Journal of Infrastructure, Policy and Development 2024, 8(9), 6179.
https://doi.org/10.24294/jipd.v8i9.6179

Article

Enhancing sustainable mobility and communities: A structural equation modelling analysis of motorcyclists' proneness in road accidents

Muhammad Asyraf Mohd Kassim[1,2], Md. Sharif Hassan[3], Mohammad Bin Amin[4,*], Muhammad Safizal Abdullah[1], Shahrul Nizam Salahudin[5], Csaba Bálint Illés[6]

[1] Faculty of Business & Communication, Universiti Malaysia Perlis, Kangar, Perlis 01000, Malaysia
[2] Center of Excellence Social Innovation and Sustainability, Universiti Malaysia Perlis, Kangar, Perlis 01000, Malaysia
[3] School of Accounting and Finance, Taylor's University, Subang Jaya, Selangor 47500, Malaysia
[4] Doctoral School of Management and Business, Faculty of Economics and Business, University of Debrecen, 4032 Debrecen, Hungary
[5] Faculty of Technology Management & Business, Universiti Tun Hussein Onn, Parit Raja, Johor 86400, Malaysia
[6] Doctoral School of Management and Business Administration, John von Neumann University, 6000 Kecskemét, Hungary
*** Corresponding author:** Mohammad Bin Amin, binamindu@gmail.com

CITATION

Kassim MAM, Hassan MS, Amin MB et al. (2024). Enhancing sustainable mobility and communities: A structural equation modelling analysis of motorcyclists' proneness in road accidents. Journal of Infrastructure, Policy and Development. 8(9): 6179. https://doi.org/10.24294/jipd.v8i9.6179

ARTICLE INFO

Received: 3 May 2024
Accepted: 20 June 2024
Available online: 6 September 2024

Abstract: Road accidents involving motorcyclists significantly threaten sustainable mobility and community safety, necessitating a comprehensive examination of contributing factors. This study investigates the behavioral aspects of motorcyclists, including riding anger, sensation-seeking, and mindfulness, which play crucial roles in road accidents. The study employed structural equation modeling to analyze the data, utilizing a cross-sectional design and self-administered questionnaires. The results indicate that riding anger and sensation-seeking tendencies have a direct impact on the likelihood of road accidents, while mindfulness mitigates these effects. Specifically, mindfulness partially mediates the relationships between riding anger and road accident proneness, as well as between sensation-seeking and road accident proneness. These findings underscore the importance of effective anger management, addressing sensation-seeking tendencies, and promoting mindfulness practices among motorcyclists to enhance road safety and sustainable mobility. The insights gained from this research are invaluable for relevant agencies and stakeholders striving to reduce motorcycle-related accidents and foster sustainable communities through targeted interventions and educational programs.

Keywords: mindfulness; riding anger; road safety; structural equation modeling; road accident proneness

1. Introduction

A road accident (collision, overturning, or sliding) occurs on a public road and causes harm, death, suffering, or any combination involving at least one moving vehicle. World Health Organization (2019) reported that road accidents annually result in over a million fatalities and millions of mild to severe injuries, and in most countries, road accidents' financial expenses amount to around 3% of the gross domestic product. The consequences of road accidents, including injuries and fatalities, are severe, as victims may sustain serious injuries. Wali et al. (2019) stated that an accident in which an individual sustains a serious head injury or severe head and chest injuries is classified as a substantial injury. However, road accidents affect people and influence other matters, such as damage or loss of property and economic problems due to the expenses taken to compensate for property or people (Eboli et al., 2020; Yange et al., 2020).

Today's trends in the world are directed towards sustainable mobility, where the use of motorcycles is promoted (Huy et al., 2022), and urban plans are defined in this way (de Oliveira et al., 2019), as well as road construction (Simić et al., 2023). Although the dominant factor in the suffering of motorcyclists is the human factor (Brockhus et al., 2024), the construction of roads and urban plans should be aimed at increasing the passive safety of all road users (Trifunović et al., 2024).

On the other hand, the ability to predict traffic accidents (Kodepogu et al., 2023) can also play a crucial role in reducing their occurrence, an area where the development of new technologies can make significant contributions (Kaye et al., 2024). Reducing traffic-related deaths aligns directly with the Third Sustainable Development Goal, which aims to ensure healthy lives and promote well-being for all people, regardless of age. This critical objective underscores the urgent need for intensified, multi-pronged efforts to effectively address road safety issues and turn this vital global goal into a realized achievement.

The number of road accidents is rising at an alarming rate worldwide, including in Malaysia. Malaysia has had alarming cases of road accidents, with a total of 598,635 cases recorded in 2023. According to the Bukit Aman Traffic Investigation and Enforcement Department (2023), road accidents continued to rise over five years from 2018 to 2023. In terms of road accident deaths, motorcycle riders and passengers account for more than 65% of the total deaths (Bukit Aman Traffic Investigation and Enforcement Department, 2023). Moreover, motorcyclists aged 16 to 35 years have the highest death rate among riders. (Bukit Aman Traffic Investigation and Enforcement Department, 2023). Therefore, it may be determined that road accidents and motorcyclist deaths in Malaysia are in high volume. This problem has resulted in most victims suffering from minor and severe injuries, being permanently disabled, or dying. Consequences of road accidents include low- and middle-income victims, as road accidents can render people disabled or cause their deaths. It also has the potential to force victims to lose their sources of income, leaving them unable to support their families. As a result, this study concentrates on accident proneness in traffic circumstances.

