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Driving Behavior Factors of Young Drivers Influencing Motorcycle Traffic Accidents in Jember, East Java

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Abstract

Traffic accidents are unexpected and undesirable incidents that occur on the highway, resulting in damage and casualties. Traffic accidents occur due to several contributing factors, including driver behavior, road conditions, technical errors in vehicles, and environmental conditions. Based on several studies, motorcycles are the vehicles most frequently involved in traffic accidents. Jember is one of the districts in East Java with a high number of motorcycle accidents. Based on data from 2017 to 2019, motorcycle traffic accidents in Jember reached 3,543 cases. Most of motorcycle riders involved in accidents in Jember are young riders. Young riders are considered to lack proper driving attitudes. This study was conducted to determine the relationship between driving behavior and accidents in Jember District among young motorcycle riders using structural equation modeling (SEM). The primary data used were survey results with respondents consisting of motorcycle riders aged up to 24 years old residing in Jember District. There is also supporting data in the form of accident data that occurred in Jember District from 2018 to 2022. Using that method, the results showed that driving behavior variables significantly influencing traffic accidents are traffic violations and stunts. The traffic violations variable has an influence of 0.840. Meanwhile, the stunts variable has an influence of 0.267.

Keywords

Traffic accident, driving behavior, young motorcyclists, MRBQ

INTRODUCTION

The issue of traffic accidents needs to be addressed and treated seriously, especially in Indonesia where the accident rates are already very concerning, not to mention the congestion problem. [1]. Traffic accidents are caused by several factors, which is human as motor vehicle users, road geometric conditions, vehicle conditions, and environmental conditions. [2]. One factor contributing to the increasing number of traffic accidents is the intense rise in motor vehicle ownership over the last decade, especially the ownership of motorbikes. [3].

Based on BPS data in 2021, the most widely types of motorized vehicle is the motorcycle, with 141,992,573 units and a growth rate of 4.62% annually. Furthermore, the number of issued type-C driving licenses in the Republic of Indonesia in 2021 reached 64.36% of the total types of licenses issued. This indicates that most Indonesians own motorcycles [4]. Some studies reveal that most accidents occur involving motorcycles. [4], [5].

The issue of traffic accidents doesn't just occur at the national level, but also in regional areas such as Jember Regency, which is the focus of this research. The number of motorcycles in Jember Regency in 2022, as recorded by the Jember Regency BPS, reached 89.01%.[6]. During the period 2017 to 2019, there were 3,543 motorcycle accidents in Jember Regency. [7].

Accidents are one of the leading causes of death among young children or teenagers aged 14 to 24 years old. [8], [9]. Other research explains that drivers under the age of 17 are more likely to experience traffic accidents due to a lack of driving experience. [10]. The younger someone's age is, the greater the likelihood of experiencing a traffic accident. [11]. Traffic behavior is a factor influencing the occurrence of accidents. [12].

In efforts to address accident occurrences, there are widely used measurement instruments to assess driver behavior aspects using questionnaires, often known as Driver Behavior Questionnaire (DBQ) [8]. Considering the distinct characteristics of motorcycle riders' behavior compared to car drivers, there have been developments in the form of questionnaire adaptations to Motorcycle Rider Behavior Questionnaire (MRBQ) that conducted by several countries such as the UK, Australia, Persia, and Indonesia. The MRBQ contains several driving behaviors that influence traffic accidents. In its development, driving behavior is classified into 6 variables. Which are traffic errors, control errors, speed violations, traffic violations, safety violations, dan stunts [13]. Therefore, it is necessary to conduct an analysis using the MRBQ instrument to determine the relationship between driving behavior and motorcycle traffic accidents in Jember Regency, then preventive measures can be taken to reduce accidents in Jember Regency.

RESEARCH SIGNIFICANCE

This study aims to determine the driving behavior factors that influence traffic accidents at the study location. By identifying the influencing factors, it is hoped to provide input to relevant authorities then preventive measures can be taken to reduce accidents in Jember Regency, specifically for motorcycle riders.

