Applied Mathematics and Computational Intelligence
Volume 15, No. 4, 2026 [71-80]

Prioritizing Road Accident Factors at Universiti Utara Malaysia using Analytical Hierarchy Process

Ruzleeta Zakaria[1], Zakiah Hashim[2], Azatuliffah Alwi[3], Loo Pei Yin[4]

[1,2,3,4]School of Quantitative Sciences, UUM College of Arts and Sciences, Universiti Utara Malaysia, 06010, Sintok, Kedah Darul Aman, Malaysia.

Corresponding author : ruzleeta@uum.edu.my

Received: 23 October 2025
Revised: 24 July 2026
Accepted: 28 July 2026

ABSTRACT

Road safety has become increasingly critical as Malaysia progresses toward high-income nation status, with rising motorization rates leading to increased traffic exposure and accidents. This has caused increased traffic exposure, leading to more road traffic accidents. Realizing the severity of road traffic accidents as a major public health issue that needs to be tackled in a structured and systematic manner, research is needed. This study employs the Analytical Hierarchy Process (AHP) to prioritize road accident factors at Universiti Utara Malaysia (UUM). This study aims to achieve the objectives which are to identify the factors contributing to road accidents, determine the prioritized factors, and the use of the Analytical Hierarchy Process (AHP) is proposed. Based on data collected from 247 students, the findings indicate that factors such as lack of knowledge of traffic signs, bad driving behavior, lack of proper driving training, and speeding significantly contribute. Quantitative analysis revealed that lack of proper training (0.2694) was the most significant factor, followed by speeding (0.2565), lack of knowledge of traffic signs (0.2384), and bad driving behavior (0.2356). The analysis emphasizes the significance of lack of proper driving training as the main factor and potential interventions to decrease road accidents were proposed.

Keywords: analytical hierarchy process, road accident, university students

1 INTRODUCTION

According to a WHO report, road traffic accidents claim approximately 1.19 million lives globally each year (2023). Additionally, 20 to 50 million people suffer non-fatal injuries, which can result in life-altering disabilities. These statistics highlight the global significance of road safety as a public health concern. These accidents cause personal loss and impose significant economic burdens on individuals, families, and nations. The high costs of medical treatments, rehabilitation, and long-term care for those injured contribute to this financial strain. The societal impact of disability includes lost productivity, as affected individuals often struggle to resume normal life. Family members may need to take time off from work or school to provide care, further exacerbating economic consequences. Many countries allocate about 3% of their gross domestic product to address the repercussions of road traffic crashes. This underscores the urgent need for comprehensive strategies and collaborative efforts to enhance road safety and reduce the human and economic toll of these incidents [1].

A recent report by the New Straits Times [2] highlighted a tragic incident where a student from UUM and a friend lost their lives in a road accident while returning to the university. According to the accident records from the Security Unit of UUM, there has been a notable increase in road accidents involving students on campus over the past five years. This rise is attributed to a growing number of students driving vehicles without displaying the required vehicle stickers**.** Table 1 illustrates the increasing number of road accidents among students at UUM.

Table 1: Number of road accident cases at uum (2019-2023)

Year	**Number of Road Accident Cases**
2019	7
2020	4
2021	9
2022	21
2023	31

This incident emphasizes the importance of UUM students understanding and addressing road safety issues. Road traffic accidents can lead to devastating outcomes, including loss of life, injury, and profound grief for the affected individuals and their families. To prevent such tragedies and ensure the safety of UUM students, it is crucial to identify and prioritize the factors contributing to road accidents in the vicinity of the university. By doing so, this study can implement appropriate measures and interventions to reduce the occurrence and severity of accidents, thereby safeguarding the well-being of students and promoting a safer campus environment [2].

This study focuses on prioritizing road accident factors among UUM students. Thus, this study aims to identify key factors that contribute to road accidents, enabling us to concentrate our efforts on finding effective solutions to minimize this issue. To achieve this, this study will utilize the Analytic Hierarchy Process (AHP) to analyze the data and determine the prioritization of these factors. AHP is recognized as a valid and reliable method for this purpose [3].

