Available online at www.CivileJournal.org

Civil Engineering Journal

(E-ISSN: 2476-3055; ISSN: 2676-6957)

Vol. 9, Special Issue, 2023

"Innovative Strategies in Civil Engineering Grand Challenges"

The Development of Motorcycle Accident Models Based on Riders' Characters

Margareth Evelyn Bolla [1*], Ludfi Djakfar [2], Achmad Wicaksono [2], Cleoputri Al Yusainy [3]

[1] *Department of Civil Engineering, Faculty of Science and Engineering, Nusa Cendana University, Kupang, Indonesia.*

[2] *Department of Civil Engineering, Faculty of Engineering, Brawijaya University, Malang, Indonesia*

[3] *Department of Psychology, Faculty of Social and Political Sciences, Brawijaya University, Malang, Indonesia*

Received 01 July 2023; Revised 04 December 2023; Accepted 15 December 2023; Published 26 December 2023

Abstract

Human errors have commonly been perceived as the dominant cause of accidents. Different individuals may behave differently towards certain situations, leading to accidents. This study aims to model the relationship between the riders' personalities, riding performance, and the probability of being involved in an accident. Adding mindfulness as a mediating variable and demographic factors as moderating variables are also essential points to developing the model. The Big Five Inventory (BFI) and Mindful Attention Awareness Scale (MAAS) were used to measure the respondents' traits, while the Honda Riding Trainer (HRT) was used as a simulation tool. The Structural Equation Modelling (SEM) analysis shows that only the neuroticism variable significantly predicts mindfulness and riding performance. The openness and conscientiousness variables only significantly predicted mindfulness, while agreeableness is the only Big Five personality that significantly predicted riding performance. The results also show that although the mindfulness (M) variable in this study has not been able to become a mediating variable, it is strong enough as an exogenous variable for riding performance. The logistic regression analysis found that the worse the rider's performance, the greater the chance of an accident. Female riders are more than twice as likely to have an accident as male riders. These results indicate the need to research road safety that is differentiated by sex and its characteristics based on it.

Keywords: Big Five Personality; Riding Simulator; Mindfulness; Mediating Variable; Moderating Variable.

1. Introduction

A global status report on road safety [1] shows that traffic accidents are still a severe problem worldwide. Even in the COVID-19 pandemic, the reduction in the accident fatality rate was only 8%, not as expected [2]. Worldwide, pedestrians and motorcyclists account for 28 percent of all deaths [3]. The same problem can also be found in Indonesia, which ranks third in Asia for the highest number of deaths due to traffic accidents. In fact, according to the WHO, when viewed from the statistical percentage of the population, Indonesia ranks first with a death rate due to traffic accidents of 0.015% of the total population, and most of the victims are motorcyclists. Based on data from the Central Statistics Agency (BPS) of Indonesia, from 2020 to 2022, after the pandemic, Indonesia experienced an

* Corresponding author: margiebolla@staf.undana.ac.id

http://dx.doi.org/10.28991/CEJ-SP2023-09-018

increase in traffic accidents and reached 103,645 incidents in 2021. In 2022, the number of fatalities in road traffic accidents in Indonesia was approximately 27.53 thousand, indicating an increase compared to the previous year [4]. Indonesia is one of the Association of Southeast Asian Nations (ASEAN) countries that has a relatively high death rate due to driving accidents on the road.

The fact that motorcycle accidents are the type of accident with the largest proportion, dominated by human factors as the cause of accidents, becomes the basis for thinking in this study. Humans as drivers have factors that influence driving behavior, namely, physiological factors related to the condition of the human body, such as the nervous system, sight, hearing, and other senses, as well as psychological factors, which include motivation, intelligence, experience, emotions, maturity, and habits.

Previous studies related to human factors as the cause of accidents have focused on demographic aspects such as gender, age, education level, and occupation [5–7]. Although the studies provide essential information, they must also provide good insights into aspects of riders' behavior that affect road safety [8]. However, the demographic variables studied have great potential as moderator variables [9, 10]. The variables are not the target of intervention in safety action programs. Different individuals may behave differently towards certain situations, which may be due to individual personality traits leading to accidents [11].

In psychology, personality has been modeled and grouped theoretically to describe individual characteristics that distinguish them from others. One such personality model is the Big Five, which was introduced by Goldberg in 1981. The Big Five theory is the most researched and used personality theory from the late 1980s to the present. The development of a personality taxonomy simplifies thousands of traits into five personality dimensions. The popular acronym for the Big Five is OCEAN, which are Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. The Big Five approach to personality is mainly based on research rather than theory; in other words, it is an inductive approach to personality in which the theory is generated from data [12]. These five dimensions do not provide completely exhaustive explanations of personality, but they are known as the Big Five because they encompass a large portion of personality-related terms. Each of the Big Five personality dimensions has several examples of traits that describe some characteristics of each trait based on high and low scores, as presented in Table 1 [13]:

Table 1. Some characteristics of the Big Five traits based on scores

Trait Scales	Low Scores	High Scores
Neuroticism	Anxious, Nervous, Emotional, Insecure, Feeling Inadequate, Fragile, Impulsive.	Calm, Relaxed, Secure, Satisfied with Himself, Emotionally Strong.
Extraversion	Optimistic, Easily Adapts to the Environment, Active, Talkative, Full of Affection.	Less Friendly, Authoritative, Likes to Be Alone, Task-Oriented, Quiet.
Openness	Curious, Broad Interest, Creative, Original, Imaginative, Untraditional.	Conventional, Simple, Narrow Interests, Unartistic, Closed, Conservative.
Agreeableness	Gentle, Trusting Others, Helpful, Forgiving, Obedient.	Cynical, Rude, Suspicious, Uncooperative, Vindictive, Mean, Manipulative.
Conscientiousness	Organized, Hardworking, Reliable, Disciplined, Punctual, Neat, Careful.	Aimless, Unreliable, Lazy, Reckless, Inattentive, Give Up Easily.

Previous research [14] discovered that certain elements of the Big Five dimensions, including altruism representing agreeableness, anxiety representing neuroticism, and sensation-seeking representing extraversion, could predict both mediating and endogenous variables. This suggests that personality traits influence risky driving behavior through their impact on attitudes that dictate driver behavior.

One concept considered to have important implications for the structure of human personality that helps a person train his attention and focus on wandering thoughts is mindfulness [15]. Mindfulness, rooted in the contemplative tradition of Buddhist beliefs [16], has been widely used in studying drivers and their behavior on the road [17]. Mindfulness has been proven effective as a person-oriented emotion regulation strategy to strengthen the individual's self-control capacity [18]. Emotion regulation can be understood as a process of intervention in emotional experiences that is useful for producing appropriate emotional responses, such as neutralizing negative emotions in the form of anger, which significantly increases the risk of increasing driving speed [19]. Mindfulness can be interpreted in two forms: a trait [20] and a state [21]. It can also be interpreted as a set of skills composed of traits and states that could be enhanced. In its position as a trait and state, mindfulness needs further investigation regarding its role in transportation safety. The potential of mindfulness as a mediating variable has been researched to see its usefulness in positive daily behavior [21, 22]. It gives a space that supports mindfulness training to be used as a therapy for motorcyclists in intervening with personality interventions [23, 24].

