



Educational Background Factors on Motor Vehicle Accident; Analysis Using a Structural Equation Modeling

Pada Lumba¹

¹ Faculty Member, Civil Engineering, Faculty of Engineering, Universitas Pasir Pengaraian, Pasir Pengaraian, Indonesia

INFO ARTIKEL

ABSTRAK

Penelitian ini berfokus pada dampak faktor manusia, jalan, lingkungan, dan kendaraan terhadap risiko kecelakaan pada pengemudi kendaraan bermotor. Studi ini berlokasi di Indonesia. Data dikumpulkan dengan mendistribusikan kuesioner melalui media sosial. Jumlah responden dalam penelitian ini terdiri dari 260 pengemudi kendaraan bermotor dengan 87 responden berpendidikan SMA (SMA) ke bawah, 100 responden berpendidikan S1, dan 73 responden berpendidikan S2. Data dianalisis menggunakan Structural Equation Modeling (SEM). Temuan utama dalam penelitian ini terkait dengan indikator variabel laten yaitu pengalaman pengemudi. Semua kelompok (SMA, S1, dan S2) dalam penelitian ini menunjukkan bahwa indikator pengalaman pengemudi memengaruhi variabel laten kinerja mengemudi dan variabel laten perilaku mengemudi berisiko. Selain itu, semakin kecil nilai R kuadrat model, semakin tinggi latar belakang pendidikan pengemudi kendaraan bermotor. Hal ini menunjukkan bahwa terdapat hubungan antara latar belakang pendidikan pengemudi dan terjadinya kecelakaan lalu lintas. Artinya, semakin tinggi latar belakang pendidikan pengemudi, semakin kecil risiko terjadinya kecelakaan lalu lintas.

Kata kunci: Kecelakaan; Kendaraan Bermotor; SEM

CONTACT

¹**Program Studi Teknik Sipil**
Universitas Pasir Penaraian
Jl.Tuanku Tambusai, Rambah, Kec.
Rambah Hilir, Kabupaten Rokan
Hulu, Riau 28558
padalumba@gmail.com

ABSTRACT

This research focuses on the impact of human, road and environmental as well as vehicles factors on the risk of accidents in driver of motor vehicle. The study is located in Indonesia. The data were collected by distributing questionnaires through social media. The number of respondents in this study consist of 260 drivers of motor vehicle with 87 respondents from senior high school (SMA) educated and below, 100 respondents from undergraduate (S1) educated and 73 respondents from postgraduate (S2) educated. The data were analyzed using Structural Equation Modeling (SEM). Key finding in this study related to indicator of latent variable is driver experience. All group (SMA, S1 and S2) in this study show indicated that driver experience indicator influence the latent variables driving performance and latent variables risky driving behavior. In addition to, the smaller value of R square of the model, the higher educational background of motor vehicle drivers. This shows that there is a relationship between the educational background of drivers and the road accidents occurrence. Meaning that the higher educational background of drivers, the smaller the risk of road accidents occurrence of drivers.

Kata kunci: Accident; Motor Vehicle; SEM.

Corresponding Author:

✉ Pada Lumba

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I.INTRODUCTION

Accidents that were caused fatigue factor occurring between 12.00 PM and 18.00 PM [1]. Another study in Australia indicated that 1.9% of accidents were caused by fatigue, most of them occurred between 14.00 pm and 16.00 pm [2]. A study was conducted by [3] in Australia on motor vehicles that age, sex, work status, vehicle type, driver's license status, fatigue, speed, and accident location were independent variables of the accident severity. Fatigue can decrease performance of driver to drive safely [4]. The fatigue are caused by some factors include: lack of rest, long duration of driving, and monotonous roads [5]. Another hand, monotonous road and low traffic volume can cause driver experienced fatigue earlier [6].