The rising number of road accidents involving UUM students poses significant concerns regarding their safety and the potential societal and economic ramifications. Despite its importance, there remains a lack of understanding regarding how drivers can mitigate the risks associated with factors specific to this population. Consequently, there is insufficient research focused on prioritizing the factors contributing to accidents among students. Without a clear understanding of these factors and their relative importance, developing effective road safety interventions and policies tailored to this student demographic is challenging. Therefore, the objective of this study is to investigate and prioritize the road accident factors among UUM students using the AHP. The specific objectives are to identify key factors contributing to road accidents at UUM and to determine the priority ranking of these factors using AHP

2 LITERATURE REVIEW

This section begins by exploring the research domain related to road accidents, with a focus on the factors affecting students. Several key issues include a lack of knowledge about traffic signs, speeding, bad driving behavior, and lack of proper driving training.

2.1 Lack of Knowledge of Traffic Signs

A lack of knowledge about traffic signs indicates that drivers may not fully understand the significance of various signals, such as stop signs, yield signs, speed limits, and other regulatory or warning indicators. This lack of knowledge is identified as a critical factor contributing to road accidents [3]. Such violations occur when drivers intentionally disregard traffic rules and regulations. Key factors include failing to obey traffic signs, tailgating, dangerous overtaking, driving under the influence of alcohol or illegal drugs, speeding, neglecting seat belts, using mobile phones while driving, and failing to use child restraints [4][5].

2.2 Speeding

In Malaysia, nearly 80% of road accidents are attributed to human factors, which encompass individual attributes, traits, and psychological limitations. Traffic violation behavior is the leading contributor to road accidents in the country. The highest factor that contributed to the motorcycle fatal crashes among young students in University Technology Malaysia (UTM) is the human behavior factor and then followed by road and vehicle and finally the environment factor. The most crucial factor related to human attitude is the speeding behaviours [6]. Inappropriate speed relative to traffic conditions is critical and comparable to the impact of poor driving behavior [7][8].

2.3 Bad Driving Behaviour

Reckless driving involves taking unnecessary risks on the road, encompassing behaviors such as speeding, tailgating, failing to signal, weaving through traffic, making unsafe lane changes, running red lights, and driving against the flow of traffic [4][5]. Some drivers intentionally disobey traffic rules, engaging in unacceptable behaviors [9]. Furthermore, forcing the right-of-way is a particularly significant issue leading to accidents, reflecting a driver's choice to disregard established rules [7]. This type of reckless driving endangers not only the driver and passengers but also other road users, making it one of the leading causes of accidents and fatalities on Malaysian roads.

2.4 Lack of Proper Driving Training

These factors suggest that many drivers lack the essential skills and knowledge necessary for safe driving [3]. The study indicates that insufficient driving skills significantly contribute to road accidents, implying that drivers may not have received adequate instruction or practice to develop the necessary skills for safe and effective driving [8].

2.5 Application of Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP), a general theory of measurement, allows for the creation of ratio scales from both discontinuous and continuous paired comparisons. These comparisons can be made using actual measurements or a fundamental scale that reflects varying degrees of preferences and emotions [6]. Common practices for constructing weighted indicators depend on the underlying weighting and aggregation functions [10]. Weights play a crucial role in quantifying the relative importance of various criteria. Generally, criteria weights can be determined through subjective, objective, or a combination of both methods. Subjective methods derive criteria weights based solely on the preferences of decision-makers or experts and include rank-based and pairwise comparison methods.