METHODOLOGY

This study was conducted by analyzing primary data obtained from the results of questionnaires regarding respondents' driving behavior. The questionnaire was distributed online using Google Forms. Data analysis was performed using the Structural Equation Modeling (SEM) method. In general, the SEM procedure consists of 5 stages: model specification, model identification, model estimation, model evaluation, and model respecification. [14]. The research steps coherently can be seen in Figure 1.

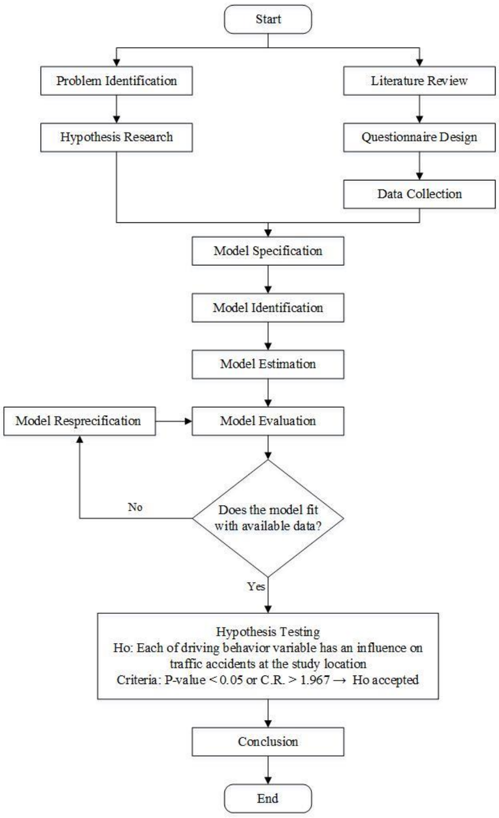

Figure 1 Research Flowchart

A. TECHNIQUE OF DATA COLLECTION

The questionnaire was filled out online through Google Forms, specifying the required criteria for respondents. The criteria for respondents in this study are motorcycle riders aged up to 24 years old and residing in Jember Regency. The link was distributed to respondents using messaging platforms (WhatsApp) and social media (Instagram).

Based on question from MRBQ Indonesia [13], research about accidents [15] and adjustment to the behavior of motorcycle riders at the study location, the variables and indicators in this research can be seen in Table 1.

Table 1 Variable and Indicator on Research

Code	Indicator
Traffic Errors (TE)	
TE1	Failing to check for pedestrians when turning from a small road to a main road
TE2	Not realizing the presence of people behind parked vehicles
TE3	Misjudging the speed of vehicles behind when trying to pull over
TE4	Unable to observe or anticipate other vehicles intending to pull over
TE5	Nearly colliding with vehicles ahead while queuing to turn left
TE6	Attempting to overtake a vehicle that has signaled a right turn
TE7	Difficulty stopping when traffic lights turn red
TE8	Failing to maintain a safe distance with the vehicle ahead
TE9	Turning too wide when making a turn on a curve
TE10	Pulling over on an uphill or downhill road
TE11	Forgetting or not using turn signals when turning
Control Errors (CE)	
CE1	Difficult to control the motorcycle at high speeds
CE2	Experiencing skidding on wet roads or when passing over road pothole covers
CE3	Unable to cope when other drivers interfere with driving
CE4	Carrying a large/heavy load on the motorcycle
CE5	Difficult to control the motorcycle because of not anticipating parked cars suddenly opening doors
Traffic Violations (TV)	
TV1	Break through a red light
TV2	Driving against traffic to shorten travel time/distance
TV3	Riding a motorcycle on the sidewalk (pedestrian lane) during heavy traffic
TV4	Using a mobile phone while driving
TV5	Smoking while driving
TV6	Stopping briefly on the roadside with a "No Stop" sign
TV7	Making a turn at a roundabout without following the directional signs
TV8	Stopping in the wrong lane at a red light (intending to turn right but stopping in the left lane or vice versa)
Speed Violations (SPV)	
SPV1	Driving too fast on curves, resulting in loss of control
SPV2	Exceeding the speed limit on intercity roads (maximum 80 km/h)
SPV3	Exceeding the speed limit in urban areas (maximum 50 km/h)