Drivers who sleep average less than 5 hours every night will more likely to experience a crash almost 5 times due to falling asleep than accidents caused by the other factors [7]. Drivers who experience sleep disorders can experience fatigue and tend to violate traffic regulation than drivers with normal sleep times [8]. The probability of accidents for driver of motorcycle who sleep 6 hours and below is 51% and 27% for driver who sleep between 6 hours until 7 hours, and 22% for driver who sleep more than 7 hours [9]. Several strategies to decrease fatigue on bus drivers include: providing backup drivers, making the atmosphere on the road pleasant, and increasing long of time to take a rest during the trip [10].

The research that conducted in Singapore indicate that the failure to detect suddenly hazard will complicate driver to make decision for braking or evasive action [11]. The vigilance of the drivers does not increase when driving on a straight road, on the other hand the vigilance of the driver will increase when driving on a curve [12]. Differences on motorcycle performance will affect the risky driving behavior and it will be risky to experienced fatal accidents [13].

Male drivers have better driving skills than female drivers, but male drivers have a lower perception of the risk of accidents compared to female drivers [14]. 35.29% of motorcyclist's aged over 20 years experienced fatigue before the accident, and 33.8% of motorcyclist's aged 20 years and under 20 years experienced fatigue before the accident [15]. Motorists aged 20 years and below will more likely to experience a fatal accident almost 12 times, and this condition decreases dramatically with increasing the driver age, then rises again after the driver passes 65 years old [16].

80 minutes was the safe limit for driving on monotonous roads [17]. Driving for a long time will decrease the reaction time of the driver, and there are correlation between the driver's reaction time and the variation on driving performance [17]. 90 minutes was the safe limit for driving on monotonous roads [18].

A study was conducted by [3] in Australia on motor vehicles that age, sex, employment status, vehicle type, drivers license status, fatigue, speed, and accident location are independent variables from the variable of accident severity. Driver behavior is influenced by several factors that can increase the risk of an accident, including: age, gender, driver experience, road conditions and vehicle characteristics [19]. Good driving behavior factor was found to have the highest influence on the WTP [20].

Accident between motorcycle and the other motor vehicles, day time accidents, male driver of motor vehicle at fault, right angle and head on crush significantly related with severely motorcycle accident injured [21]. Driver aged above 55 years tend to experienced severely injured in the single vehicle run off road crash on 4 lanes road and driver aged 25-

35 years were more likely to mitigate accident severity on 2-lane road [22]. Young driver aged group un/lowly educational level has a high impact on fatal accident [23]. The driver experience and vehicle familiarity factors can improve ability of driver to make variation of driving performance [24]

The growth of motor vehicles in Indonesia each year were quite high, amount at 6.49%. Based on data [25] shows that the number of motor vehicles in Indonesia in 2014 were 112,209,260 vehicles. In 2015 the number of motor vehicles increased by 121,394,185 vehicles. Then in 2016 the number of motor vehicles increased by 129,094,823 vehicles. In 2017 the number of motor vehicles increased by 137,211,819 vehicles. Furthermore, in 2018 the number of motor vehicles increased by 146,858,759 vehicles.

The growth of number of accident cases in Indonesia each year were quite high, namely at 3.3%. Based on data [25] shows that the number of accident cases in 2014 were 95,906 cases. In 2015, accident cases increased by 96,233 cases. Then in 2016 the accident cases increased by 106,644 cases. In 2017, the number of accidents decreased by 104,327. Furthermore, the number of accident cases in 2018 increased again by 109,215 cases.

This study aimed to analyze several factors related educational background of driver of motor vehicle which influenced risk of accident. Model of accident took human factor, road and environment, and vehicle into consideration. The factors were analyzed simultaneously to obtain the model of accident in motor vehicle. The study related to affect of background of educational of drivers with the road accident occurrence is just a few. Therefore it need to be conducted study related to correlation between educational background and risk of road accident in order to minimize risk of accident in motor vehicle.

II. MATERIALS AND METHODS

The study area is located in Indonesia. The approach method in this research is quantitative method. The data were collected by distributing questionnaires through social media to drivers of motor vehicle. The number of respondents in this study consist of 260 drivers of motor vehicle with 87 respondents from SMA, 100 respondents from S1 and 73 respondents from S2.