The AHP, is a mathematical approach used for multi-criteria decision-making (MCDM). AHP utilizes a hierarchical structure of criteria and alternatives, making it one of the most popular decision-making methods due to its use of pairwise comparisons to incorporate qualitative information [11]. Numerous studies have applied AHP across various domains, including weights in the social life cycle assessment of mobility services, as it is a widely used method for weighing environmental and social aspects in sustainability assessments [12], and selecting the most economically advantageous tender in Italian public procurement, allowing for the evaluation of both qualitative and quantitative components of public tenders [13]. Another study applied AHP in internship selection, assisting students who faced difficulties in choosing the ideal internship by analyzing the scores of influencing factors [14], and in road selection, by prioritizing roads with significant contextual characteristics while maintaining the integrity of the road network [15]. Fernandez [3] concluded that using AHP to prioritize road accident factors is a valid approach. Additionally, AHP is frequently employed to address complex real-life problems, helping to determine the weight of criteria, rank alternatives, or do both simultaneously [16].

AHP assists decision-makers in systematically and quantitatively comparing the relative importance of various factors or criteria. Therefore, the application of AHP in this study is robust and minimizes bias, as the judgment regarding weights depends on the respondents' decisions.

3 METHODOLOGY

3.1 Data Collection

This study employed a quantitative approach using the AHP. Data collection was conducted from September 2023 until December 2023 through Google Forms questionnaires, allowing respondents to indicate their preferences for various road accident factors. The ideal sample size calculated was 379 respondents (based on a population of 27,732 undergraduates), the study obtained responses from 247 students, representing a 65.17% achievement of the target sample size.

The preference level reflects the value that indicates the order or position on a scale, where a higher level of preference signifies that the respondent favors that particular factor more than others. Conversely, a lower level of preference indicates that the respondent prefers another factor over the one in question. Table 2 below illustrates the preference levels and their corresponding numerical values. Each rating on the scale is based on a comparison between two items or alternatives.

Table 2 : Preference scale for AHP pairwise comparison

Preference Level	**AHP scale of important**
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

3.2 Model Development

Model development will be the first phase of the research design. During this stage, the problem statement will be established. From the developed model, the researcher will identify the main objectives that need to be achieved, along with the criteria and alternatives selected for this study. This research will focus on prioritizing road accident factors among students at UUM using the AHP. Figure 1 below illustrates the hierarchical structure of road accident factors at UUM.

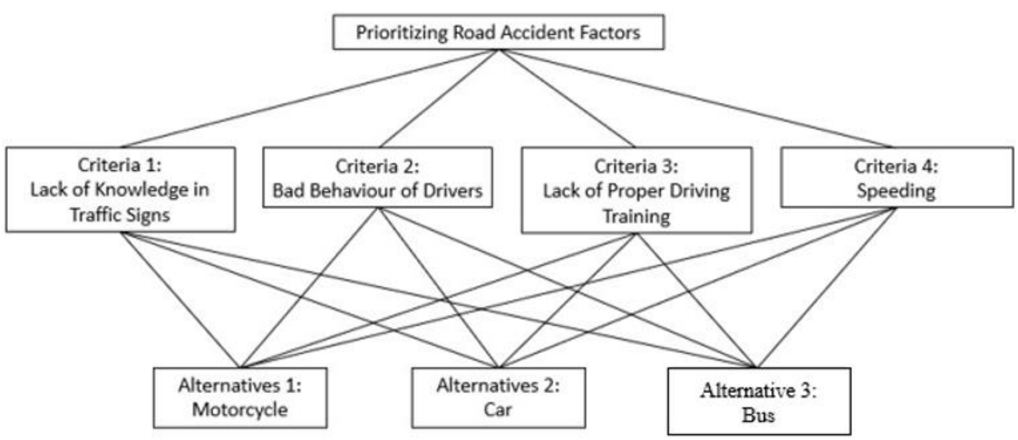

Figure 1 : Hierarchical structure of road accident factors at UUM.