Code	Indicator
SPV4	Exceeding the speed limit in residential areas/local roads (maximum 30 km/h)
SPV5	Ignoring speed limits at night due to sparse traffic
SPV6	Attempting to overtake other vehicle drivers at signalized intersections (red light)
SPV7	Engaging in illegal street racing with motorcycle riders or other car drivers
SPV8	Not reducing speed on slippery roads due to rain to quickly reach the destination
SPV9	Speeding up when the traffic light turns green or yellow to avoid red lights
SPV10	Overtaking other vehicles using the left side of the road
SPV11	Not reducing speed when passing over speed bumps
Safety Violations (SFV)	
SFV1	Riding a motorcycle after consuming drugs that may affect concentration while driving
SFV2	Using a helmet without a chin strap
SFV3	Carrying more than one passenger while riding a motorcycle
SFV4	Riding a motorcycle that is damaged and affects vehicle movement (e.g., worn-out tires, broken chain, etc.)
SFV5	Riding a motorcycle without wearing a helmet
SFV6	Carrying a passenger who is not wearing a helmet
SFV7	Driving while unfit, tired, or drowsy
SFV8	Continuing to ride at night when the motorcycle's main lights are damaged or dim
SFV9	Riding a motorcycle with modified parts or body
Stunts (ST)	
ST1	Attempting to perform a wheelie on the road (lifting the front wheel of the motorcycle)
ST2	Performing a wheel spin (causing the rear wheel to continuously spin until emitting smoke)
ST3	Hitting a parked vehicle causing damage, but fleeing without taking responsibility
ST4	Cutting off the road without considering the position of other vehicles
Accident (ACC)	
ACC1	Experience of receiving a traffic ticket (proof of violation)
ACC2	Experience of being involved in an accident where you are the cause or responsible party (as the perpetrator of the accident)
ACC3	Experience of being involved in an accident where you are not the cause or responsible party (as the victim of the accident)

Measurement of the driving behavior variables uses a Likert scale with scale magnitudes as shown in the Table 2.

Table 2 Traffic Behavior Scale

Answer Category	Score
Never	1
Seldom	2
Sometimes	3
Often	4
Always	5

If the sample size is too large, it will be difficult to obtain a suitable model, and it is recommended to have a sample size between 100 – 400 respondents to facilitate estimation and interpretation with Structural Equation Modeling (SEM) [16]. There are also other references in determining the sample size based on the number of parameters in the study. The determination of the sample size based on the number of parameters for SEM is [16]:

$$\text{sample} = \text{parameter x } (5 \text{ until } 10) \quad (1)$$

Note:
Parameter = The parameters used in the MRBQ indicators

From equation 3.1, The sample size is calculated as follows.
Sample = 51×5
= 255 respondents
Based on the calculation above, the minimum required sample size is 255 respondents.

B. TECHNIQUE OF DATA ANALYSIS

Data analysis in this research uses the structural equation modeling (SEM) method. Structural equation modeling is an analysis that combines factor analysis, structural model, and path analysis approaches. [17]. SEM has characteristics that serve as an analytical technique, which functions more for confirmation than explanation. In other words, a researcher is more likely to use SEM to determine whether a particular model is valid or not, rather than using it to find out whether a particular model fits or not. [18]. The stages of the SEM method in general are:

1. Model Specification

Model specification is a step in identifying research issues based on theory or previous research. Model specification can also be done using a path diagram with a hybrid model, which is a combination of measurement model and structural model.

In this study, there are seven latent variables, which is traffic errors (TE), control errors (CE), traffic violations (TV), speed violations (SPV), safety violations (SFV), stunts (ST), and accident (ACC). The conceptual model depiction in this study can be seen in Figure 2.