The data were analyzed Using Structural Equation Modeling (SEM) which is a combination of analysis factor and regression. The variables in SEM model consist of latent and indicator variables. Each latent variable consists of two or more indicator variables. Latent variables cannot be measured directly unless the latent variable is measured using one or more indicator variables. Latent variables consist of latent variables exogenous and latent variables endogenous. Exogenous variables are independent variables that affect the dependent or endogenous variables. Confirmatory Factor Analysis (CFA) is an analytical tool used to examine a measurement model, whether the indicators can explain the construct variables. Meanwhile, Multiple Regression Analysis is an analytical tool to examine the structure of the model, whether there is a significant relationship between exogenous (independent) and endogenous (dependent) variables.

2.1 Measurement model

Measurement model describes the relationship between latent variables and indicator variables. Trust variable is a latent variable that cannot be measured directly, and image, care and honest are manifest variables or

indicators of latent trust. Image, care and honest are variables that can be measured, as shown in Figure 1.

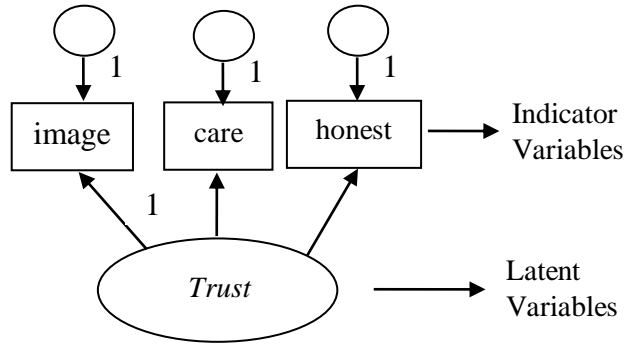


Figure 1. Correlation between latent and indicator variables
Source: [26]

2.2. Structural model

The model structure describes the relationship between latent variables as shown in Figure 2.

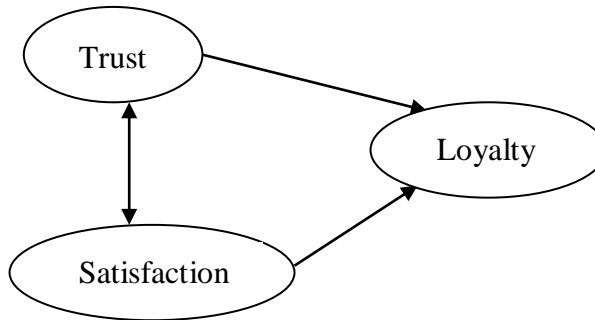


Figure 2. Model of structural equation modelling
Source : [26]

III.RESULTS AND DISCUSSION

3.1. PLS (Partial Least Square) Analysis

The exogenous variables in this model are latent variables of vigilance, performance, fatigue, monotonous road and risky driving behavior as shown in Figure 3.

Note: A = Accident, P = Driving performance, V = Driver vigilance, F = Fatigue, M = Monotonous road, R = Risky driving behavior, X2.1 = Brake condition, X2.2 = Potholes road, X2.3 = Slip road, X2.4 = Lack of sleep, X2.5 = Road lighting, X2.6 = Obstructed view, X2.7 = Tire condition, X3.1 = Age of driver, X3.2 = Vehicle familiarity, X3.3 = Gender of driver, X3.4 = Driver experience, X3.5 = Route familiarity, X4.1 = Coffee consumption, X4.2 = Driving on curve, X4.3 = End of journey, X4.4 = Energy drink consumption, X4.5 = Road marking, X4.6 = Monotonous road, X4.7 = Straight road, X4.8 = Get enough sleep, X5.1 = Driving time, X5.2 = Lack of rest, X5.3 = Long duration of driving, X5.4 = Monotonous road, X5.5 = Work Routines, X5.6 = Work schedules , X5.7 = Types of work, X6.1 = Long duration of driving, X6.2 = Roadside variability, X6.3 = Traffic volume, X7.1 = Age of driver, X7.2 = Engine capacity, X7.3 = Driver experience, X7.4 = Gender of driver