Research on how the psychological elements of a driver affect safe driving behavior on the road is constantly evolving. Investigating how driving performance directly impacts the probability of traffic accidents is essential. Much research has been carried out on driving performance for the development of four-wheeled vehicles, but the driving

performance of two-wheeled vehicle drivers, who require higher driving performance when driving than four-wheeled vehicle drivers, has yet to be studied in detail. One study that tried to quantify motorbike driving performance concerning the possibility of a collision was conducted by researchers from the Japan Automobile Research Institute [25]. In their research, riding simulators were used to investigate riding behavior. Several studies using the Honda Riding Trainer (HRT) simulation tool have been carried out to build a behavioral model of at-risk motorcyclists [26]. The use of HRT was found to reduce the number of accidents in a virtual environment due to increased hazard perception skills [27]. As a motorcycle riding simulation tool, it is also beneficial for psychophysical measurements [28].

The relationship between personality, riding behavior, and accident probability has been widely studied [29–31]; however, there is no clear pattern that describes how the overall dimensions of the Big Five personality affect the riders' performance using the Honda Riding Trainer (HRT) simulation tool. This study aims to produce a comprehensive model for describing the relationship between the personality of a motorcyclist, riding performance, and the probability of being involved in an accident. The addition of mindfulness as a mediating variable and demographic factors as moderating variables are also essential points in this study to complete the model to be developed.

2. Material and Methods

2.1. Participants

Data collection was carried out in Surabaya and Malang City, which represent East Java Province, Indonesia. As of October 2022, the province had the highest accident rate in Indonesia [32]. Since the HRT equipment belongs to PT Astra Honda Motor (AHM), data collection was carried out at PT AHM dealers by taking respondents from people who came to these dealers. Sampling was conducted on people who met the requirements needed in this study, namely, age > 18 years, having an active motorcycle license, and having experience riding a motorcycle for more than one year. The total number of respondents was 415, but 19 did not complete the questionnaire, so they were excluded from the analysis, leaving 396 respondents.

2.2. Measures and Procedures

This study used the Big Five Inventory (BFI) and Mindful Attention Awareness Scale (MAAS) questionnaires as personality measures. The BFI scale consists of 28 indicators that have previously been adapted into Indonesian and have been tested for validity and reliability [33], while the MAAS scale (Brown & Ryan, 2003), which consists of 15 indicators, is a scale that has also been adapted to Indonesia [34]. Both questionnaires use a Likert scale, where the BFI uses a 7-point Likert scale from "strongly agree," which is valued at 1, to "strongly disagree," which is valued at 7. The MAAS questionnaire uses 6 points from "almost always," which is valued at 1, until "very rarely," which is valued at 6. The BFI value is calculated by scaling and scoring [35], where the smallest value indicates the most dominant character of the respondents.

The HRT simulator is the tool chosen to represent the actual situation on the highway. Research has shown that driving simulators have proven to be excellent practical educational tools and are effective in training all motorists in safe driving techniques [25, 26, 36]. As shown in Figure 1, this motorcycle simulator is like a computer game, consisting of a computer with software, motorcycle handlebars, transmission pedals, seats, and a video monitor. HRT users can choose the type of motorcycle to be used in the simulation, such as automatic transmission, duck (cub), or motorsport, and can also choose riding times, such as day, night, or foggy. The simulation program for this HRT consists of six (6) types of scenarios; each scenario has a different road map and traffic situation but has relatively the same challenge weight. In each scenario, respondents will encounter many cases on the road, such as pedestrians suddenly crossing, taxis suddenly pulling over and stopping, trucks opening their doors carelessly, vehicles suddenly turning around, and many others. At the end of the HRT session, two (2) evaluation outputs will be issued in the form of: 1. the riders' performance, namely the driver's behavior score in each simulation scenario; and 2. the result of whether the driver had an accident or not.

(a) (b)

Figure 1. Honda Riding Trainer (HRT): (a) The simulator tools; and (b) Its interface

Each respondent was given 10 minutes to practice on the exercise program before being tested on the road program with a predetermined time choice; it was done as a form of control over the research. In each simulator scenario, riding performance, errors, accidents, and road code violations are logged automatically. Riding performance is assessed on a four-level scale [26], which is adjusted for the results of the HRT simulator tool, namely: A = 3, which means safe behavior (no accidents, hazards avoided without braking hard or approaching other vehicles, following the speed limit), B = 2, which means precautionary behavior (not following the speed limit, braking hard, approaching other vehicles), C = 1, which means dangerous behavior (violating violently near other vehicles), and D = 0, which means having an accident. Another output obtained from this HRT is whether or not the driver had an accident.

The analysis carried out in this study is divided into two parts: the first is SEM analysis using WarpPLS 5.0 software to model the dynamics of the relationship between the rider's character (BF) and riding performance by adding mindfulness as a mediating variable and 3 (three) moderating variables, namely the age of the driver (Ma), the age when he started riding (Ms), and accident history (Mh). Then, logistic regression analysis was carried out with IBM SPSS Statistics 23.0 to form a motorcycle accident probability model. The 95% significance level is a criterion for estimating model parameters. This study produced 2 (two) models, where the purpose of each model analysis, analysis method, and variables are presented in Table 2, and the theoretical framework as seen in Figure 2.

Table 2. Models aim, methods, and variables

Aims	Analysis method	Variable Types	Variable Names (Symbol)	Measuring Scale	Coding/Weight
To model the relationship between riders' personalities and riding performance	Structural Equation Modeling (SEM) with WarpPLS 5.0	Endogenous	Riding performance (P)	Ordinal	A = 3 B = 2 C = 1 D = 0
		Exogenous	Openness (Xo)	Ordinal	Xo1 - Xo6
			Conscientiousness (Xc)	Ordinal	Xc1 - Xc6
			Extraversion (Xe)	Ordinal	Xe1 - Xe5
			Agreeableness (Xa)	Ordinal	Xa1 - Xa7
			Neuroticism (Xn)	Ordinal	Xn1 - Xn4
		Mediation	Mindfulness (M)	Ordinal	M1 - M15
		Moderation	Age (Ma)	Ratio	
			Age when start riding (Ms)	Ratio	
			Accident history (Mh)	Interval	
To model the probability of a motorcyclist crash	Logistic Regression with IBM SPSS Statistics 23.0	Endogenous	Probability of having an accident (Y)	Nominal	Accident (0) No accident (1)
		Exogenous	Riding performance (P)	Ordinal	A = 3 B = 2 C = 1 D = 0
			Gender (G)	Nominal	Female (0) Male (1)
			Motorcycle Transmission Type (T)	Nominal	Manual (0) Matic (1)

