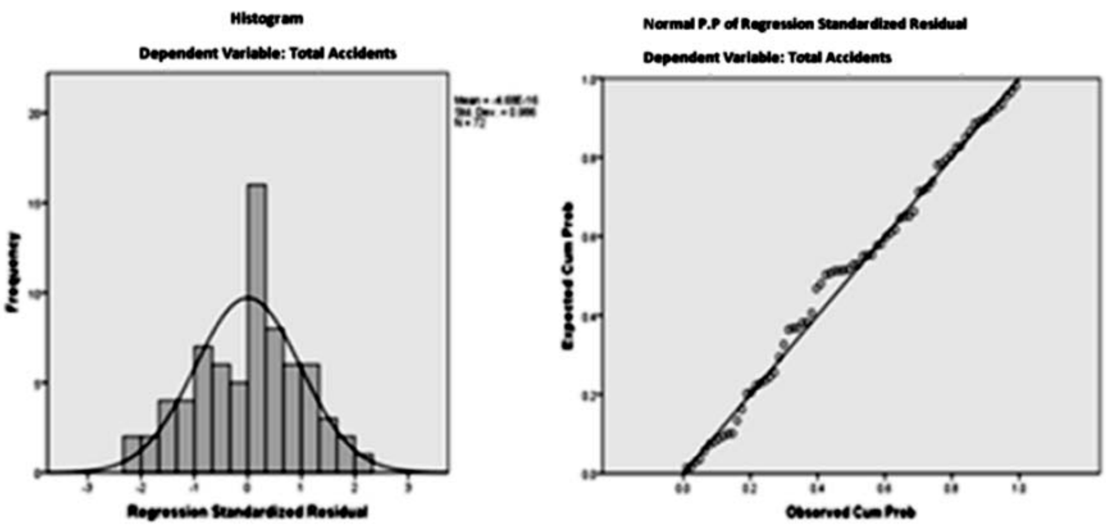

Figure 4: Normality Test Result Graph

Figure 4 presents that the error spread of the dependent variable is in bell form, and the data cluttered around the diagonal line. It indicates that the error is of normal distribution.

4.1.2. *Multicolinearity Test*

Table 5
Multicolinearity Test Result
Cefficients[b]

Model	*Collinearity Statistics*	
	Tolerance	*VIF*
(Constant)	.544	1.839
Total of car	.544	1.839

(***b***) **Dependent Variable: Total Accidents**

Cefficient Correlations[b]

Model		*Total Population*	*Total*
Correlations	Total Population	1.000	-.675
	Total No. of cars	-.675	1.000
Covariances	Total Population	.015	-.007
	Total No. of cars	-.007	.008

(***b***) **Dependent Variable: Total Accidents**

From Table 5, it can be seen that the correlation between ln(number of population) and ln(number of population) is quite high (-0.675). This is suspicious because there is no multi-colinearity that can explain the problem of multicolinearity in the model. Therefore, the model needs to be reformulated by removing one variable, either ln(number of population) or ln(number of vehicle).

4.1.3. Homoscedasticity Test

Figure 5: Homoscedasticity Test Result Graph

On Figure 5, it can be seen that the dependent variable data scatter randomly without forming any pattern. The plots are distributed randomly above and below the zero point of Y axis. It indicates that there is no heterocedasticity.