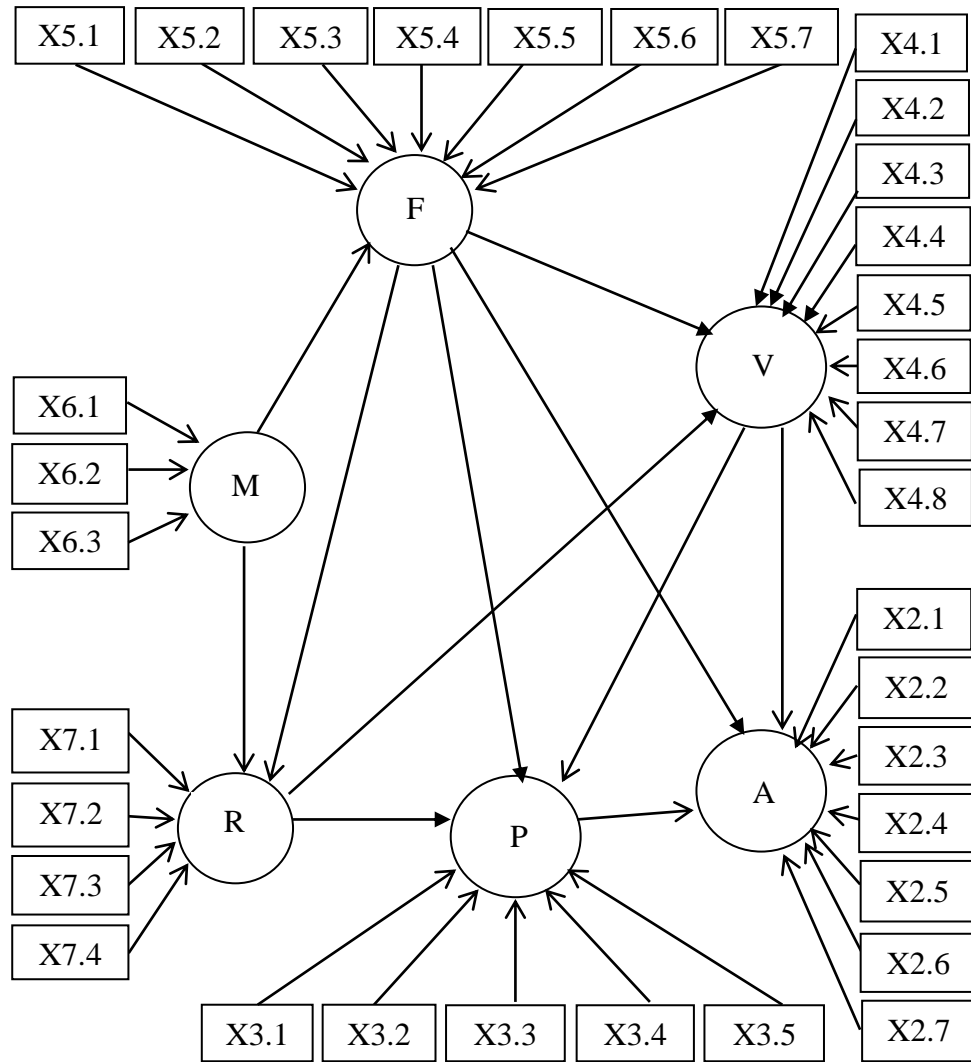


Figure 3. Model SEM Accident on driver of motor vehicle

3.2 Evaluation of the measurement model (Measurement outer model)

Because latent variables and formative indicators are regression relationships, the ways to evaluate the outer model is to look at the P value of the indicators, as shown in Table 1 below:

Table 1. P value of indicator

latent Variables	Indicator	Remark	P Value		
			SMA	S1	S2
Accident (A)	X2.1	Brake condition	0,427	0,141	0,449
	X2.2	Potholes road	0,273	0,381	0,171
	X2.3	Slip road	0,393	0,054	0,220
	X2.4	Lack of sleep	0,016	0,084	0,349
	X2.5	Road lighting	0,371	0,437	0,060
	X2.6	Obstructed view	0,351	0,034	0,378
	X2.7	Tire condition	0,072	0,396	0,336
Driving performance (P)	X3.1	Age of driver	0,101	0,200	0,007
	X3.2	Vehicle familiarity	0,006	0,231	0,326
	X3.3	Gender of driver	0,388	0,370	0,356
	X3.4	Driver experience	0,014	0,006	0,008
	X3.5	Route familiarity	0,442	0,058	0,303
Driver vigilance (V)	X4.1	Coffee consumption	0,181	0,216	0,351
	X4.2	Driving on curve	0,186	0,066	0,007
	X4.3	End of journey	0,430	0,338	0,263
	X4.4	Energy drink consumption	0,338	0,274	0,225
	X4.5	Road marking	0,001	0,002	0,317
	X4.6	Monotonous road	0,077	0,137	0,483

	X4.7	Straight road	0,043	0,321	0,195
	X4.8	Get enough sleep	0,004	0,297	0,009
Fatigue (F)	X5.1	Driving time	0,254	0,331	0,034
	X5.2	Lack of rest	0,000	0,233	0,016
	X5.3	Long duration of driving	0,433	0,145	0,142
	X5.4	Monotonous road	0,320	0,366	0,101
	X5.5	Work Routines	0,288	0,289	0,119
	X5.6	Work schedules	0,185	0,096	0,315
	X5.7	Types of work	0,140	0,166	0,334
Monotonous road (M)	X6.1	Long duration of driving	0,001	0,401	0,170
	X6.2	Roadside variability	0,202	0,004	0,003
	X6.3	Traffic volume	0,209	0,072	0,147
Risky driving behavior (R)	X7.1	Age of driver	0,054	0,113	0,106
	X7.2	Engine capacity	0,003	0,072	0,110
	X7.3	Driver experience	0,000	0,010	0,002
	X7.4	Gender of driver	0,284	0,388	0,347

Based on Table 1 above, formative indicators that affect the latent variables are as shown in Table 2 below:

Table 2. Formative indicator that affect the latent variables

Latent variables	Indicator	Remark	P Value		
			SMA	S1	S2
Accident (A)	X2.4	Lack of sleep	V	NV	NV
	X2.6	Obstructed view	NV	V	NV
Driving performance (P)	X3.1	Age of driver	NV	NV	V
	X3.2	Vehicle familiarity	V	NV	NV
	X3.4	Driver experience	V	V	V
Vigilance (V)	X4.2	Driving on curve	NV	NV	V
	X4.5	Road marking	V	V	NV
	X4.7	Straight road	V	NV	NV
	X4.8	Get enough sleep	V	NV	V
Fatigue (F)	X5.1	Driving time	NV	NV	V
	X5.2	Lack of rest	V	NV	V
Monotonous road (M)	X6.1	Long duration of driving	V	NV	NV
	X6.2	Roadside variability	NV	V	V
Risky driving behavior (R)	X7.2	Engine capacity	V	NV	NV
	X7.3	Driver experience	V	V	V

Notes : V = Valid, NV = Not Valid

Description related respondents in this study as shown in Table 3.

Table 3. Description of respondents

	SMA	S1	S2
Average age	18 years 10 month	24 years 8 month	35 years 1 month
Motorcycle	97,7%	92,0%	45,21%
Car	2,3%	8%	54,79%

The results of SEM analysis, the coefficient of each latent variable were as shown in Table 4 below

Table 4. Path Coefficient

Latent variables	SMA	S1	S2
Monotonous road - Fatigue	0,467	0,432	0,542
Monotonous road - Risky driving behavior	0,294	0,167	0,092
Fatigue - Accident	0,354	0,014	0,154
Fatigue - Vigilance	0,574	0,339	0,421
Fatigue - Driving performance	0,474	0,226	0,439
Fatigue - Risky driving behavior	0,522	0,401	0,349
Vigilance - Accident	0,399	0,269	0,334
Vigilance - Driving performance	0,252	0,277	0,140
Driving performance - Accident	0,088	0,450	0,213
Risky driving behavior - Vigilance	0,371	0,341	0,418

Risky driving behavior - Driving performance	0,077	0,338	0,243
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3.3. Evaluation of structural models (Measurement inner model).