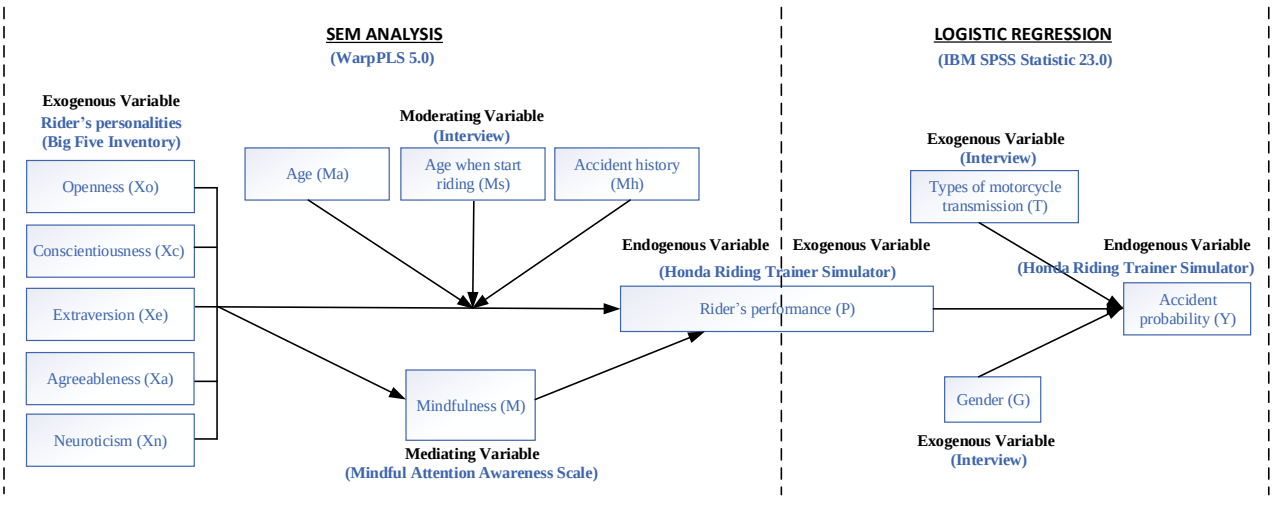

Figure 2. Theoretical Framework

3. Results and Discussion

3.1. Descriptive Analysis

The majority of the respondents (79%) were male (Figure 3), and Figure 4 shows that the automatic transmission motorcycle is the most widely used by the respondents (57%).

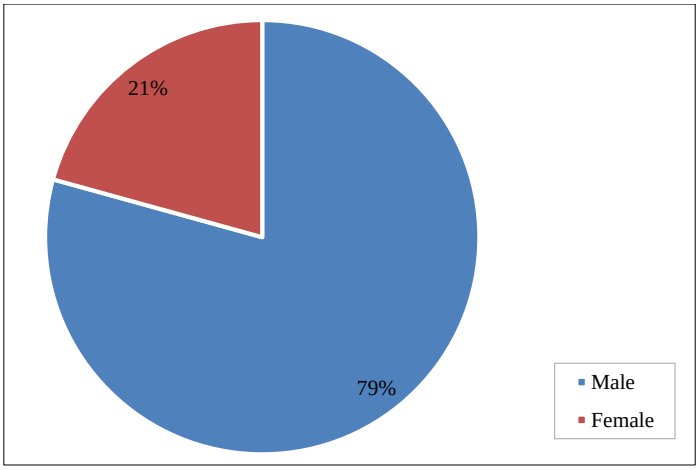

Figure 3. Gender

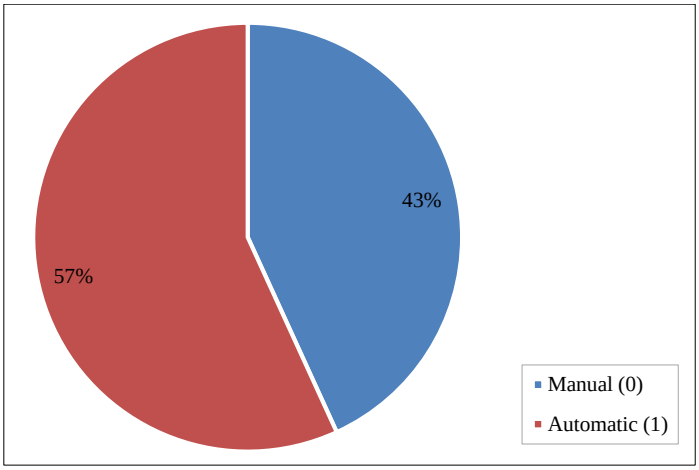

Figure 4. Motorcycle transmission type

The age of the riders ranges from 18 to 56 years old, and the average age is 24 years old (mean (M)=23.677, standard deviation (SD)=2.963). Meanwhile, 91% of the respondents were 18-29 years old (Figure 5). Moreover, most respondents (71%) have ridden a motorcycle before 17 years old. The age when they started riding a motorcycle was from 7 to 38 years old (M=15.311, SD=1.991) (Figure 6); in fact, the minimum age for gaining a driving license in Indonesia is 17 years old.

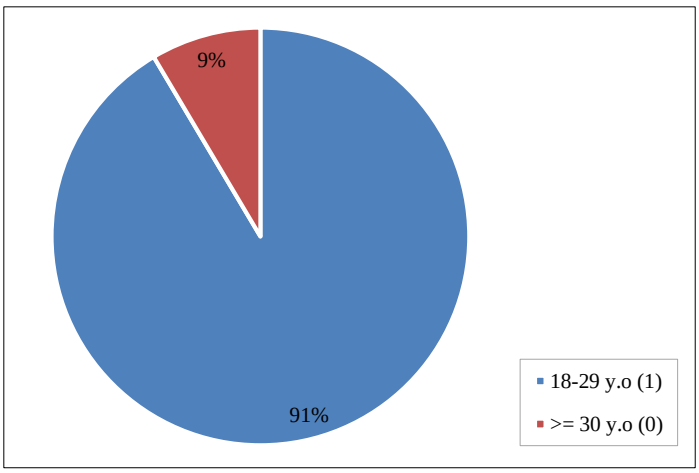

Figure 5. Age

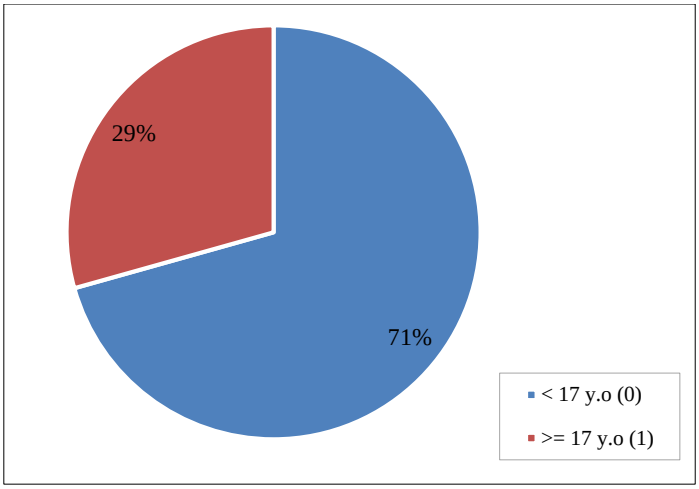

Figure 6. Age to start riding

The accident history data based on the questionnaire show that 41% of respondents (M=1.457, SD=1.008) have never been involved in an accident (Figure 7). Meanwhile, the rider personality data based on the Big Five inventory shows that most riders have the dominant personality of agreeableness (46%) and the most minor personality of neuroticism (Figure 8).