Figure 1 illustrates the hierarchical decision-making structure established using the Analytic Hierarchy Process (AHP) framework. At the top level, the overall objective of the study is defined as

Prioritizing Road Accident Factors. The second level outlines four main risk criteria evaluated to achieve this objective: Criteria 1 (Lack of Knowledge in Traffic Signs), Criteria 2 (Bad Behaviour of Drivers), criteria 3 (Lack of Proper Driving Training), and Criteria 4 (Speeding). Finally, the third level details the decision alternatives, consisting of three vehicle types: Alternative 1 (Motorcycle), Alternative 2 (Car), and Alternative 3 (Bus). The interconnecting lines across the levels demonstrate how each vehicle alternative is evaluated against each of the four identified risk factors through pairwise comparisons.

3.3 Data Analysis

Data collected via the completed questionnaires are first analyzed and subsequently structured into a matrix format following equation (1). The relative preferences are assigned using Saaty's 1–9 fundamental scale as shown in Table 2.

$$M = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a_{21} & 1 & \dots & a_{2n} \\ \dots & \dots & 1 & \dots \\ a_{m1} & a_{m2} & \dots & 1 \end{bmatrix} \quad (1)$$

Using Microsoft Excel, the construct matrices are evaluated to determine the priority weights for all criteria and alternatives. A synthesis procedure is subsequently applied to establish the preference matrix, enabling the computation of the final aggregated score for each decision alternative. The synthesization process is a critical component of the AHP. The first step involves summing the values in each column of the pairwise comparison matrices. Next, each value in the column is divided by the corresponding column sum. After normalization, the average of the values in each row of the normalized matrix is calculated. This results in a combined preference vector for each criterion. Subsequently, a pairwise comparison matrix is developed for the criteria. Once this matrix is created, the normalized matrix is computed, and the row averages and column totals for each criterion are calculated. This process leads to the development of the preference vector. The numerical values obtained from these procedures represent the preferences for each criterion. Finally, the preferences for each site are multiplied by the preference vector for each criterion. At the end of this process, the scores for each alternative, such as cafes, will be ranked to determine the significant road accident factors.

3.4 Data Evaluation

The next step in the AHP process involves calculating the Consistency Ratio (CR). The consistency ratio assesses the degree of consistency in the respondents' judgments, who are regarded as experts, in relation to one another. A CR threshold of equal to or less than 0.10 is required to ensure that the decision is reliable and valid [17]. Calculating the CR requires determining the Consistency Index (CI) first, as formulated in Equation (2).

$$\text{Consistency Index (CI)} = \frac{\text{Average of Consistency Measure} - \text{n}}{\text{n} - 1} \quad (2)$$

Where *n* denotes the number of rows in the matrix.

The Consistency Ratio (CR) calculation is as presented in equation (3):

$$Consistency\ Ratio\ (CR) = \frac{Consistency\ Index\ (CI)}{Random\ Index\ (RI)} \tag{3}$$

The Random Index (RI), established by [17] is outlined in Table 3:

Table 3 **:** Random index

n	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

If the degree of consistency is below 0.10, the results are considered acceptable; otherwise, the pairwise comparison procedure must be reevaluated and repeated until an acceptable result of 0.10 or lower is achieved.

4 RESULTS AND DISCUSSION

This section first presents the demographic distribution of the surveyed participants. Next, it outlines the AHP results, detailing the priority rankings of the road accident criteria and vehicle alternatives. Concluding the section is a discussion on the primary insights and practical implications of these findings for road safety. A total of 247 responses were collected through an online survey; the demographic breakdown of the sample is presented in Table 4.

Table 4 : Demographic profile

Demographic	**Classification**	**Frequency**
Gender	Male	60
	Female	187
Ethnicity	Malay	116
	Chinese	82
	Indian	39
	Others	10
Years of study	1	13
	2	25
	3	63
	4	146

In terms of gender distribution, female respondents represented the majority of the sample 75.7%, while male respondents accounted for 24.3%. Regarding ethnic composition, the largest group was

Malay (47%), followed by Chinese (33.2%), Indian (15.8%), and individuals belonging to other ethnic groups (4.0%). Analysis of the academic seniority (years of study) indicates that final year students (Year 4) comprised the largest proportion of participants.