The value of R square for model of SEM can be seen in Table 5 below

Table 5. R square

Latent Variables	SMA	S1	S2
Accident	0,619	0,422	0,358
Fatigue	0,218	0,187	0,294
Vigilance	0,747	0,341	0,492
Driving performance	0,566	0,470	0,468
Risky driving behavior	0,502	0,246	0,165

3.4. Discussion

Correlation variabel latent and indicators

There are 7 indicators used to measure the causes of the road accidents occurrence to drivers of motor vehicle in this study. The results of SEM analysis show only 2 indicators that affect the risk of an accident, namely lack of sleep for respondent with educational background SMA and obstructed view for respondent with for respondents with educational background S1. The result was in accordance with the studies conducted by [7, 8, 9, 11]. However, of all indicators are assumed influencing accident in this study, it is not one of indicators that influence risk of accident for respondent with educational background S2. Meaning that there are others indicator influence risk of accident beside indicator were assumed in this study.

In this study there are 5 indicators used to measure performance of drivers of motor vehicle. The results of SEM analysis show 3 indicators that affect performance of drivers, namely age of driver for respondent with educational background S2 and vehicle familiarity for respondent with educational background SMA, and driver experience for respondent with educational background SMA, S1 and S2. The result was in accordance with the studies conducted by [15, 16, 24].

In addition to, there are 8 indicators used to measure the vigilance of drivers of motor vehicle in this study. The results of SEM analysis show 4 indicators that affect the vigilance of drivers, namely driving on curve for respondent with educational background S2 and road marking for respondent with educational background SMA, S1 and straight road for respondent with educational background SMA, and get enough sleep for respondent with educational background SMA and S2. The result was in accordance with the studies conducted by [4, 11, 12].

Further more there are 7 indicators used to measure the causes of fatigue of drivers of motor vehicle in this study. The results of SEM analysis show 2 indicators that affect fatigue of drivers, namely driving time for respondent with educational background S2 and lack of rest for respondent with educational background SMA, S2. The result was in accordance with the studies conducted by [1, 2, 5].

3 indicators are used to measure the monotonous road of drivers of motor vehicle in this study. The results of SEM analysis show 2 indicators that affect monotonous road of drivers, namely long duration of driving for respondent with educational background SMA and roadside variability for respondents with educational background S1, S2. The result was in accordance with the studies conducted by [17, 18].

There are 4 indicators used to measure risky driving behavior of drivers of motor vehicle in this study. The results of SEM analysis show 2 indicators that affect risky driving behavior of drivers, namely engine capacity for respondent with educational background SMA and driver experience for respondent with educational background SMA, S1, and S2. The result was in accordance with the studies conducted by [6,13, 19, 24].

3.5. Model SEM

The results of the analysis for SMA respondents indicate that the latent variables of vigilance, driving performance and fatigue can explain the latent variables of accidents by 61.9%, while 38.1% are explained by other factors. The results of the analysis for respondents with educational background S1 indicate that the latent variables of vigilance, performance and fatigue can explain the latent variables of accidents by 42.2%, while 57.8% are explained by other factors. The results

of the analysis for respondents with educational background S2 show that the latent variables of vigilance, performance and fatigue can explain the latent variables of accidents by 35.8%, while 64.2% are explained by other factors.

IV. CONCLUSION

Key finding in this study related to indicator of latent variable is driver experience indicator. All group in this study that driver experience influence driving performance and risky driving behavior. In addition to, the value of R square of the model is getting smaller with the higher educational background of motor vehicle drivers. This shows that there is a relationship between the educational background of drivers and the road accidents occurrence. Furthermore, It mean that the higher educational background of driver's, the smaller the risk of accidents.

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