4.1.4. Linearity Test

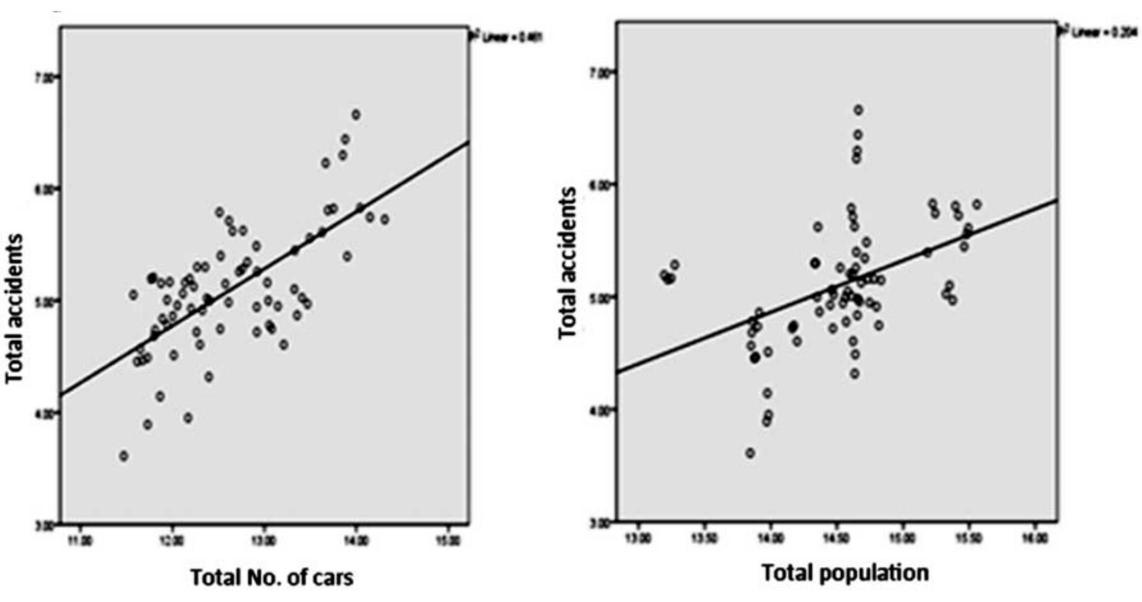

Figure 6: Linearity Test Result Graph

Based on Figure 6, it is clear that there is linear correlation between the two variables. However, the variable with higher correlation to ln(number of fatality) is ln(number of vehicle), with coefficient of determination of 0.461; while the coefficient of determination of ln(number of population) and ln(number of facility) is 0.204.

Based on the result of regression tests, it can be concluded that: (1) the result of normality test shows that the error is distributed normally; (2) the correlation between ln(number of population) and ln(number of vehicle) shows that there is a problem of multicolinearity in the model; (3) the result of homoscedasticity test shows that there is no heterocedasticity; (4) the result of linearity test indicates that there is linear relationship between the two variables, with higher coefficient of determination for number of vehicle variable. These results requires a re-run of Andreassen's model using only the number of vehicle variable; the variable of number of population is not used and is assumed to equal zero.

4.2. Andreassen's Model Re-running Model Andreassen Without Population Variable

Table 6 presents a model summary as a result of calculation of Andreassen's model re-running with only one variable (number of variable), without population (P) variable.

Table 6

Model summary of Andreassen's Model Re-runningusing one Variable of V (Vehicle)

Model Summary[a]

Model	*R*	*Adjusted R Square*	*Std. Error of the estimate*
1	.679[a]	.453	.41289

(*a*) Pridictors: (Constant), Total of cars

ANOVA[b]

Model	*Sum of squares*	*df*	*Mean Square*	*F*	*Sig.*
1. Regression Residual Total	10.195 11.934 22.129	1 70 71	10.195 .170	59.802	.000[a]

(*b*) Dependent Variable: No. of accidents

From Table 6, it is found that R-square is 0.461. This indicates that 46.1% variety/diversity of ln(number of fatality) can be explained by the model; and the rest (53.9%) is affected by other factors. Data from the ANOVA table shows that the significance value of the model is 0.000, lower than the 0.05 significance level at 95% reliability. It can be concluded that Andreassen's model with one variable (V) is good. The measurement of the coefficient value of Andreassen's model with one variable ln(number of vehicle) can be seen in Table 7.

Table 7

Result of Coefficient Measurement of Andreassen's Model with One Variable V (Vehicle)

Model	*Unstanderdized coefficients*		*Standardized Coef-ficients*	*t*	*Sig.*
	B	*Std. Error*	*Beta*		
1. (Constant) Total No. of cars	10.195 11.934	1 70	10.195 .170	59.802	.000[a]

(*b*) Dependent variable: No. of accidents

The significance value of ln(number of vehicle) is 0.000 < 0.05; indicating that ln(number of vehicle) has significant influence over ln(number of fatality) with $\alpha = -1.335$, $\beta = 0.509$. Since ln(number of population) is assumed to have no effect on ln(number of fatality), $\gamma = 0$. With linear equation of $\ln F = \alpha + \beta \ln V + \gamma \ln P$, the formula is found to be $F = e^{-1,335} V^{0,509} P^0$.

Based on the result of re-running with one variable of V (number of vehicle), or without variable population (P), the following Andreassen's one variable model equation is found:

$$F = e^{-1,335} V^{0,509} P^{0}, \text{ atau}$$

$$F = e^{-1,335} V^{0,509} \quad (8)$$

F = Fatality

V = Number of vehicle

P = Population.

4.3. Validation of Model's Equation of the Fatality Data

Table 8

Validation of Andreassen's model equation against factual fatality

No	*Regency/City*	*Factual Fatality Data*)*		*Number of Prediction Fatality with Andreassen's Equation*	
				Before re-running	*After re-running*
		*Police data**	*Hospital Survey data+*	$F = e^{-1,228} V^{0,516} P^{-0,013}$	$F = e^{-1,335} V^{0,509}$
1.	Bandung City	109	671`	331	327
2.	Depok City	86	44	239	236
3.	Cimahi City	144	53	178	174
4.	Bekasi Regency/City	169	137	386	383
5.	Bogor Regency/City	207	130	289	288
6.	Sukabumi Regency/City	89	83	159	159
7.	Tasikmalaya Reg./City	65	81	162	161
8.	Cirebon Regency/City	87	54	214	212
9.	Bandung and Bandung Barat Regency	241	91	280	280
10.	Indramayu Regency	195	81	166	165
11.	Cianjur Regency	101	79	130	130
12.	Ciamis Regency	75	76	144	143
13.	Majalengka Regency	27	25	130	129
14.	Subang and Purwakarta Regencies	110	82	190	189
15.	Sumedang Regency	82	47	120	118
16.	Garut Regency	111	57	133	133
17.	Kuningan Regency	68	51	116	115
18.	Karawang Regency	62	57	206	202
	Total	2028	1899	3571	3544
		3927			
	MAPE			33.47	33.47
	MAE			68.78	68.78
	RMSE			120.25	120.25