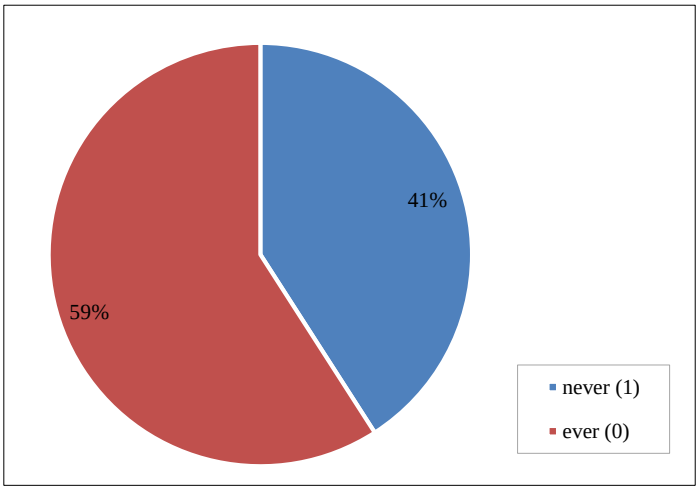

Figure 7. Accident history

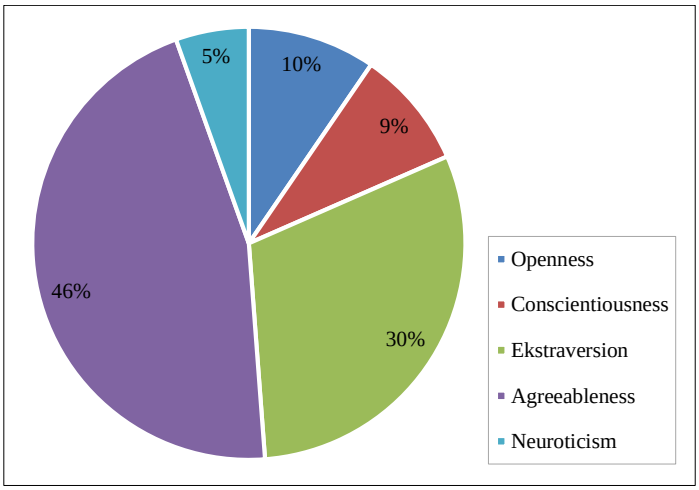

Figure 8. Rider's personality

Riding simulation results using the Honda Riding Trainer (HRT) are presented based on the riders' performance category (Figure 9) and their experience of an accident (Figure 10). The survey has revealed that the majority (46%) of

the riders' performance is in category B, indicating precautionary behavior (not following the speed limit, braking hard, and approaching other vehicles). Meanwhile, 41% of the riders have an accident on the HRT simulator.

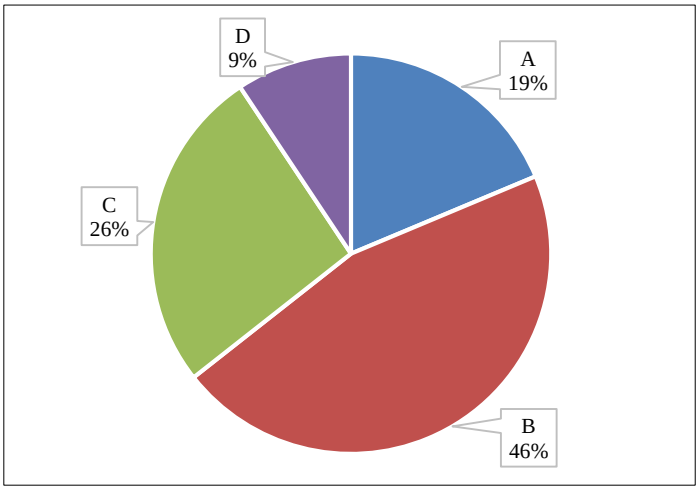

Figure 9. Rider's performance

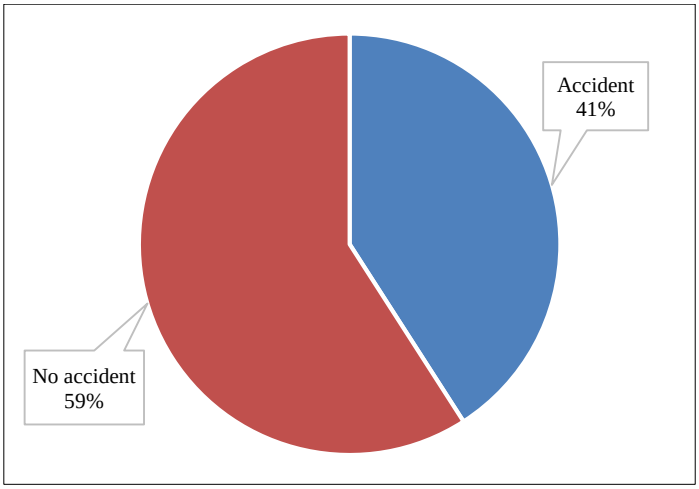

Figure 10. Simulation result

3.2. SEM Analysis

3.2.1. Confirmatory Factor Analysis

Adaptation of the BFI and MAAS personality measurement tools into Indonesian so that they are more appropriate to the language style and cultural context of Indonesia is carried out by setting the Chi-square ($\chi 2$) criteria, which are expected to be small, $p \geq 0.05$, The Root Mean Square Error of Approximation (RMSEA) ≤ 0.05, Comparative Fit Index (CFI) ≥ 0.90 and The Root Mean Square Residual (RMR) ≤ 0.05. Reliability testing is carried out by looking at the Composite Reliability (CR) value; namely, if the CR value is > 0.7 or Cronbach's Alpha value > 0.6, then the variable is declared reliable [33, 34, 37].

3.2.2. The Goodness of Fit Model

The goodness of fit model in WarpPLS is carried out using the coefficient of determination (R-Square) and the Q-Square predictive relevance (Q-Square). The R-squared values of the goodness of fit model analysis showed that the BF variable (Xo, Xc, Xe, Xa, Xn) contributes to the mindfulness variable by 36.2% and that the riding performance variable can be explained by BF, the mindfulness variable, and the moderating variable by 28%. The remaining 63.8% and 72% values are contributions from other factors not discussed in this study. Then, the Q-squared of mindfulness variables and the riding performance are positive, indicating that exogenous variables can predict endogenous variables.

3.2.3. Direct Effect Hypothesis Testing

The path diagram for the results of the testing is shown in Figure 11. Converting the path diagram to a structural model in the following mathematical equation model (Equation 1):