Several riding factors contribute to road accidents, such as the fact that much earlier research used a person's gender and age as a predictor in road accident studies (Chang et al., 2019; Idris et al., 2019; Manan and Varhelyi, 2012; Tang et al., 2021). Additionally, other psychological factors such as speeding, drug use, and alcohol use (Cubranic et al., 2017; Kashani et al., 2020; Manan et al., 2017; Rundmo and Ulleberg, 2002; Sultan et al., 2016; Yange et al., 2020) were examined as predictors to road accident proneness. However, the main concern is that these predictors were frequently used in past studies, which made other behavioral factors hidden and less studied. On top of that, most road accident studies in Malaysia were focused on the technical components, such as road development and design, rather than riding behavior (Ashraf et al., 2019; Darma et al., 2017; Hsu and Wen, 2017; Kelly and Efthymiou, 2019; Wang et al., 2019). It shows the shortage of studies and the critical need to conduct studies mainly about riding behavior in Malaysia. The lack of studies on riding behavior and the current literature on road accident proneness in Malaysia necessitate more empirical studies. Therefore, this study provided extensive knowledge of the relationship between riding behavior and road accident proneness

among Malaysian riders to bridge the existing gap. This study contributed to all generations' understanding of mindfulness and road accident proneness. In addition, this study examined the mediating effects of mindfulness in the case of road accident proneness. The study answers the following research questions based on the research problem and existing gaps.

RQ1: What factors affect road accident proneness?

RQ2: Does mindfulness mediate the relationship between riding anger and road accident proneness, sensation seeking, and road accident proneness?

2. Literature review

2.1. Road accident proneness (RAP)

Road accident proneness can be described as a person's tendency to be involved in more accidents than someone who is not prone to accidents (Darma et al., 2017; Kamaluddin et al., 2018). The greater the chance of getting engaged in a traffic accident, the more probable the vehicle may exhibit abrupt barking. In other words, it is dangerous not just to oneself but to anybody else on the way. Motorcycle riders were considered one of the most dangerous road users worldwide, including in Malaysia. Farooq and Juhasz (2019) indicated that motorcycle riders are among the most vulnerable users among other road users. The researcher stated that the number of motorcycles on the road increases, so motorcycle fatality can be expected to remain a big concern for road safety. This problem has been a source of worry for both road users in general and motorcycle riders in particular. Given the diversity of behavioral factors associated with motorcycle riders' involvement in road accidents, this study focuses on critical predictors of motorcycle rider behavior, such as riding anger (RAG), mindfulness (MF), and sensation seeking (SS) to gain a more precise and comprehensive understanding of the effects of these predictors on a motorcycle rider's tendency for road accidents.

2.2. Riding anger (RAG)

Riding enables an individual to communicate their reality to others and how an individual expresses anger from how they represent the emotion in other settings. Riding anger is often used to describe an emotional state marked by feelings such as aggravation or wrath (Gunson et al., 2019). Riding anger is an uncontrollable feeling and can potentially steer any person's behavior in the wrong direction, leading to a road accident. Additionally, it has become a worldwide concern among teenagers due to the difficulty of comprehending, analyzing, and devising coping mechanisms for anger (Elsaieh et al., 2023). For instance, riding anger is a strong predictor of violence and is associated with socialization, narcissism, and suicidal thoughts or impulses (Chang et al., 2019). Hence, examining how riders express their anger while riding is crucial. Herrero and Fonseca (2017) studied angry thoughts among road users in Spain about their relationship with crash-related events and the mediation effect of aggressive and risky riding. The study finds a significant correlation between anger expressions and road accidents, particularly in the case of minor and severe accidents. In addition, Kelly and Lambert (2012) found that mindfulness can reduce anger. Anger,

mainly when intense and uncontrolled, can decrease feelings of empathy and compassion towards oneself and others. Mindfulness fosters compassion, making it challenging to maintain when anger is in the driver's seat. Based on the above discussion, the study proposed the following hypotheses.

H1: RAG has a significant positive effect on RAP.

H2: RAG has a significant negative effect on MF.

2.3. Sensation seeking (SS)

Sensation-seeking is a tendency to search out fresh and distinct experiences or emotions in one's life. According to Stanojević (2020), motorcyclists with sensation-seeking traits are willing to incur any risks to feel thrilled and enjoy. Additionally, sensation-seeking behavior may affect unsafe riding and increase the tendency to be involved in an accident (Kang et al., 2019). Breivik et al. (2017) conducted a study on the Norwegian population and found that sensation-seeking significantly affected risk-taking behavior. According to prior research by Cabarkapa et al. (2018), when personality traits such as sensation-seeking are treated as a thought, that appears to be the most significant behavioral factor for traffic. Experience-seeking will alter riders' minds, reducing their awareness of their surroundings and increasing the risk of a road accident. Motorcyclists are often eager to incur risks to obtain sensation since adrenaline and excitement increase the motorcyclist's interest (Borhan et al., 2018). Based on the discussion, the study proposed the following hypotheses.

H3: SS has a significant positive effect on RAP.

H4: SS has a significant negative effect on MF.

2.4. Mindfulness (MF)

Mindfulness is described as a state of awareness and acceptance of what is occurring in the present moment without judgment. Moreover, mindfulness involves intentionally focusing on the present moment and adopting a tolerant and appreciative attitude toward one's reality rather than striving to change or control it (Kashiwazaki et al., 2020).

Furthermore, drivers must retain concentration and pay more attention to traffic flow. Individuals must be cautious and vigilant around them to reflect on this information and take appropriate action in the current circumstance. In Malaysia, for instance, it is common for motorcycles to pass automobiles by passing between two cars in front of them. This type of stun will be challenging without concentration and knowledge of one's behavior. After all, this is the essence of rider mindfulness (Abdul Hanan and King, 2010).

Moreover, when an individual's mindfulness has been disrupted, whether by one lack of focus or an external factor such as an environmental display of objects will result in road accidents, affecting not only themselves but all-around road users. Since mindfulness has considerable potential to impact the riders' riding anger and sensation-seeking when riding, several prior studies have suggested that mindfulness should be examined as the mediator predictor because it may alter numerous individual behaviors when someone fails to focus on the road (Abdul Hanan et al., 2010; Koppel et al., 2019; Moore and Brown, 2019).