P = Population

V = Vehicle

\+ = Survey Data

The validation of results of the study is important to figure out the similarities of the best prediction model to forecast the number of factual and actual fatality, *i.e*. the fatality data from the Police and the hospital. Validation is conducted based on the test criteria of Mean Absolute Percent Errors (MAPE), Mean Absolute Errors (MAE), and Root Mean Square Errors (RMSE). Makridakias S, et al (1998) states that the MAPE test of the model measures the average of a series of actual data periods so that it can measure the accuracy of interpretation of prediction relative to the actual value. The RMSE model test is used as an alternative model to evaluate forecasting technique to measure the value of squared average of errors. MAE and RMSE can be used together to find out the error variation of a forecast. The greater the difference between MAE and RMSE values, the greater the varians of individual error of the sample will be. The result of validation test for the Andreassen's prediction model equation agains the prediction of factual fatality before and after re-running is presented in Table 8.

Table 8 shows that using the criteria of MAPE, MAE, and RMSE tests, there is no difference in the test results of Andreassen's one-variable Vehicle model before and after re-running. Both equations have the same accuracy and have corresponding average of forecast and observation values; *i.e*. able to forecast 90.93% of the actual fatality (accumulated from Police data and hospital survey). Both equations are also able to forecast the same number of factual fatality, *i.e*. 176.08% of the data reported by the National Police. Therefore, it is concluded that the general model of Andreassen's prediction () is not suitable to be used in Indonesia. The equation formulated in the present study ($F = e^{-1,335} V^{0,509}$) is able to present a better prediction of actual fatality in Indonesia, compared with Andreassen's two-variables prediction model.

The findings of this study is in line with Agus S (2014) statement that Andreassen's model is not suitable for predicting actual fatality in Indonesia, because it is not in line with the regional characteristics and transportation infrastructure of the country. The findings also show that the actual fatality in 2010 is 3544 people, 176.8% larger than the 2028 people reported by the National Police of Indonesia. It means the the findings of the present study reinforce the findings of previous studies; e.g. Susilo et al (1996), Utama S.U. (2007) and Susilo (2009), that the actual fatality data in Indonesia is bigger than the number reported by the Police. It also confirms Agus S. (2014), that the fatality data reported by the National Police of Indonesia and the fatality data obtained from the study using Andreassen's prediction model are unfit to use as primary data for road safety study in Indonesia because both of them do not have high accuracy. In this case, the use of primary data with low accuracy in road safety study will not yield great benefit; it cannot be used to develop and improve road safety management system or for *projustia* purposes in Indonesia.

5. CONCLUSION

Based on the findings of the study, the analysis and the validation of Andreassen's equation model to predict actual fatality in Indonesia, the following conclusions are drawn:

The general Andreassen's two-variables prediction model ($F = CV^{M_1} P^{M_2}$) is not suitable for predicting actual fatality in Indonesia. This is proven by the fact that the variable of Population (P) has no significant effect on the prediction of actual fatality ($F = e^{-1,228} V^{0,516} P^{-0,013}$). In this equation, the coefficient of P variable is considered as zero.

Based on the variables of population and vehicles in Indonesia, the equation $F = e^{-1,335} V^{0,509}$ atau $F = e^{-1,228} V^{0,516} P^{-0,013}$ is formulated; developed from the Andreassen's two-variables (P and V) prediction model.

Andreassen's one-variable model developed in the present study, with the equation of $F = e^{-1,335} V^{0,509}$ is able to predict the actual fatality in Indonesia; i.e. 176,8% (3571 people) more than the data reported by KNRI (2008-2011). The findings of the study also confirm the findings of previous studies that the actual fatality in Indonesia is higher than the reported data from the Police.

6. RECOMMENDATIONS

Based on the findings of the study, the researcher recommends the following to road safety researchers and transportation practitioners in Indonesia:

In road safety studies in Indonesia, the researchers need to consider the use of primary data with high accuracy; for instance, the one-variable Andreassen's prediction model developed in this study with the equation of $F = e^{-1,335} V^{0,509}$ atau $F = e^{-1,228} V^{0,516}$. With primary data of fatality that can accurately describe the actual data in the field, the result of the study will provide great benefit; including for the improvement of road safety management system to realize the national transportation program of "Safety Road in Indonesia".

The fatality prediction model developed in this study can be used by the National Police of Indonesia to improve the accuracy of fatality data reported to the public, as well as to meet the regulation of Road Traffic and Transportation Law No 22/2009 and the recommendation of the 1998 International Road Traffic and Accident Database (IRTAD, 1998).

An upated fatality prediction model needs to be developed in Indonesia; a prediction model developed based on regional characteristics and road (transportation) infrastructure of Indonesia, so that it can be used widely in all region of Indonesia to predict the actual fatality in the future.

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