$$M = -0.118\ Xo - 0.261\ Xc + .037\ Xe - 0.069\ Xa + 0.394\ Xn \quad (1)$$

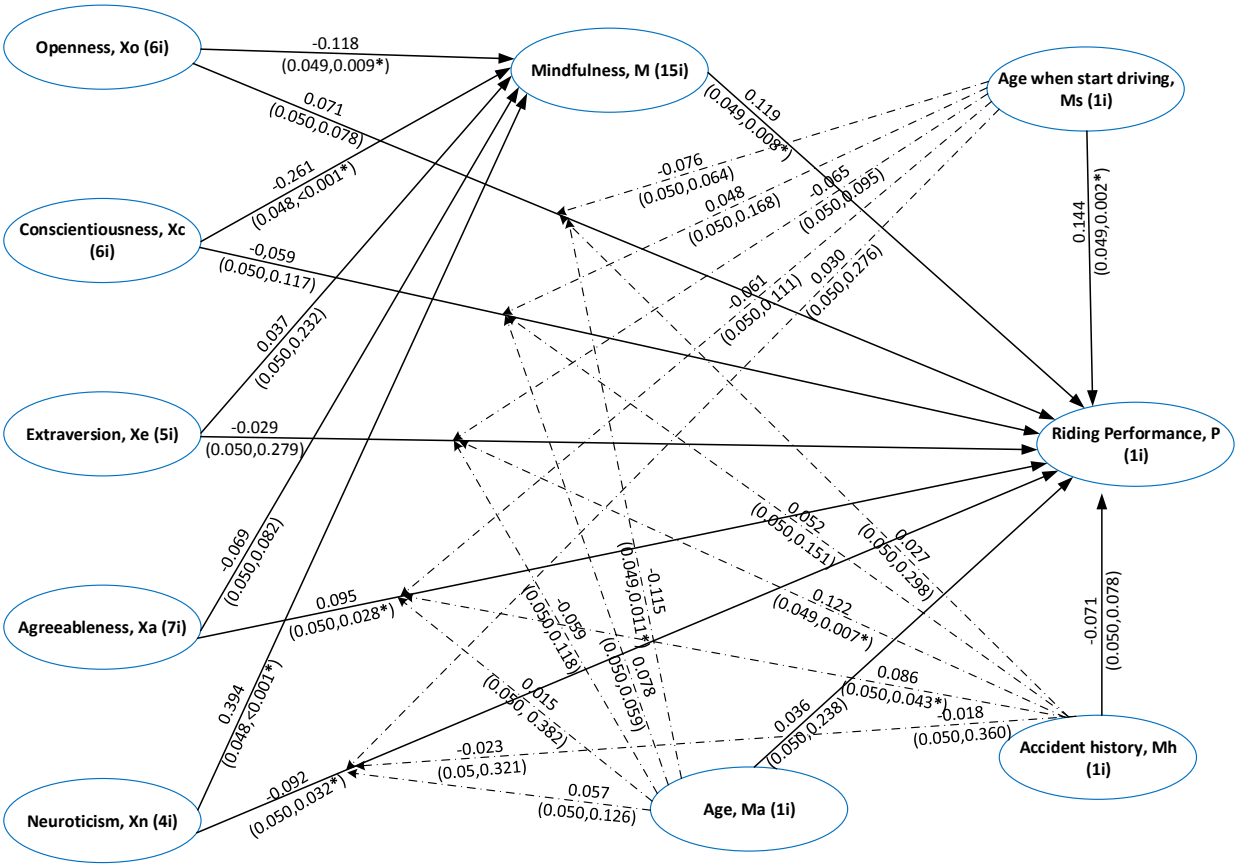

Figure 11. Path Diagram (Note: $\frac{path\ coefficient}{(standard\ error, p-value)}$**, * p < .05)**

From Equation 1, it can be seen that of the five Big Five Personality dimensions, only the Openness, Conscientiousness, and Neuroticism variables are significantly correlate with mindfulness. As shown in Table 1, someone with the dominant trait of Openness tends to have curiosity, broad interests, creativity, originality, imagination, and non-traditionalness. The positive correlation of openness with mindfulness shows that someone who is dominant in the trait of openness will find it easier to be mindful on the road, meaning that he or she will be more attentive and alert to traffic situations. Positive values also apply to the conscientiousness trait, which can be interpreted as the riders who are dominant in conscientiousness acting in line with mindfulness, for example, responding effectively rather than reacting impulsively or habitually [13]. Neuroticism is a BF trait that resists attention negatively. Neurotic individuals tend to have an anxious driving style and consider other drivers as an additional source of stress [38], in contrast to mindful individuals with a more remarkable ability to tolerate various thoughts, emotions, and experiences [39]. This result strengthens a previous meta-analysis of the relationship between mindfulness and the Big Five personality traits, the results of which showed similar positive and negative values in the correlation [40]. The correspondence between each dimension trait and how the relationship occurs between BF and mindfulness in this study provides additional knowledge for researchers who are trying to reconsider how mindfulness is conceptualized in relation to established, well-understood constructs such as the Big Five personality traits and its positive and negative affect [41]. This will be an important insight to explore for researchers to continue to learn more about mindfulness.

The coefficient for the relationship between the mindfulness variable and riding performance, as seen in the path diagram (Figure 11), is 0.119, so:

$$P = 0.071\ Xo - 0.059\ Xc - 0.029\ Xe + 0.095\ Xa - 0.092\ Xn + 0.119\ M \quad (2)$$

From Equation 2 and the p-value in Figure 11, it can be seen that the variables significantly correlated with riding performance are two (2) dimensions of BF (Agreeableness and Neuroticism) and Mindfulness. In contrast to agreeableness and mindfulness, which have positive values, neuroticism has a negative correlation with riding performance, which means that the dominant trait of neuroticism of the riders will reduce their riding performance. These results contributed to the differences compared to previous studies [42], which showed that together, these five factors accounted for 38% of Risky Driving Behavior (RDB). In contrast, in another study [43], it was found that there

were only 3 (three) significant factors (neuroticism, agreeableness, and conscientiousness). Another study showed that there is a positive effect of neuroticism and a negative effect of agreeableness and conscientiousness on RDB [44], while trait extraversion has no significant effect on RDB [14].

Direct effect hypothesis testing is also carried out to see the role of moderator variables in strengthening or weakening the relationship between variables. For the moderating variable, there are three significant correlations in the moderating relationship between personality variables (Big Five) and riding performance (Table 3), while the only significant moderating variable on riding performance is the age when start riding (Figure 11).

Table 3. Moderating results of the Big Five variables on riding performance

Exogenous	Moderator	Path Coefficient	SE	p-Value	Moderation Type
Openness	Age	-0.115	0.049	0.011*	Absolute
Agreeableness	Accident history	0.086	0.05	0.043*	Pure
Extraversion	Accident history	0.122	0.049	0.007*	Absolute

Note: * p <0.05

Based on Table 3, it can be explained that the age variable is an absolute moderating variable, which means that the existence of this variable is needed so that the openness variable is significantly correlated with riding performance. The same type of moderation also applies to the accident history variable, which moderates the extraversion variable on riding performance. Accident history can also play a pure role only as a moderating variable (pure moderation), which moderates the agreeableness variable to correlate with riding performance significantly. For the variable of age when starting to ride, the analysis results show that this variable, originally hypothesized as a moderating variable, turns out to be significantly correlated as an exogenous variable with riding performance. The significance of the age variable as a moderating variable is in line with the research of Haerani et al. [45] and Mahachandra et al. [46], which found that the higher the age, the stronger the influence of personality on driving behavior. The same personality may influence driving behavior and driving outcomes at different age levels for different drivers. At a young age, drivers with a patient, calm, friendly, tolerant character and the ability to avoid conflict can behave recklessly on the road and commit traffic violations that can cause accidents.

Since age plays a significant role in influencing the strength of the relationship between personality and riding behavior, it is necessary to implement safety policies based on the driver's age. Descriptive data in Figure 6, which shows that almost 30% of motorists start riding motorbikes under the minimum age to obtain a driving license, shows that there should be an extra concern for teenage riders. This concern could be in the form of introducing traffic rules from an early age, which can be done by including traffic safety material in the school curriculum from elementary school.

3.2.4. Indirect Effect Hypothesis Testing and Dominant Effect

The indirect coefficient results from multiplying the direct coefficient of BF traits-Mindfulness with the direct coefficient of Mindfulness-Riding Performance. The results of testing the indirect influence hypothesis (Table 4) show that the mindfulness variable is not significant in mediating the relationship between the Big Five personality and the riding performance of motorcyclists.

Table 4. The results of direct and indirect effect hypothesis testing and dominant effect

Exogenous	Mediator	Endogenous	Coefficient			SE	p-value
			Direct	Indirect	Total		
Openness		Mindfulness	-0.118		-0.118	0.049	0.009*
Conscientiousness		Mindfulness	-0.261		-0.261	0.048	<0.001*
Extraversion		Mindfulness	0.037		0.037	0.050	0.232
Agreeableness		Mindfulness	-0.069		-0.069	0.050	0.082
Neuroticism		Mindfulness	0.394		0.394	0.048	<0.001*
Openness	Mindfulness	Riding Performance	0.071	-0.014	0.057	0.035	0.346
Conscientiousness	Mindfulness	Riding Performance	0.059	-0.031	-0.091	0.035	0.190
Extraversion	Mindfulness	Riding Performance	-0.029	0.004	-0.025	0.036	0.451
Agreeableness	Mindfulness	Riding Performance	0.095	-0.008	0.087	0.035	0.408
Neuroticism	Mindfulness	Riding Performance	-0.092	0.047	-0.045	0.035	0.092
Mindfulness		Riding Performance	0.119		0.119	0.049	0.008*

Note: * p <.05

This study has not succeeded in showing the role of mindfulness as a mediator of BF on riding performance; however, from Figure 11, it could be seen that mindfulness is a significant exogenous variable that is positively correlated with riding performance, which supports the earlier research [20, 40]. This finding is interesting because, as previously discussed, there is a correspondence between the personality constructs of BF personality and mindfulness. In contrast to the definition of the BF trait, which is conventionally assumed to be a relatively stable personality trait, research related to mindfulness shows that the mindfulness personality can change over time as a result of life experiences or through mindfulness practice [23, 47, 48]. It is also quite interesting to see the results of previous research [49] where the mindfulness variable is placed as an exogenous variable while BF is the mediator, showing the results that conscientiousness and neuroticism significantly mediated the effects of the relationship between the subject's mindfulness levels and the riding performance. These variations of mindfulness position as a variable supply a space to conduct more research regarding how mindfulness training could be used as a therapy for motorcyclists in intervening with personality interventions.