Considering mindfulness, this highlights the need to understand how anger and sensation-seeking impact our overall proneness to road accidents. Therefore, this study integrates mindfulness with anger, sensation-seeking, and road accident proneness in a single framework and assesses mindfulness's direct and indirect relationship between anger and sensation-seeking to road accident proneness, considering the rule of mediation established by Baron and Kenny (1986). Based on the above discussions, the study proposed the following hypotheses.

H5: MF has a significant negative effect on RAP.

H6: MF mediates the relationship between RAG and RAP.

H7: MF mediates the relationship between SS and RAP.

Based on the discussion above, the study proposed the following research framework (**Figure 1**).

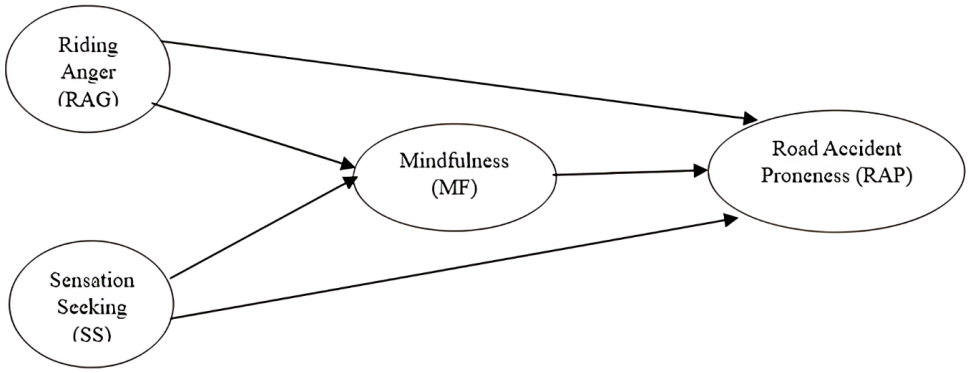

Figure 1. Research framework.

3. Methodology

Self-administered questionnaires were distributed to motorcyclists via electronic mediums using a convenient sampling method. The construct measures were adapted from several authors: riding anger from Chang et al. (2019), sensation seeking from Wong et al. (2010), mindfulness from Abdul Hanan and King (2010), and road accident proneness from Ulleberg and Rundmo (2003). Respondents indicated their level of agreement using a five-point Likert scale ranging from (1) "Very Low" to (5) "Very High." The data was collected for three months, from December 2023 to February 2024, by distributing the online questionnaire through motorcyclist social media groups and forums across Malaysia. A total of 402 responses were received during this period.

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) Version 28. Before analysis, the dataset was examined for any missing or incomplete entries. A visual inspection revealed 16 responses with insufficient data, which were removed, leaving 386 valid responses for analysis. The proposed correlations were validated using the partial least squares structural equation modeling (PLS-SEM) approach. PLS-SEM was chosen due to its ability to handle non-normal data distributions. The threshold for statistical significance was set at $p < 0.05$ for all analyses.

4. Results

As displayed in **Table 1**, the study participants shared their details, such as their gender, age, race, marital status, education level, type of license held, experience in riding, place of residence, and preferences for speed limits. Among the 386 respondents, 67.6% were male, and 32.4% were female. Most participants (69.2%) fell in the 18 to 35 age group, with 18.9% aged 36 to 55 and 11.9% aged over 55, while 73.1% identified as Bumiputera and 26.9% as non-Bumiputera. Marital status showed that 58.3% were married, and 41.7% were unmarried. Education-wise, 75.4% held a bachelor's degree or higher, while others had a diploma (11.1%), STPM/Matric (8%), or SPM (5.4%). 80.3% held a full license, and 19.7% had a P license. Riding experience indicated 76.9% had 5 to 10 years, and 23.1% had over 11 years. Residence-wise, 66.1% lived in urban areas, while others were in rural areas. Regarding speed limits, 58.5% rode at 51 to 100 km/h, 28.5% at 10 to 50 km/h, and 13.3% beyond 101 km/h.

Table 1. Profile of the respondents'.

Profile	Description	Frequency	Percentage (%)
Gender	Males	261	67.6
	Females	125	32.4
Age	18–35	267	69.2
	36–55	73	18.9
	Above 56 Years Old	46	11.9
Race	Bumiputera	282	73.1
	Non-Bumiputera	104	26.9
Marital Status	Married	225	58.3
	Single	161	41.7
Academic Qualification	SPM	21	5.4
	STPM/Matric	31	8.0
	Diploma	43	11.1
	Degree And above	291	75.4
Type Of License	P License	76	19.7
	Full License	310	80.3
Riding Experience	5–10 Years	297	76.9
	More Than 11 Years	89	23.1
Place Of Residence	Urban Area	255	66.1
	Rural Area	131	33.9
Speed Limit	10–50 km/h	110	28.5
	51–100 km/h	226	58.5
	More Than 101 km/h	50	13

Source: Compiled by authors and computed data.

The validity and reliability of each construct's items were rigorously assessed within the measurement model. This evaluation encompassed various methodologies, including construct validity, convergent validity, discriminant validity, and reliability

analysis.

Figure 2 provides a visual representation of the model, illustrating four latent constructs: riding anger and sensation seeking as independent variables, mindfulness as a mediating variable, and road accident proneness as the dependent variable. The numerical values within the boxes denote the loadings of the individual items.