Table 5 : Priority ranking of road accident factors

Factors	Average score	Ranking
Lack of Proper Training	0.2694	1
Speeding	0.2565	2
Lack of Knowledge of Traffic Signs	0.2384	3
Bad Driving Behaviour	0.2356	4

Table 5 presents the priority weights and corresponding rankings of the evaluated road accident factors derived from the AHP. Among the four criteria, lack of proper training emerged as the most critical factor contributing to road accidents, securing the highest priority weight of 0.2694. Speeding was identified as the second most dominant factor, with an average score of 0.2565. Lack of knowledge of traffic signs and bad driving behaviour yielded lower priority weights, ranking third (0.2384) and fourth (0.2356), respectively. These results indicate that formal driving instruction and speed management are perceived as the primary determinants of road safety risks relative to sign comprehension and behavioral attributes.

Table 6 : Priority ranking for alternatives

Alternatives	Average score	Ranking
Cars	0.5947	1
Motorcycles	0.2868	2
Buses	0.1185	3

Table 6 details the final synthesized priority scores and overall rankings for the three vehicle alternatives evaluated in this study. Among the transport modes, cars recorded the highest priority weight by securing an average score of 0.5947 (Rank 1). Motorcycles placed second with an average score of 0.2868 (Rank 2), while buses received the lowest priority score of 0.1185 (Rank 3). These findings demonstrate that cars are perceived as the primary vehicle category associated with or impacted by the prioritized accident risk factors, followed by motorcycles and public buses.

Thus, the objectives of this study have been achieved. The key factors contributing to the prioritization of road accident causes among students at UUM include a lack of knowledge about traffic signs, speeding, lack of proper driving training, and bad driving behavior. The application of the AHP revealed that cars had the highest average score among the three vehicle alternatives, followed by motorcycles and buses. In terms of criteria, the lack of proper training received the highest average score, identifying it as the primary factor contributing to road accidents among UUM students. These findings suggest that traffic safety interventions, regulatory policies, and targeted enforcement should prioritize passenger car operators and focus heavily on improving formal driver education standards and speed control mechanisms to effectively mitigate road safety risks.

5 CONCLUSION AND RECOMMENDATION

This study provides crucial empirical insights into the factors influencing traffic safety risks among UUM students. The AHP results demonstrate that lack of proper training and speeding represent the primary criteria contributing to road accidents, while cars emerged as the vehicle mode associated with the highest risk. To achieve the overarching goal of reducing traffic incidents and fostering a safer campus environment, target intervention strategies must align directly with these identified priorities:

Enhanced Driver Training Programs (Addressing Priority 1 Factor)
Given that lack of proper training emerged as the leading cause of road safety risks, university management should collaborate with local transport authorities to institute campus wide driver enhancement programs. Special workshops focusing on defensive driving, hazard perception, and student-driver awareness should be mandated, particularly targeting new student vehicle permit applicants, to bridge the gap between basic licensing requirements and practical road safety competency.

Speed Management Technology and Enforcement (Addressing Priority 2 Factor)
With speeding ranked as the second most critical criterion, technological interventions should be deployed across high-risk campus zones. Implementing automated speed monitoring systems, electronic speed display signs, and intelligent traffic calming measures (such as radar speed displays and redesigned speed tables) can effectively enforce campus speed limits and provide real-time feedback to deter speeding among student drivers.

Target-Specific Focus on Passenger Cars (Addressing Top Vehicle Alternative)
Because passenger cars accounted for nearly 60% of the overall priority weight, campus traffic enforcement and safety policies should focus heavily on car operators. Tailored interventions, such as stricter campus vehicle permit regulations, routine safety checks, and dedicated lane safety guidelines should prioritize car drivers without neglecting motorcycle safety.