The total coefficient value is also presented in Table 4, which results from the sum of the direct and indirect coefficients. From Figure 11, the neuroticism variable has the most significant coefficient value (0.394) compared to the mindfulness variable. Thus, neuroticism has the most dominant influence on mindfulness. Furthermore, the variable with the most significant total coefficient on riding performance is conscientiousness, with a total coefficient of 0.091. Neuroticism is a negative character characterized by individuals who are easily nervous, often feel worried, easily tensed, and easily depressed. At the same time, conscientiousness is a positive character characterized by being reliable, responsible, diligent, and achievement-oriented individuals [33]. This result differs from previous research conducted in Indonesia [45], indicating that agreeableness is the BF variable with the most dominant influence on driving performance. Overall, SEM analysis reveals that the Big Five are quite powerful in directly predicting the mindfulness and riding performance of motorcyclists.

3.3. Logistic Regression Analysis

In this analysis, the 'no accident' category (coding 0) becomes the reference category, with 162 respondents (41%) who have never had an accident. The contribution of riding performance, gender, and motorcycle type variables to accident probability is obtained from the coefficient of determination of the Nagelkerke R-Square, which is .507 or 50.7%. This means that these variables contribute 50.7%, while the rest are influenced by other variables not discussed in this study. The simultaneous test gives the chi-square value for the whole model 186,822 with a p-value < 0.001* significance level. This means that the model simultaneously significantly influences the chance of an accident. At the same time, for the partial significance test, the value shows that the variable Motorcycle Transmission Type (T) is not significant (Table 5). Therefore, it is excluded from the estimation model (Equation 3).

Table 5. Results of partial significance test

Variable	Likelihood ratio test			
	B	Wald	df	Sig.
Intercept	5.693	72.509	1	< 0.001*
Riding Performance (P)	-2.447	83.625	1	< 0.001*
Gender (G)	-0.726	4.637	1	0.031*
Motorcycle Transmission Type (T)	-0.214	0.613	1	0.434

The probability model for a motorcyclist accident is:

$$Log\ (Prob(Y1)/Prob(Y0)) = 5.693 - 2.447\ P - 0.726\ G \quad (3)$$

Based on the calculation of the logistic regression using Equation 3, as shown in Table 6, it is found that for the same level of performance, female riders contribute more than double the probability of having an accident than male drivers. Although this result is in line with previous research [50], however different from most of the previously published studies [51–54], which state that male drivers are the most at-risk and most involved in accidents. The difference in this finding may be related to the unequal gender distribution in the sample. Since 79% of the sample were male participants (Figure 3), a female's road crash during the test would have stronger gender effects. The unequal gender distribution of the sample may exert a significant bias in this finding. Another finding from logistic regression analysis was that the worse the rider's performance, the higher the chance of having an accident. This result is in line with previous studies, namely that the chance of a person having an accident is strongly influenced by driving performance [45].

Table 6. Probability of having an accident (time) based on riding performance and gender

Riding Performance	Male	Female
A	0.093	0.192
B	1.076	2.718
C	12	25
D	136	296

This study and many previous studies on personality factors analyzed based on the Big Five personality in relation to traffic safety tend to give varying results. This can happen, which may not only be due to different analytical tools and methods but also shows how human personality is a very complex subject. Some of the limitations of this research are due to the restrictions on the COVID-19 pandemic, so the respondents involved are not varied enough. Respondents who are primarily young drivers who see the HRT simulation tool as a game tool also make them less serious during the simulation. However, the experiment with the HRT simulator is not the same as the actual driving test. Thus, it may not be appropriate to investigate driving behavior that may differ from typical driving behavior on the road. Still, driving simulator experiments are necessary to control for multiple scenarios and many experimental variables. The use of HRT in this study is an approach method that seeks to provide insight into the results of using HRT in analyses of motorcycle rider performance in relation to traffic accidents. Considerations for using HRT in future studies include applying more realistic situation settings, perhaps ambient sounds and outdoor conditions, as well as selecting respondents who are serious about carrying out the simulation and a longer adaptation time with the tool.

Another reason for the varying results might be the location of this study, Indonesia, which is a middle-income country [55], where personality measurements based on the Big Five inventory show contrasting differences in validity levels between respondents with low and high education, as well as distortion of measurement results related to the interaction of respondents with surveyors [56]. The results of this study were obtained without filtering out possible outliers due to unreliable respondents. For this reason, it is recommended that further research be carried out by filtering the data, one of which is by eliminating the highest and lowest values of 5% of the total value of the questionnaire. Overall, SEM analysis reveals that the Big Five are quite powerful in directly predicting the mindfulness and riding performance of motorcyclists.

4. Conclusion

This study contributes results that are able to describe the dynamics of the relationship between psychological traits, riding performance, and the probability of being involved in an accident. SEM analysis shows that only the neuroticism variable predicts mindfulness and riding performance significantly. The openness and conscientiousness variables only significantly predicted mindfulness, while agreeableness was the only BF personality that significantly predicted riding performance. The mindfulness variable, which in this study is expected to play a significant role as a mediator of the BF variable on riding performance, has not been able to become a mediating variable but is significantly strong enough as an exogenous variable for riding performance. This finding shows that although mindfulness has become a popular concept in the last decade, due to the broad scope of human personality, further research is needed on the effect of mindfulness related to its role both as a trait and, especially, as a state quicker to intervene in the form of interventions so that it can improve riding performance.

The logistic regression analysis found that the worse the rider's performance, the higher the chance of having an accident, and female riders contribute more than double the possibility of having an accident than male riders. These results indicate the need to conduct research on road safety that is differentiated by sex and their characteristics based on it. This research, with a combination of endogenous, exogenous, mediator, and moderator variables, as well as a combination of analytical methods and the use of simulators, is one of the first in Indonesia and certainly requires further validation.

5. Declarations

5.1. Author Contributions

Conceptualization, B.M.E., D.L., and Y.C.A.; methodology, D.L. and Y.C.A.; software, B.M.E. and W.A.; formal analysis, B.M.E.; writing—original draft preparation, B.M.E.; writing—review and editing, D.L. and Y.C.A.; visualization, W.A.; supervision, D.L. and W.A. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

5.4. Conflicts of Interest

The authors declare no conflict of interest.

6. References

[1] WHO. (2023). Transport systems need to be made safe, healthy and sustainable. World Health Organization (WHO), Geneva, Switzerland. Available online: https://www.who.int/news/item/15-05-2023-transport-systems-need-to-be-made-safe--healthy-and-sustainable (accessed on January 2023).