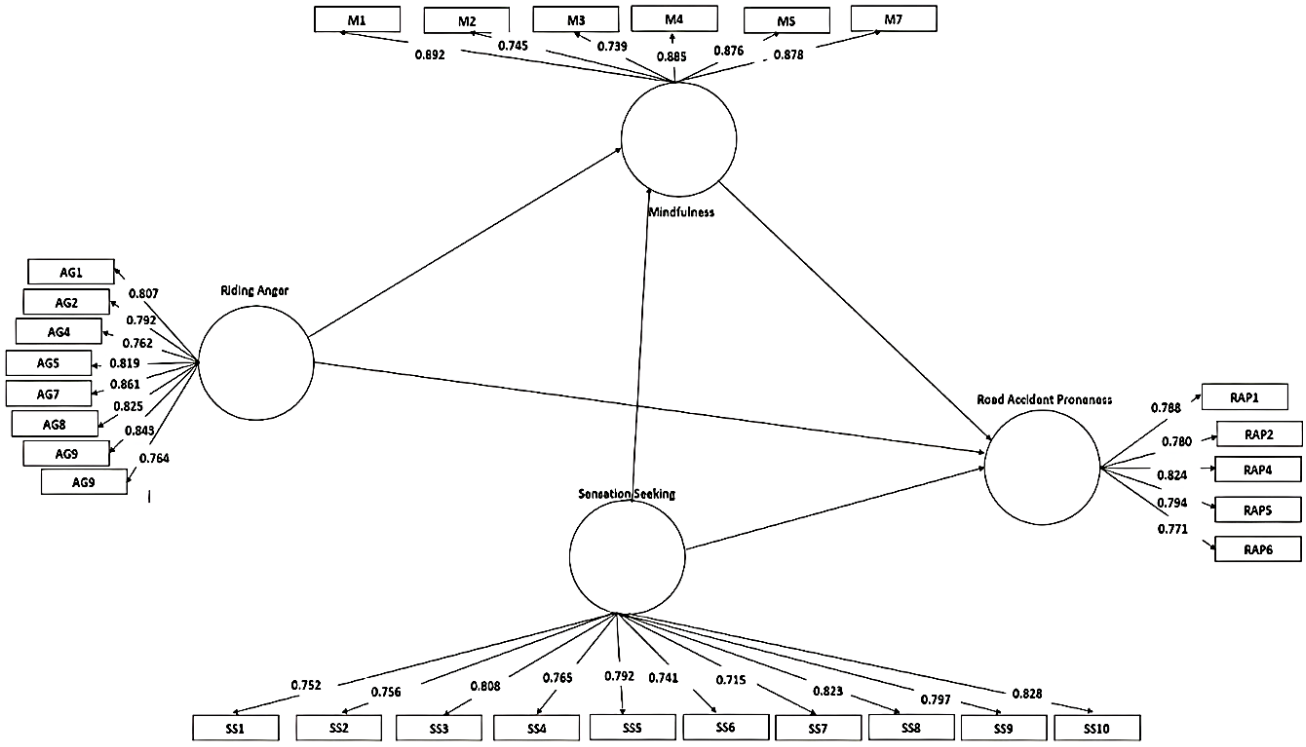

Figure 2. PLS measurement model.

Table 2 offers a comprehensive analysis of each construct, encompassing outer loadings, composite reliability, and average variance extracted (AVE), which are essential for evaluating construct validity. Notably, loadings exceeding 0.708 are considered significant, while composite reliability and AVE values above 0.70 are acceptable benchmarks (Hair et al., 2019). The outcomes of this analysis affirm the appropriateness of external loading values, which are consistent with satisfactory composite reliability and AVE values.

Further, to ensure the measurement model's robustness, this study assessed its discriminant validity, employing the Heterotrait-Monotrait correlation ratio (HTMT). The results, as presented in **Table 3**, indicate that all HTMT values are comfortably below the widely accepted threshold of 0.85 (Henseler et al., 2015), affirming the presence of discriminant validity across all pairs of constructs. With this confirmation, based on both convergent and discriminant validity, it can be confidently concluded that the measurement model employed in this study is appropriate and suitable for evaluating the outcomes of PLS-SEM.

Table 2. Result of construct validity and composite reliability.

Constructs	Items	Loadings	Composite Reliability	AVE
Mindfulness	M1	0.892	0.815	0.771
	M2	0.745		
	M3	0.739		
	M4	0.885		
	M5	0.876		
	M7	0.878		
Riding Anger	AG1	0.807	0.825	0.733
	AG2	0.792		
	AG4	0.762		
	AG5	0.819		
	AG7	0.861		
	AG8	0.825		
	AG9	0.843		
	AG11	0.764		
Road Accident Proneness	RAP1	0.788	0.852	0.772
	RAP2	0.780		
	RAP4	0.824		
	RAP5	0.794		
	RAP6	0.771		
Sensation Seeking	SS1	0.752	0.878	0.768
	SS2	0.756		
	SS3	0.808		
	SS4	0.765		
	SS5	0.792		
	SS6	0.741		
	SS7	0.715		
	SS8	0.823		
	SS9	0.797		
	SS10	0.828		

Source: Compiled by authors and computed data.

Table 3. HTMT discriminant validity.

	Mindfulness	Riding Anger	Road Accident Proneness	Sensation Seeking
Mindfulness	-	-	-	-
Riding Anger	0.613	-	-	-
Road Accident Proneness	0.560	0.639	-	-
Sensation Seeking	0.613	0.583	0.567	-

Source: Compiled by authors and computed data.

Upon meticulously evaluating the measurement model, the study assessed the structural model. This evaluation encompassed several vital facets, including examining Variance Inflation Factors (VIF) to address collinearity among constructs.

The importance of path coefficients, the coefficient of variance explained (R^2), effect size (f^2), and predictive relevance (Q^2) were also considered, as recommended by Hair et al. (2019). Hypothesized connections in **Figure 3** were tested through bootstrapping procedures. Specific results are presented in **Tables 4** and **5**.