Traffic Sign Awareness and Behavioral Modification (Addressing Secondary Factors)
Although lack of knowledge of traffic signs and bad driving behaviour received comparatively lower weights, they remain integral components of overall traffic safety. Campus wide awareness campaigns, educational drives on traffic sign compliance, and incentive based behavioral modification programs should be maintained as complementary measures to mitigate distracted and aggressive driving behaviors.

REFERENCES

[1] W.H Organization. (2023). Road Traffic Injuries. [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/road-trafficinjuries.

[2] H. Reduan. (2017). UUM student and friend died on the spot in crash. [Online]. Available: https://www.nst.com.my/news/nation/2017/09/277386/uum-student-and-friend-diedspot-crash.

[3] J. J. Fernandez *et al,* “Driver’s road accident factor prioritization using AHP in relation to mastery of traffic signs in the city of Manila,” *Transportation Research Procedia*, vol. 48, pp. 1316-1324, 2020.

[4] M. Mohamed and N. F. Bromfield, “Attitudes, driving behavior, and accident involvement among young male drivers in Saudi Arabia,” *Transportation Research Part F: Traffic Psychology and Behaviour,* vol. 47, pp. 59-71, 2017.

[5] A. K. Jameel and H. Evdorides, “Developing a safer road user behaviour index,” *IATSS Research*, vol. 45, no.1, pp. 70-78, 2021.

[6] Z. Sultan, N. I. Ngadiman, F. D. A. Kadir, N. F. Roslan, and M. Moeinaddini, “Factor analysis of motorcycle crashes in Malaysia,” *Journal of the Malaysian Institute of Planners,* vol. 14, no. 4, pp.135-146, 2016.

[7] J. Sordyl, “Application of the AHP method to analyze the significance of the factors affecting road traffic safety,” *Transport Problems*, vol. 10, no. 2, pp. 57-68, 2015.

[8] K. V. Raja, M. Ponnusamy, G. T. Selvi, R. Saravanakumar, M. Ashok, and V. Nagaraj, “Assessment and prioritization of the critical factors triggering road accidents in India,” *International Journal of Safety and Security Engineering*, vol. 11, no. 2, pp. 207-211, 2021.

[9] G. O. Camilo and C. Pedraza, “Modern data sources and techniques for analysis and forecast of road accidents: A review,” *Journal of Traffic and Transportation Engineering*, vol. 7, no. 4, pp. 432-446, 2020.

[10] P. Zhou, l. Fan and D. Zhou, “Data aggregation in constructing composite indicators: A perspective of information loss,” *Expert Systems with Applications*, vol. 37, no. 1, pp. 360–365, 2010.

[11] T. L. Saaty, “How to make a decision: The analytic hierarchy process,” *European Journal of Operational Research*, vol. 48, no. 1, pp. 9–26, 1990.

[12] G. Katharina, M. Traverso and J. Hetterich, "Using analytical hierarchy process (AHP) to introduce weights to social life cycle assessment of mobility services," *Sustainability,* vol. 13, no. 3, pp. 1258, 2021.

[13] G. Marcarelli and A. Nappi, "Multicriteria approach to select the most economically advantageous tender: The application of AHP in Italian public procurement," *Journal of Public Procurement*, vol. 19, no. 3, pp. 201-223, 2019.

[14] H. Wang, J. Jiang, M. Sun and Y. Xiao, "Analytic Hierarchy Process Based Internship Selection,” *Journal of Physics: Conference Series,* vol. 1903, no. 1, 2021.

[15] Y. Han, Z. Wang, X. Lu and B. Hu, "Application of AHP to road selection," *International Journal of Geo-Information,* vol. 9, no, 2, pp. 86, 2020.

[16] G. Piotr, and H. Tylicki, "Methodology for optimizing factors affecting road accidents in Poland," in *Forecasting* 5(1), (2023), pp. 336-350. https://doi.org/10.3390/forecast5010018

[17] T. L. Saaty, (1980). "The Analytic Hierarchy Process," New York: McGraw Hill, 1980.