2. Model Identification

Model identification is conducted to determine whether the research model has a unique value or not. Model identification is done by calculating the degrees of freedom. Model identification is performed to determine whether further analysis can be conducted or not. There are 3 categories of model identification results in SEM, which is:

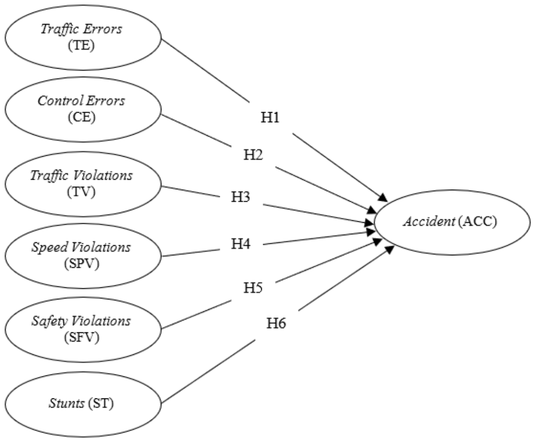

Figure 2 Research Conceptual Model

a. Under Identified, if the score of degrees of freedom (df) in this model are less than zero (negative).
b. Just Identified, if the score of degrees of freedom (df) in this model are zero.
c. Over Identified, if the score of degrees of freedom (df) in this model are more than zero (positive).

SEM analysis can proceed if the model identification yields a positive value for df (over identified).

3. Model Estimation

Estimation of the model is carried out to generate parameter values using available estimation methods. The estimation techniques available are:

- Unweighted Least Square Estimation (ULS)
- Scale Free Least Square Estimation (SLS)
- Asymptotically Distribution Free Estimation (ADF)
- Maximum Likelihood Estimation (MLE)
- Generalized Least Square Estimation (GLS)

For sample 200-500 technique that can be chosen are MLE or GLS [19]. The method that is used in this research is Maximum Likelihood Estimation (MLE) method.

4. Model Evaluation

This stage is conducted with the aim of evaluating the model. In this stage, the model's adequacy is evaluated to determine whether the overall fit of the model meets the criteria of goodness of fit (GoF). Evaluation of the model's adequacy is performed when the model is estimated. Model evaluation is done through tests of the measurement model and tests of the structural model.

a. Measurement Model Test

Measurement model testing shows how manifest variables (indicators) represent latent variables by testing the validity and reliability of variables in the research.

Validity testing is obtained by looking at the loading factor values (λ). Loading factor values > 0.5 indicate that the indicator validly measures the constructed construct and can explain the variations present in the indicator. [20].

Construct reliability is conducted to prove the accuracy, consistency, and precision of the research instrument. There are two methods that can be used, namely calculating Construct Reliability (CR) and Average Variance Extracted (AVE). The cut-off value for Construct Reliability (CR) is a minimum of 0.70, while the cut-off value for Average Variance Extracted (AVE) is a minimum of 0.50 [20]. Reliability test can be obtained through the following formula.

$$\mathrm{CR} = \frac{(\Sigma\,\lambda)^2}{(\Sigma\,\lambda)^2 + \Sigma \mathrm{e}} \quad (2)$$

$$\mathrm{AVE} = \frac{\Sigma\,\lambda^2}{\Sigma\,\lambda^2 + \Sigma \mathrm{e}} \quad (3)$$

Note:
λ = loading factor value
e = error (1 – λ)

b. Structural Model Test

Structural model testing is conducted using the full model from the measurement model testing results with the aim of determining whether the model can be considered fit with the available data. If the goodness of fit value indicates a good fit, then the model can be accepted, and hypothesis testing can be conducted. However, if the goodness of fit value does not indicate a good fit, then the model needs to be respecified (modified) to achieve a better fit.

The cut-off values for goodness of fit indices used to test the model in this research can be seen in the Table. 3.