[2] ITF. (2019). Road Safety Annual Report 2021: The Impact of Covid-19. International Transport Forum (ITF): OECD Publishing, Paris, France.

[3] WHO. (2018). Global Status Report on Road Safety 2018. World Health Organization (WHO), Geneva, Switzerland. Available online: https://www.who.int/publications/i/item/9789241565684 (accessed on January 2023).

[4] Statista. (2022). Indonesia: Number of Fatalities in Traffic Accidents 2021 | Statista, Hamburg, Germany. Available online: https://www.statista.com/statistics/979068/indonesia-number-of-fatalities-traffic-accidents/ (accessed on January 2023).

[5] Lakhan, R., Pal, R., Baluja, A., Moscote-Salazar, L. R., & Agrawal, A. (2020). Important Aspects of Human Behavior in Road Traffic Accidents. Indian Journal of Neurotrauma, 17(02), 085–089. doi:10.1055/s-0040-1713079.

[6] Sagar, S. (2020). Effect of Socioeconomic and Demographic Factors of Driver Residence on Crash Occurrence. Ph.D. Thesis, University of Kentucky, Lexington, United States.

[7] Tahmasebi, S., Javadi, S. M. H., Azari Arghun, T., Edrisi, F., & Tajlili, A. (2020). Identification of Factors Contributing to Traffic Accidents amongst Girls in Tehran with Specific Focus on Psychosocial Factors. Bulletin of Emergency and Trauma, 8(1), 19–26. doi:10.29252/beat-080104.

[8] Zuraida, R., Iridiastadi, H., & Sutalaksana, I. Z. (2017). Indonesian drivers' characteristics associated with road accidents. International Journal of Technology, 8(2), 311–319. doi:10.14716/ijtech.v8i2.6148.

[9] Lucidi, F., Girelli, L., Chirico, A., Alivernini, F., Cozzolino, M., Violani, C., & Mallia, L. (2019). Personality Traits and Attitudes Toward Traffic Safety Predict Risky Behavior Across Young, Adult, and Older Drivers. Frontiers in Psychology, 10. doi:10.3389/fpsyg.2019.00536.

[10] Trapsilawati, F., Priatna, N. U., Wijayanto, T., Widyanti, A., Syafitri, U. D., & Chamidah, N. (2021). Examining drivers' socio-demographic variables and perceptions towards sanction mechanisms on speeding behaviour on highways: Targeting appropriate prevention. Journal of Navigation, 74(4), 726–737. doi:10.1017/S0373463321000217.

[11] Goyal, R., Kumar, V., Shantanu, K., Walliullah, S., Singh, S., & Singh, A. (2015). Analysis of personality traits in patients of road traffic accident (RTA) with special reference to motorcycle riders. Clinical Epidemiology and Global Health, 3, S54–S57. doi:10.1016/j.cegh.2015.10.010.

[12] Friedman, H. S., & Schustack, M. W. (2020). Personality Classical Theory and Modern Research. Repositori IAIN Batusangkar. Available online: https://repo.iainbatusangkar.ac.id/xmlui/handle/123456789/18173. (In Indonesian).

[13] McCrae, R. R., & John, O. P. (1992). An Introduction to the Five- Factor Model and Its Applications. Journal of Personality, 60(2), 175–215. doi:10.1111/j.1467-6494.1992.tb00970.x.

[14] Cellar, D. F., Nelson, Z. C., & Yorke, C. M. (2000). The five-factor model and driving behavior: Personality and involvement in vehicular accidents. Psychological Reports, 86(2), 454–456. doi:10.2466/pr0.2000.86.2.454.

[15] Hanley, A. W., & Garland, E. L. (2017). The Mindful Personality: a Meta-analysis from a Cybernetic Perspective. Mindfulness, 8(6), 1456–1470. doi:10.1007/s12671-017-0736-8.

[16] Grossman, P. (2015). Mindfulness: Awareness Informed by an Embodied Ethic. Mindfulness, 6(1), 17–22. doi:10.1007/s12671-014-0372-5.

[17] Abdul Hanan, S., King, M., & Lewis, I. (2010). Are you a mindful driver? A review of the potential explanatory value of mindfulness in predicting speeding behaviour. Proceedings of the 2010 Australasian Road Safety Research, Policing and Education Conference, 31 August – 3 September 2010, Canberra, Australia.

[18] Yusainy, C., Nurwanti, R., Dharmawan, I. R. J., Andari, R., Mahmudah, M. U., Tiyas, R. R., Husnaini, B. H. M., & Anggono, C. O. (2019). Mindfulness as an Emotion Regulation Strategy. Journal of Psychology, 17(2), 174. doi:10.14710/jp.17.2.174-188.

[19] Hu, T. Y., Xie, X., & Li, J. (2013). Negative or positive? the effect of emotion and mood on risky driving. Transportation Research Part F: Traffic Psychology and Behaviour, 16, 29–40. doi:10.1016/j.trf.2012.08.009.

[20] Cardaciotto, L., Herbert, J. D., Forman, E. M., Moitra, E., & Farrow, V. (2008). The assessment of present-moment awareness and acceptance: The philadelphia mindfulness scale. Assessment, 15(2), 204–223. doi:10.1177/1073191107311467.

[21] Keng, S. L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. Clinical Psychology Review, 31(6), 1041–1056. doi:10.1016/j.cpr.2011.04.006.

[22] Yusainy, C., Ilhamuddin, I., Ramli, A. H., Semedi, B. P., Anggono, C. O., Mahmudah, M. U., & Ramadhan, A. R. (2018). Between Here-and-Now and Hereafter: Mindfulness as a Guard of Orientation towards Life and Fear of Death. Journal of Psychology, 17(1), 18. doi:10.14710/jp.17.1.18-30.

[23] Kiken, L. G., Garland, E. L., Bluth, K., Palsson, O. S., & Gaylord, S. A. (2015). From a state to a trait: Trajectories of state mindfulness in meditation during intervention predict changes in trait mindfulness. Personality and Individual Differences, 81, 41–46. doi:10.1016/j.paid.2014.12.044.

[24] Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2016). Traits and states in mindfulness meditation. Nature Reviews Neuroscience, 17(1), 59. doi:10.1038/nrn.2015.7.

[25] Lee, J., Kishino, S., & Suzuki, K. (2020). Riding performance quantification method for motorcycles in terms of collision probability using the logit model. Mechanical Engineering Journal, 7(4), 20-00015. doi:10.1299/mej.20-00015.

[26] Di Stasi, L. L., Álvarez-Valbuena, V., Cañas, J. J., Maldonado, A., Catena, A., Antolí, A., & Candido, A. (2009). Risk behaviour and mental workload: Multimodal assessment techniques applied to motorbike riding simulation. Transportation Research Part F: Traffic Psychology and Behaviour, 12(5), 361–370. doi:10.1016/j.trf.2009.02.004.

[27] Vidotto, G., Bastianelli, A., Spoto, A., Torre, E., & Sergeys, F. (2008). Using a riding trainer as a tool to improve hazard perception and awareness in teenagers. Advances in Transportation Studies, 16, 51–60.

[28] Surya, A. Z., & Bagaskara, S. (2017). The Effect of the Emotion of Fear on Risk Perception in Motorcycle Riders: A Study Using a Simulator. Symposium XIX FSTPT, Jakarta, Indonesia.

[29] Čubranić-Dobrodolac, M., Lipovac, K., Čičević, S., & Antić, B. (2017). A Model for Traffic Accidents Prediction Based on Driver Personality Traits Assessment. PROMET - Traffic; Transportation, 29(6), 631–642. doi:10.7307/ptt.v29i6.2495.