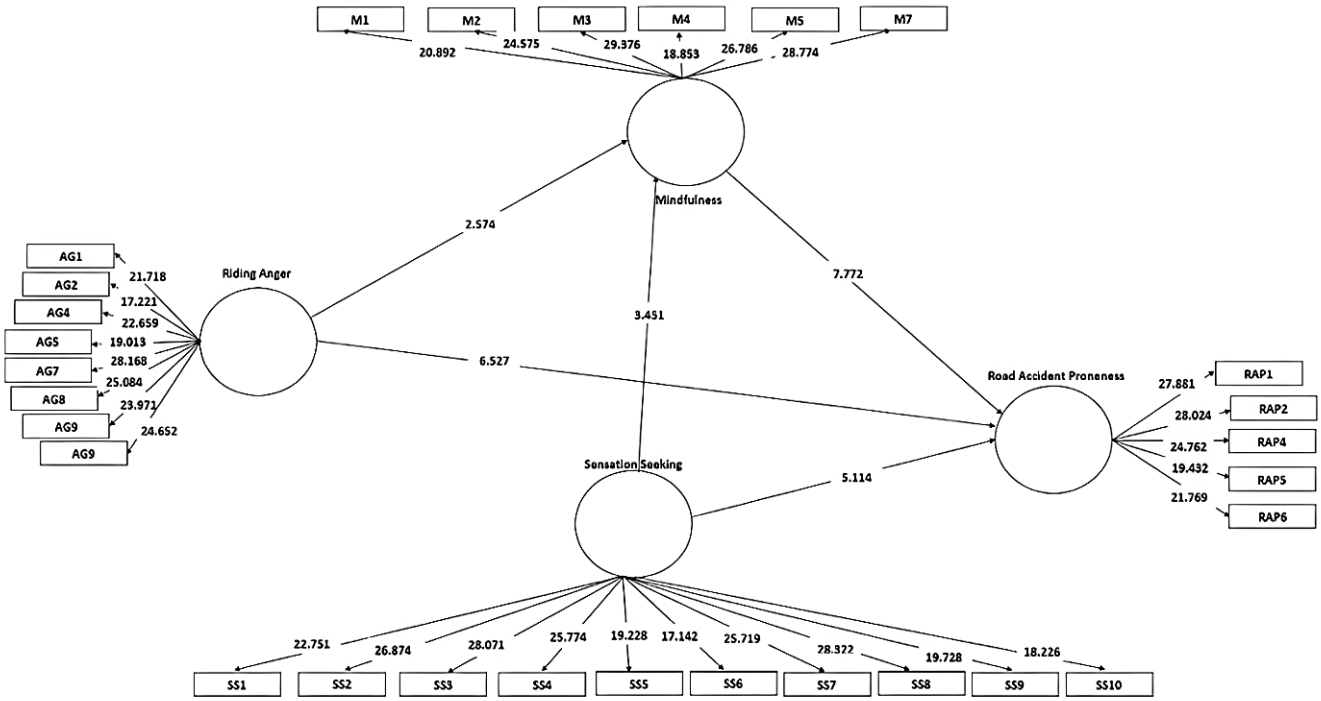

Figure 3. PLS structural model.

Table 4. Collinearity assessment.

CONSTRUCT	VIF
Riding Anger	2.534
Sensation Seeking	2.710
Mindfulness	2.674
Road Accident Proneness	2.463

Source: Compiled by authors and computed data.

Table 5. Direct path coefficients

Path	*β* (Beta)	*T*-Value	Hypothesis Decision	R^2	f^2	Q^2
RAG → RAP	0.262	6.527	Supported	0.540	0.245	0.365
SS → RAP	0.186	5.114	Supported		0.358	
MF → RAP	−0.296	7.772	Supported		0.326	
RAG → MF	−0.297	2.574	Supported	0.644	0.366	0.382
SS → MF	−0.242	3.451	Supported		0.257	

Note: RAG = Riding Anger, SS = Sensation Seeking, MF = Mindfulness, RAP = Road Accident Proneness.

Table 4 provides insight into the VIF values, demonstrating that all inner VIF values are well below 5, indicating an absence of multicollinearity issues in this study. **Table 5** presents the results of hypothesis tests for direct relationships. Notably, riding

anger (β = 0.262, t = 6.527) and sensation seeking (β = 0.186, t = 5.114) exhibit positive associations with road accident proneness, while mindfulness (β = −0.296, t = 7.772) displays a negative relationship with road accident proneness. Furthermore, riding anger (β = −0.297, t = 2.574) and sensation seeking (β = −0.242, t = 3.451) reveal negative associations with mindfulness.

Additionally, the factors account for 54% and 64% of the variance in road accident proneness and mindfulness, respectively, indicating an acceptable level of predictive accuracy (Hair et al., 2019). The findings further emphasize that all path coefficients possess significant effect sizes, with the Q^2 value (Q^2 = 0.365 and Q^2 = 0.382) highlighting the moderate predictive significance of the direct path on road accident proneness and mindfulness, respectively.

Additionally, the indirect effect of riding anger and sensation-seeking through mindfulness is shown in **Figure 3** and **Table 6**. Based on the findings, mindfulness has significantly mediated both riding anger and sensation seeking on road accident proneness.

Table 6. Mediating path coefficient.

Path	T-Value	Hypothesis Decision	Confidence Interval	
			LL	UL
RAG → MF → RAP	4.830	Supported	0.023	0.074
SS → MF → RAP	5.321	Supported	0.027	0.081

Note: RAG = Riding Anger, SS = Sensation Seeking, MF = Mindfulness, RAP = Road Accident Proneness, → = path between constructs, LL = Lower Level, UL = Upper Level.
Source: Compiled by authors and computed data.

The findings determined that riding anger, sensation seeking, and mindfulness substantially influence road accident proneness in Malaysia. Road accidents in Malaysia continue to increase yearly, with motorcyclists being the most frequently involved. It is because, in terms of emotions like anger, many riders experience riding anger, but they often do not know how to confront it or moderate it (Gunson et al., 2019). Ultimately, we live in a world of sensitive riders, which might result in catastrophic traffic accidents (Adu et al., 2023). Therefore, riding anger may be avoided by avoiding grudges and conversing with others before riding or driving a vehicle.