Table 3 Goodness of Fit Indices

Goodness of Fit	Cut-off Value
Chi-Square	Expected small
Probability	$\geq$0,05
CMIN/DF	$\leq$2,00
RMSEA	$\leq$0,08
GFI	$\geq$0,90
AGFI	$\geq$0,90
TLI	$\geq$0,90
CFI	$\geq$0,90
PCFI	$\geq$0,50
NFI	$\geq$0,90

5. Respecification Model

Model respecification is done when the goodness of fit values does not indicate a good fit. Model respecification involves modifying the model, so it is often referred to as the model modification stage. Respecification is done by correlating variables that have the largest Modification Index (MI).

6. Hypothesis Testing

The hypothesis of this research is that each driving behavior variable, namely traffic errors, control errors, traffic violations, speed violations, safety violations, and stunts, has an influence on traffic accidents at the study location.

RESULTS AND DISCUSSIONS

A. MODEL SPECIFICATION

Model specification is the initial stage of SEM testing, which involves conceptually defining the constructs under study, including variables, indicators, and their relationships. This research consists of 7 variables: traffic errors (TE), control errors (CE), traffic violations (TV), speed violations (SPV), safety violations (SFV), stunts (ST), and accidents (ACC). These seven variables have a total of 51 indicators, which can be seen in the Table. 4.

Table 4 Variabel Code and Research Indicators

No	Variable	Indicator
1	Traffic Errors (TE) have 11 indicators	TE1, TE2, TE3, TE4, TE5, TE6, TE7, TE8, TE9, TE10, TE11
2	Control Errors (CE) have 5 indicators	CE1, CE2, CE3, CE4, CE5
3	Traffic Violations (TV) have 8 indicators	TV1, TV2, TV3, TV4, TV5, TV6, TV7, TV8
4	Speed Violations (SPV) have 11 indicators	SPV1, SPV2, SPV3, SPV4, SPV5, SPV6, SPV7, SPV8, SPV9, SPV10, SPV11
5	Safety Violations (SFV) have 9 indicators	SFV1, SFV2, SFV3, SFV4, SFV5, SFV6, SFV7, SFV8, SFV9
6	Stunts (ST) have 4 indicators	ST1, ST2 ST3, ST4
7	Accident (ACC) have 3 indicators	ACC1, ACC2, ACC3, ACC4

B. MODEL IDENTIFICATION

Model identification in SEM is done by looking at the value of degrees of freedom. The value of degrees of freedom is obtained directly from the analysis software. Based on the analysis, the value of degrees of freedom in the initial full model stage is 1203 (degrees of freedom > 0), indicating that the available data can be used for further testing.

C. MODEL ESTIMATION

The estimation model used in this research is Maximum Likelihood Estimation (MLE). This estimation technique is employed because it is the most used method for estimating models with SEM [21].

D. MODEL EVALUATION

Based on the calculation of the minimum required sample using equation (1), the minimum sample size obtained is 255 respondents. The number of samples analyzed after conducting outlier tests is 333 respondents. This number meets the required sample range.

Based on the model evaluation results, there are several indicators excluded from the study because they did not meet the validity criteria, namely the loading factor values. > 0.5 [20]. The indicators are TE11, SPV1, SPV7, SPV8, SFV3, SFV5, SFV6, dan SFV7.

In addition to sample and validity evaluations, it is necessary to conduct reliability testing to demonstrate the accuracy, consistency, and precision of the research instrument. Model reliability is based on the critical ratio (C.R.) values with a cut-off value of 0.7 and average variance extracted with a cut-off value of 0.5 [20]. The calculation of C.R. and A.V.E. is based on the formulas from equations (2) and (3). The results of the reliability testing can be seen in Table 5.

Table 5 Reliability Construct Result

Variable	C.R.	A.V.E	Information
Traffic Errors	0,886	0,660	Good Reliability
Control Errors	0,771	0,406	Enough Reliability
Traffic Violations	0,935	0,643	Good Reliability
Speed Violations	0,870	0,460	Enough Reliability
Safety Violations	0,879	0,597	Good Reliability
Stunts	0,973	0,902	Good Reliability
Accident	0,754	0,506	Good Reliability

Based on Table 5, it is found that the traffic errors, traffic violations, safety violations, stunts, and accidents variables have CR and AVE values that meet the cut-off value. Meanwhile, the control errors and speed violations variables only have one of the CR and AVE values that meet the cut-off value. If one of the values has been met, then it can be said that the variable has sufficient reliability and can proceed to the next analysis. [22].