[30] Rahardjo, I. A., & Kusumawardhani, D. E. (2020). Relationship Between Sensation Seeking and Attitude on Reckless Riding Behavior in Jabodetabek, Indonesia. Psychological Research on Urban Society, 3(2), 120. doi:10.7454/proust.v3i2.75.

[31] Shen, B., Qu, W., Ge, Y., Sun, X., & Zhang, K. (2018). The relationship between personalities and self-report positive driving behavior in a Chinese sample. PLoS ONE, 13(1), 1–16. doi:10.1371/journal.pone.0190746.

[32] Korlantas. (2022). Statistik Laka - Korlantas Polri, Indonesia. Available online: https://pusiknas.polri.go.id/ (accessed on January 2023).

[33] Ramdhani, N. (2012). Linguistic and cultural adaptation of the big five personality scales. Jurnal Psikologi, 39(2), 189-205. doi:10.22146/jpsi.6986. (In Indonesian).

[34] Yusainy, C. A. L. (2013). Overcoming Aggression: Musing On Mindfulness and Self-Control. Ph.D. Thesis, University of Nottingham, Nottingham, United Kingdom.

[35] Lubis, S. M. (2015). Relationship between Big Five Personality, Motivation and Organizational Citizenship Behavior (OCB) in Employees at Hospital X Bandung. Ph.D. Thesis, Universitas Pendidikan Indonesia, Bandung, Indonesia.

[36] Papantoniou, P. (2013). Assessment of Driving Simulator Studies on Driver Distraction, Road Safety and Simulation International Conference, 22-25 October, Rome, Italy.

[37] Placebo Research Group. (2023). Mindfulness attention awareness scale (MAAS), Placebo Research Group. Available online: https://placeboresearchgroup.org/translated-scales/ (accessed on June 2023).

[38] Taubman-Ben-Ari, O., Mikulincer, M., & Gillath, O. (2004). The multidimensional driving style inventory - Scale construct and validation. Accident Analysis and Prevention, 36(3), 323–332. doi:10.1016/S0001-4575(03)00010-1.

[39] Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. Psychological Inquiry, 18(4), 211–237. doi:10.1080/10478400701598298.

[40] Giluk, T. L. (2009). Mindfulness, Big Five personality, and affect: A meta-analysis. Personality and Individual Differences, 47(8), 805–811. doi:10.1016/j.paid.2009.06.026.

[41] Thompson, B. L., & Waltz, J. (2007). Everyday mindfulness and mindfulness meditation: Overlapping constructs or not? Personality and Individual Differences, 43(7), 1875–1885. doi:10.1016/j.paid.2007.06.017.

[42] Idris, F., & Napitupulu, L. (2015). The Influence of Personality Factors, Work Stress on Road Accidents among Bus Drivers in Riau Province. An-Nafs, 9(3), 56-67. (In Indonesian).

[43] Triman, A., & Bagaskara, S. (2018). The Role of Personality Traits on the Driving Behavior of Motorcycle Riders in Jakarta. Journal of Psychogenesis, 5(2), 150–158. doi:10.24854/jps.v5i2.503. (In Indonesian).

[44] Ehsani, J. P., Li, K., Simons-Morton, B. G., Fox Tree-McGrath, C., Perlus, J. G., O'Brien, F., & Klauer, S. G. (2015). Conscientious personality and young drivers' crash risk. Journal of Safety Research, 54, 83.e29-87. doi:10.1016/j.jsr.2015.06.015.

[45] Haerani, S., Parmitasari, R. D. A., Aponno, E. H., & Aunalal, Z. I. (2019). Moderating effects of age on personality, driving behavior towards driving outcomes. International Journal of Human Rights in Healthcare, 12(2), 91–104. doi:10.1108/IJHRH-08-2017-0040.

[46] Mahachandra, M., Widharto, Y., Putra, M. A., Suryoputro, M. R., & Prastawa, H. (2021). Age as the Moderating Variable in the Relationship between Risk Taker Personality and Aberrant Driving Behavior of Drivers in Semarang City. BIS-HSS 2020, 18 November 2020, Magelang, Central Java, Indonesia. doi:10.4108/eai.18-11-2020.2311608.

[47] Keng, S. L., Smoski, M. J., Robins, C. J., Ekblad, A. G., & Brantley, J. G. (2012). Mechanisms of change in mindfulness-based stress reduction: Self-compassion and mindfulness as mediators of intervention outcomes. Journal of Cognitive Psychotherapy, 26(3), 270–280. doi:10.1891/0889-8391.26.3.270.

[48] Ramli, N. H. H., Alavi, M., Mehrinezhad, S. A., & Ahmadi, A. (2018). Academic stress and self-regulation among university students in Malaysia: Mediator role of mindfulness. Behavioral Sciences, 8(1), 12. doi:10.3390/bs8010012.

[49] Valero-Mora, P. M., Martí-Belda-Bertolín, A., & Sánchez-García, M. (2021). Keep calm, pay attention, and carry on: Anxiety and consciousness mediate the effect of, mindfulness on driving performance in young drivers. Transportation Research Part F: Traffic Psychology and Behaviour, 83(September), 22–32. doi:10.1016/j.trf.2021.09.006.

[50] Chang, H. L., & Yeh, T. H. (2007). Motorcyclist accident involvement by age, gender, and risky behaviors in Taipei, Taiwan. Transportation Research Part F: Traffic Psychology and Behaviour, 10(2), 109–122. doi:10.1016/j.trf.2006.08.001.

[51] Hidalgo-Fuentes, S., & Sospedra-Baeza, M. J. (2019). Gender and age distribution of motorcycle crashes in Spain. International Journal of Injury Control and Safety Promotion, 26(1), 108–114. doi:10.1080/17457300.2018.1482927.

[52] Granié, M. A., Thévenet, C., Varet, F., Evennou, M., Oulid-Azouz, N., Lyon, C., Meesmann, U., Robertson, R., Torfs, K., Vanlaar, W., Woods-Fry, H., & Van den Berghe, W. (2020). Effect of Culture on Gender Differences in Risky Driver Behavior through Comparative Analysis of 32 Countries. Transportation Research Record, 2675(3), 274–287. doi:10.1177/0361198120970525.

[53] Regev, S., Rolison, J. J., & Moutari, S. (2018). Crash risk by driver age, gender, and time of day using a new exposure methodology. Journal of Safety Research, 66, 131–140. doi:10.1016/j.jsr.2018.07.002.

[54] González-Sánchez, G., Olmo-Sánchez, M. I., Maeso-González, E., Gutiérrez-Bedmar, M., & García-Rodríguez, A. (2021). Traffic injury risk based on mobility patterns by gender, age, mode of transport and type of road. Sustainability (Switzerland), 13(18), 10112. doi:10.3390/su131810112.

[55] World Bank Group. (2019). Aspiring Indonesia—Expanding the Middle Class. Aspiring Indonesia—Expanding the Middle Class. World Bank Group, Washington, United States. doi:10.1596/33237.

[56] Laajaj, R., Macours, K., Hernandez, D. A. P., Arias, O., Gosling, S. D., Potter, J., Rubio-Codina, M., & Vakis, R. (2019). Challenges to capture the big five personality traits in non-WEIRD populations. Science Advances, 5(7), 1-13. doi:10.1126/sciadv.aaw5226.

[57] Shi, J., Bai, Y., Ying, X., & Atchley, P. (2010). Aberrant driving behaviors: A study of drivers in Beijing. Accident Analysis and Prevention, 42(4), 1031–1040. doi:10.1016/j.aap.2009.12.010.