Next, based on the finding, riding anger has been discovered to have a negative relationship with mindfulness, and in terms of its mediating effect, mindfulness also has a significant impact on riding anger and accident proneness. It is because many motorcyclists are mindful of their emotions, particularly anger, yet cannot manage their anger owing to high levels of hatred, which can lead to a road accident.

Additionally, this study demonstrates that sensation seeking is highly associated with road accident proneness. This is because sensation-seeking motorcyclists tend to assume all risks, even when it is unsafe to experience pleasure and enjoyment. Lastly, according to the findings, mindfulness has a negative relationship with road accident proneness because it broadly refers to an individual's activities while driving a vehicle without paying attention to their surroundings or themselves, which endangers everyone on the road. For instance, persons who ride motorbikes must be more vigilant

to make decisions or react effectively while on the road, as motorcycles are among the fastest vehicles, and riding requires concentration.

5. Conclusion

This study has provided valuable insights into the relationship between riding anger, sensation seeking, road accident proneness, and mindfulness among motorcyclists in Malaysia. The research aimed to examine the mediating effect of mindfulness on the relationship between riding anger and sensation seeking with road accident proneness. The findings contribute to a better understanding of the factors influencing road accidents involving motorcyclists, a pressing issue in Malaysia.

The most significant results indicate that riding anger and sensation-seeking have a positive and significant relationship with road accident proneness. Higher levels of riding anger and a greater propensity for seeking intense sensations and thrills were associated with an increased likelihood of being involved in road accidents. Conversely, mindfulness exhibited a negative and significant relationship with road accident proneness. Higher levels of mindfulness, characterized by attention and awareness in the present moment, were associated with a reduced likelihood of being involved in road accidents.

Notably, the mediating effect of mindfulness on the relationship between riding anger and road accident proneness was statistically significant. Mindfulness partially mitigated the impact of riding anger on road accident proneness, suggesting that cultivating mindfulness can help manage anger while riding and reduce the risk of accidents. Similarly, mindfulness partially mediated the relationship between sensation seeking and road accident proneness. This has proven that mindfulness may help motorcyclists regulate their sensation-seeking tendencies, leading to safer riding behaviors and fewer accidents.

These findings hold practical implications for the Malaysian Ministry of Transportation and relevant authorities. Emphasizing the importance of managing riding anger, promoting mindfulness practices, and addressing sensation-seeking tendencies can lead to the development of targeted interventions and educational programs.

Furthermore, this study's results can serve as a valuable reference for future researchers investigating factors influencing road accident proneness among motorcyclists. Further exploration of these variables and their interrelationships can deepen our understanding and contribute to developing effective strategies for reducing motorcycle-related accidents in Malaysia and beyond.

5.1. Theoretical and practical implications

This study contributes to understanding the relationship between riding anger, sensation seeking, road accident proneness, and mindfulness in Malaysia, particularly among motorcyclists. It explores the role of mindfulness as a mediator between riding anger, sensation seeking, and road accident proneness. The study addresses the increasing issue of traffic accidents involving motorcyclists, focusing on four key variables.

The current study has identified specific personality traits that considerably

impact the likelihood of motorcyclists being prone to accidents. These factors could be employed to design road safety interventions that motivate and persuade riders to enhance their riding behavior, thus reducing the possibility of being involved in road accidents. Many riders of the younger generation in Malaysia have difficulty concentrating on the road owing to their emotions and attitudes. The importance of mindfulness on the road cannot be overstated since the likelihood of being involved in a collision increases if riders are not attentive. In order to address this issue, riders should plan their trips, and if the route is lengthy, they can take frequent rests to keep their minds alert and prevent them from dozing while riding. Moreover, considering the findings of the study, the government or media might improve road safety efforts by targeting a subset of road users with a high chance of being involved in road accidents.

5.2. Limitations and suggestions for future research

Despite the valuable insights from the present study, a few limitations must be acknowledged. Firstly, this study only uses a particular geographical area, which may limit the generalizability of the findings to other populations or regions. Finally, the data collection process experiences a delay as a result of financial and transportation constraints. These limitations should be considered when interpreting the study results and designing future research. In future studies, there is a possibility of expanding the scope of study to include alternative modes of transportation, such as cars or commercial trucks. Secondly, future studies may add another location or geographical area with different results. Thirdly, additional mediator factors such as impulsivity and risk perception may be considered in future studies.

Author contributions: Conceptualization, MAMK and MSA; methodology, MSH; software, MSH and MBA; validation, CBI, SNS and MSA; formal analysis, MAMK; investigation, MSH and SNS; resources, MBA; data curation, MAMK; writing—original draft preparation, MAMK and MSH; writing—review and editing, MBA and CBI; visualization, MBA; supervision, MSA; project administration, SNS; funding acquisition, MBA and CBI. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The authors would like to acknowledge the support from the Ministry of Higher Education Malaysia and the Road Safety Department of Malaysia.

Funding: This study is supported through a research grant from the Fundamental Research Grant Scheme (FRGS) (Ref: FRGS/1/2019/SS05/UNIMAP/03/1).

Conflict of interest: The authors declare no conflict of interest.

References

Abdul, H. S., King, M., & Lewis, I. (2010). Are you a mindful driver? A review of the potential explanatory value of mindfulness in predicting speeding behavior. In: Proceedings of the 2010 Australasian Road Safety Research, Policing and Education Conference; Australasian Road Safety Research, Policing and Education Conference. pp. 1–10.