The final test in the model evaluation stage is the structural model test, which aims to determine whether the model can be considered a good fit with the available data. If the goodness of fit values indicates a good fit, then the model can be accepted, and hypothesis testing can be conducted. However, if the goodness of fit values does not indicate a good fit, then the model needs to be respecified (modified) to achieve a better fit.

The model can be considered a good fit if there are at least 5 goodness of fit index values that meet the cut-off value. [22]. The results of the structural model test on the model can be seen in the Table. 6.

Table 6 Goodness of Fit Index Full Model

Goodness of Fit	Cut-off Value	Result	Criteria
Chi-Square	Expected Small	1906.66	Bad fit
Probability	≥0.05	0.000	Bad fit
CMIN/DF	≤2.00	2.273	Marginal fit
RMSEA	≤0.08	0.062	Good fit
GFI	≥0.90	0.771	Bad fit
AGFI	≥0.90	0.742	Bad fit
TLI	≥0.90	0.875	Marginal fit
CFI	≥0.90	0.884	Marginal fit
PCFI	≥0.50	0.821	Good fit
NFI	≥0.90	0.811	Marginal fit

Based on Table 6, it is found that only 2 goodness of fit index criteria meet the cut-off value. Therefore, it is necessary to respecify the model before proceeding to hypothesis testing.

E. MODEL RESPECIFICATION

Model respecification is carried out by correlating variables, indicators, or errors that have the highest Modification Indices (MI) values. After correlating 12 errors with the highest MI values, the full model in this study can be seen in Figure 3.

The results of the structural model test on the model that has been respecified, as shown in Figure 3, can be seen in Table 7.

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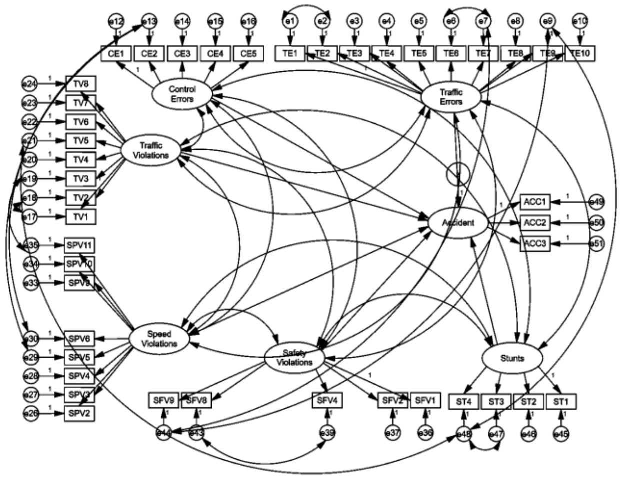

Figure 3 Full Model after Resprecification Step

Table 7 Goodness of Fit Index Full Model After Respecification

Goodness of Fit	Cut-off Value	Result	Criteria
Chi-Square	Expected Small	1643.049	Bad fit
Probability	>0.05	0.000	Bad fit
CMIN/DF	<2.00	1.987	Good fit
RMSEA	<0.08	0.055	Good fit
GFI	>0.90	0.806	Marginal fit
AGFI	>0.90	0.778	Bad fit
TLI	>0.90	0.903	Good fit
CFI	>0.90	0.911	Good fit
PCFI	>0.50	0.835	Good fit
NFI	>0.90	0.837	Marginal fit

Based on Table 7, 5 goodness of fit criteria meet the cut-off value, indicating that the model fits the available data and can proceed to hypothesis testing. A comparison of the goodness of fit values between the initial model and the fit model resulting from the respecification can be seen in Table 8.

Table 8 Comparison of Goodness of Fit Values Before and After Model Respecification

Goodness of Fit	Result of First Model	Result After Respecification Model	Information
Chi-Square	1906,66	1643,049	Better
Probability	0,000	0,000	Still
CMIN/DF	2,273	1,987	Better
RMSEA	0,062	0,055	Better
GFI	0,771	0,806	Better
AGFI	0,742	0,778	Better
TLI	0,875	0,903	Better
CFI	0,884	0,911	Better
PCFI	0,821	0,835	Better
NFI	0,811	0,837	Better

Hypothesis testing is conducted by testing the relationship values of each driving behavior variable on accidents through regression weights, which can be seen in Table 9.

Table 9 Regression Weight

Constructs			Estimate	C.R.	P
Accident	←	TE	-.136	-1.483	.138
Accident	←	CE	.090	.103	.918
Accident	←	TV	.840	2.977	.003
Accident	←	SPV	.023	.290	.772
Accident	←	SFV	.047	.449	.653
Accident	←	ST	.267	2.002	.045

The hypothesis is accepted, or the variable is considered to have a significant effect if the P-value < 0.05 or C.R. > 1.967 [19]. Meanwhile, the estimate value indicates the magnitude of the influence of the variable. In Table 8, there are two driving behavior variables that have an effect on accidents, namely TV (Traffic Violations) with P = 0.03 (< 0.05) and C.R. = 2.977 (> 1.967), and ST (Stunts) with P = 0.045 (< 0.05) and C.R. (2.002). Other variables do not meet the criteria, so they can be considered to have no effect (not significantly influential) on accidents.

The results in Table 9 also show positive and negative estimate values for driving behavior variables on accident are:

1. The behavior of Traffic Errors towards accidents is -0.136. This number indicates that for every increase of 1 unit in traffic errors, the accident rate decreases by 0.136. In other words, the more frequent the occurrence of traffic errors, the decrease in accidents, but this relationship is not reinforced because the result is not significant (p = 0.138 > 0.05).
2. The behavior of Control Errors towards accidents is 0.090. This number indicates that for every increase of 1 unit in control errors, the accident rate increases by 0.090. In other words, the more frequent the occurrence of control errors, the increase in accidents, but this relationship is not reinforced because the result is not significant (p = 0.918 > 0.05).
3. The behavior of Traffic Violations towards accidents is 0.840. This number indicates that for every increase of 1 unit in traffic violations, the accident rate increases by 0.840. In other words, the more frequent the occurrence of traffic violations, the increase in accidents, and this relationship is reinforced because the result is significant (p = 0.003 < 0.05).
4. The behavior of Speed Violations towards accidents is 0.023. This number indicates that for every increase of 1 unit in speed violations, the accident rate increases by 0.023. In other words, the more frequent the occurrence of speed violations, the increase in accidents, but this relationship is not reinforced because the result is not significant (p = 0.772 > 0.05).
5. The behavior of Safety Violations towards accidents is 0.047. This number indicates that for every increase of 1 unit in safety violations, the accident rate increases by 0.047. In other words, the more frequent the occurrence of safety violations, the increase in

accidents, but this relationship is not reinforced because the result is not significant (p = 0.653 > 0.05).

6. The behavior of Stunts towards accidents is 0.267. This number indicates that for every increase of 1 unit in stunts, the accident rate increases by 0.267. In other words, the more frequent the occurrence of stunts, the increase in accidents, and this relationship is reinforced because the result is significant (p = 0.045 < 0.05).

The variable that has the biggest influence and significant effect is the traffic violations variable. This supports previous research indicating that traffic violations are the main cause of traffic accidents. [23], [24].

CONCLUSIONS

Based on the previous analysis conducted, it was found that driving behavior variables that influence traffic accidents for young motorcycle riders (up to 24 years old) are traffic violations and stunts.

The higher the traffic violations committed, the likelihood of accidents increases by 0.840, which is reinforced by significant results (p = 0.003 < 0.05). Furthermore, the higher the dangerous actions performed by drivers and other road users (stunts), the likelihood of accidents increases by 0.267, which is also supported by significant results (p = 0.045 < 0.05).

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