Abdul Manan, M. M., Ho, J. S., Syed Tajul Arif, S. T. M., et al. (2017). Factors associated with motorcyclists' speed behavior on Malaysian roads. Transportation Research Part F: Traffic Psychology and Behavior, 50, 109–127. https://doi.org/10.1016/j.trf.2017.08.006

Abdullah, M. S., Mohamed Kassim, M. A., & Mansor, M. F. (2018). Risky Riding Behavior Among Malaysian Young Motorcyclists. MATEC Web of Conferences, 150, 05022. https://doi.org/10.1051/matecconf/201815005022

Adu, J. P., Dorasamy, N., & Keelson, S. A. (2023). Road Transport Infrastructure and Supply Chain Performance in the Beverage Manufacturing Setting: Does Road Safety Compliance Matter? Journal of Law and Sustainable Development, 11(3), e581. https://doi.org/10.55908/sdgs.v11i3.581

Ashraf, I., Hur, S., Shafiq, M., et al. (2019). Catastrophic factors involved in road accidents: Underlying causes and descriptive analysis. PLOS ONE, 14(10), e0223473. https://doi.org/10.1371/journal.pone.0223473

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology, 51(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Borhan, M. N., Ibrahim, A. N. H., Aziz, A., et al. (2018). The relationship between the demographic, personal, and social factors of Malaysian motorcyclists and risk-taking behavior at signalized intersections. Accident Analysis & Prevention, 121, 94–100. https://doi.org/10.1016/j.aap.2018.09.004

Breivik, G., Sand, T. S., & Sookermany, A. M. (2017). Sensation seeking and risk-taking in the Norwegian population. Personality and Individual Differences, 119, 266–272. https://doi.org/10.1016/j.paid.2017.07.039

Brockhus, L. A., Liasidis, P., Lewis, M., et al. (2024). Injury patterns and outcomes in motorcycle driver crashes in the United States: The effect of helmet use. Injury, 55(3), 111196. https://doi.org/10.1016/j.injury.2023.111196

Cabarkapa, M., Cubranic-Dobrodolac, M., Cicevic, S., & Antic, B. (2018). The influence of aggressive riding behavior and impulsiveness on traffic accidents. International Journal for Traffic & Transport Engineering, 8(3). https://doi.org/10.7708/ijtte.2018.8(3).09

Chang, F., Xu, P., Zhou, H., et al. (2019). Identifying motorcycle high-risk traffic scenarios through interactive analysis of driver behavior and traffic characteristics. Transportation Research Part F: Traffic Psychology and Behavior, 62, 844–854. https://doi.org/10.1016/j.trf.2019.03.010

Čubranić-Dobrodolac, M., Lipovac, K., Čičević, S., et al. (2017). A Model for Traffic Accidents Prediction Based on Driver Personality Traits Assessment. Promet-Traffic&Transportation, 29(6), 631–642. https://doi.org/10.7307/ptt.v29i6.2495

Darma, Y., Karim, M. R., & Abdullah, S. (2017). An analysis of Malaysia road traffic death distribution by road environment. Sādhanā, 42(9), 1605–1615. https://doi.org/10.1007/s12046-017-0694-9

De Oliveira, J. A. P. (2019). Sustainability Challenges in an Urban Century: Can We Change Urbanization Paths to Make Cities the Solutions for Rather than the Drivers of Global Problems? Challenges in Sustainability, 7(1), 1–4. https://doi.org/10.12924/cis2019.07010001

Eboli, L., Forciniti, C., & Mazzulla, G. (2020). Factors influencing accident severity: an analysis by road accident type. Transportation Research Procedia, 47, 449–456. https://doi.org/10.1016/j.trpro.2020.03.120

Elsaieh, A. M., Shohaimi, S., Nadzir, M. N. H. M., et al. (2023). Association between Socio-Demographic Factors and Smoking Status of Dual and Single Tobacco Users Among Malaysian University Students. Journal of Law and Sustainable Development, 11(5), e1082. https://doi.org/10.55908/sdgs.v11i5.1082

Farooq, D., & Juhasz, J. (2019). In-Depth Investigation of Contributing Factors to Car-Motorcycle Accidents in Budapest City. Romanian Journal of Transport Infrastructure, 8(2), 30–43. https://doi.org/10.2478/rjti-2019-0009

Gunson, H. P., Beanland, V., & Salmon, P. M. (2019). Road-related anger in motorcyclists versus car drivers. Transportation Research Part F: Traffic Psychology and Behaviour, 62, 327–338. https://doi.org/10.1016/j.trf.2019.01.006

Hair, J. F., Risher, J. J., Sarstedt, M., et al. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. https://doi.org/10.1108/ebr-11-2018-0203

Henseler, J., Ringle, C. M., & Sarstedt, M. (2014). A new criterion for assessing discriminant validity in variance-based structural equation modeling. Journal of the Academy of Marketing Science, 43(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Herrero-Fernández, D., & Fonseca-Baeza, S. (2017). Angry thoughts in Spanish drivers and their relationship with crash-related events. The mediation effect of aggressive and risky driving. Accident Analysis & Prevention, 106, 99–108. https://doi.org/10.1016/j.aap.2017.05.015

Hsu, T.-P., & Wen, K.-L. (2017). Collision Types of Motorcycle Accident and Countermeasures. World Congress on Civil, Structural, and Environmental Engineering. https://doi.org/10.11159/icte17.115

Huy, D. H., Chi, N. D. T., Nam, N. X. T., et al. (2022). Commuter exposures to in-transit PM in an urban city dominated by motorcycle: A case study in Vietnam. Atmospheric Pollution Research, 13(3), 101351. https://doi.org/10.1016/j.apr.2022.101351

Idris, A., Hamid, H., & Teik Hua, L. (2019). Factors contributing to motorcycle accidents in Malaysia. IOP Conference Series: Earth and Environmental Science, 357(1), 012039. https://doi.org/10.1088/1755-1315/357/1/012039

Ju, U., Kang, J., & Wallraven, C. (2019). To Brake or Not to Brake? Personality Traits Predict Decision-Making in an Accident Situation. Frontiers in Psychology, 10. https://doi.org/10.3389/fpsyg.2019.00134

Kamaluddin, N. A., Abd Rahman, M. F., & Várhelyi, A. (2018). Matching of police and hospital road crash casualty records—a data-linkage study in Malaysia. International Journal of Injury Control and Safety Promotion, 26(1), 52–59. https://doi.org/10.1080/17457300.2018.1476385

Kashani, A. T., Jafari, M., Bondarabadi, M. A., et al. (2020). Factors affecting the accident size of motorcycle-involved crashes: a structural equation modeling approach. International Journal of Injury Control and Safety Promotion, 28(1), 16–21. https://doi.org/10.1080/17457300.2020.1833041

Kashiwazaki, Y., Takebayashi, Y., & Murakami, M. (2020). Relationships between radiation risk perception and health anxiety, and contribution of mindfulness to alleviating psychological distress after the Fukushima accident: Cross-sectional study using a path model. PLOS ONE, 15(7), e0235517. https://doi.org/10.1371/journal.pone.0235517

Kaye, S.-A., Nandavar, S., Lewis, I., et al. (2024). Exploring beliefs and perceptions towards Advanced Rider Assistance Systems (ARAS) in motorcycle safety. Transportation Research Part F: Traffic Psychology and Behavior, 102, 77–87. https://doi.org/10.1016/j.trf.2024.02.011

Kelley, T. M., & Lambert, E. G. (2012). Mindfulness as a Potential Means of Attenuating Anger and Aggression for Prospective Criminal Justice Professionals. Mindfulness, 3(4), 261–274. https://doi.org/10.1007/s12671-012-0090-9

Kodepogu, K., Manjeti, V. B., & Siriki, A. B. (2023). Machine Learning for Road Accident Severity Prediction. Mechatronics and Intelligent Transportation Systems, 2(4). https://doi.org/10.56578/mits020403

Koppel, S., Bugeja, L., Hua, P., et al. (2019). Do mindfulness interventions improve road safety? A systematic review. Accident Analysis & Prevention, 123, 88–98. https://doi.org/10.1016/j.aap.2018.11.013

Moore, M. M., & Brown, P. M. (2019). The association of self-regulation, habit, and mindfulness with texting while driving. Accident Analysis & Prevention, 123, 20–28. https://doi.org/10.1016/j.aap.2018.10.013

Obadeji, A., Kumolalo, B. F., Bamidele, J. O., & Olasehinde, T. F. (2020). Road traffic accidents among commercial motorcyclists: Relationship with substance use and psychosocial factors. Social health and behavior, 3(2), 43. https://doi.org/10.4103/SHB.SHB_9_20

Road Safety Department of Malaysia. (2019). Road Accidents Statistics. Ministry of Transportation Malaysia.

Rundmo, T., & Ulleberg, P. (2002). Personality, attitudes and risk perception as predictors of risky riding behavior among young drivers. Safety science, 41(5), 427–443. https://doi.org/10.1016/S0925-7535(01)00077-7

Simić, N., Ivanišević, N., Nedeljković, Đ., et al. (2023). Early Highway Construction Cost Estimation: Selection of Key Cost Drivers. Sustainability, 15(6), 5584. https://doi.org/10.3390/su15065584

Stanojević, D., Stanojević, P., Jovanović, D., et al. (2019). Impact of riders' lifestyle on their risky behavior and road traffic accident risk. Journal of Transportation Safety & Security, 12(3), 400–418. https://doi.org/10.1080/19439962.2018.1490367

Sultan, Z., Ngadiman, N. I., Kadir, F. D., et al. (2016). Factor Analysis of Motorcycle Crashes in Malaysia. Planning Malaysia, 4. https://doi.org/10.21837/pm.v14i4.154

Tang, T., Guo, Y., Zhou, X., et al. (2021). Understanding electric bike riders' intention to violate traffic rules and accident proneness in China. Travel Behavior and Society, 23, 25–38. https://doi.org/10.1016/j.tbs.2020.10.010

Trifunović, A., Senić, A., Čičević, S., et al. (2024). Evaluating the Road Environment Through the Lens of Professional Drivers: A Traffic Safety Perspective. Mechatronics and Intelligent Transportation Systems, 3(1). https://doi.org/10.56578/mits030103

Ulleberg, P., & Rundmo, T. (2003). Personality, attitudes and risk perception as predictors of risky driving behavior among young drivers. Safety science, 41(5), 427–443. https://doi.org/10.1016/S0925-7535(01)00077-7

Wali, B., Khattak, A. J., & Ahmad, N. (2019). Examining correlations between motorcyclist's conspicuity, apparel related factors and injury severity score: Evidence from new motorcycle crash causation study. Accident Analysis & Prevention, 131, 45–62. https://doi.org/10.1016/j.aap.2019.04.009

Wang, H., Huang, Y., Khajepour, A., et al. (2019). Crash Mitigation in Motion Planning for Autonomous Vehicles. IEEE Transactions on Intelligent Transportation Systems, 20(9), 3313–3323. https://doi.org/10.1109/tits.2018.2873921

Wong, J.-T., Chung, Y.-S., & Huang, S.-H. (2010). Determinants behind young motorcyclists' risky riding behavior. Accident Analysis & Prevention, 42(1), 275–281. https://doi.org/10.1016/j.aap.2009.08.004

World Health Organization. (2019). Global Status Report on Road Safety 2019. World Health Organization.

Yange, T. S., Onyekwere, O., Adeiza Rufai, M., et al. (2020). Determination of the Severity of Motorcycle and Tricycle Accidents in Nigeria. Advances in Applied Sciences, 5(2), 41. https://doi.org/10.11648/j.aas.20200502.14