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Original Article

Driving License Testing Quality and Driver Competence in Urban Traffic Safety

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Abstract

Road traffic accidents remain a pressing public safety concern in rapidly urbanizing cities. In Bekasi City, accident cases rose from 683 in 2022 to 1,146 in 2025, with a growing proportion of perpetrators found to be licensed drivers, raising questions about whether the driving license (SIM) testing system adequately ensures driver competence. This study examines the relationship between the quality of SIM testing and driver competence, focusing on hazard perception, safety knowledge, and driving behavior in Bekasi City. A quantitative approach was employed using Analysis of Variance (ANOVA) within the General Linear Model (GLM) framework, involving 120 respondents: 60 SIM A (car drivers) and 60 SIM C (motorcycle riders). Data were collected through questionnaires based on official SIM training modules. The results show that for SIM A drivers, the model significantly affects hazard perception and safety knowledge (Sig. = 0.000), but not driving behavior (Sig. = 0.102), with R^2 values of 0.818, 0.568, and 0.197, respectively. For SIM C riders, the model is significant across all variables (Sig. = 0.000), with R^2 values of 0.696, 0.633, and 0.562. Age and driving experience significantly influence cognitive aspects, while license ownership shows a consistently strong effect (Sig. = 0.000). Questionnaire accuracy ranged from 78% to 92% across all categories. Despite high cognitive scores, a gap persists between knowledge and actual driving behavior, particularly among SIM A drivers. It is recommended that the system incorporate behavior-based evaluations and real-world driving assessments to improve road safety outcomes.

Keywords: Driver Competence, Driving License Test, Road Safety, Traffic Accidents.

1. Introduction

Traffic accident data in Bekasi City for the period 2021-2025 show a relatively consistent increasing trend, particularly over the last three years. The number of traffic accidents was recorded at 683 cases in 2022, rising significantly to 912 cases in 2023, remaining relatively stable at 921 cases in 2024, and then increasing sharply to 1,146 cases in 2025. This pattern indicates that road safety issues in Bekasi City have not demonstrated sustainable improvement; instead, they tend to worsen, especially with the substantial increase observed in the most recent year.

Figure 1 illustrates this upward trend in accident frequency from 2021 to 2025, based on data from the Indonesia National Traffic Corps Police (2026). In terms of casualties, a more complex dynamic can be observed across different severity levels. Fatalities fluctuated, with 80 deaths recorded in 2022, slightly increasing to 81 in 2023, decreasing to 56 in 2024, and rising again to 62 in 2025. Meanwhile, severe injuries showed a significant upward trend in the long term, increasing from 103 cases in 2022 to 157 in 2023, slightly declining to 137 in 2024, and then rising sharply to 298 in 2025. On the other hand, minor injuries exhibited a consistent and substantial increase, from 788 cases in 2022 to 921 in 2023, further rising to 983 in 2024, and reaching 1,143 in 2025.

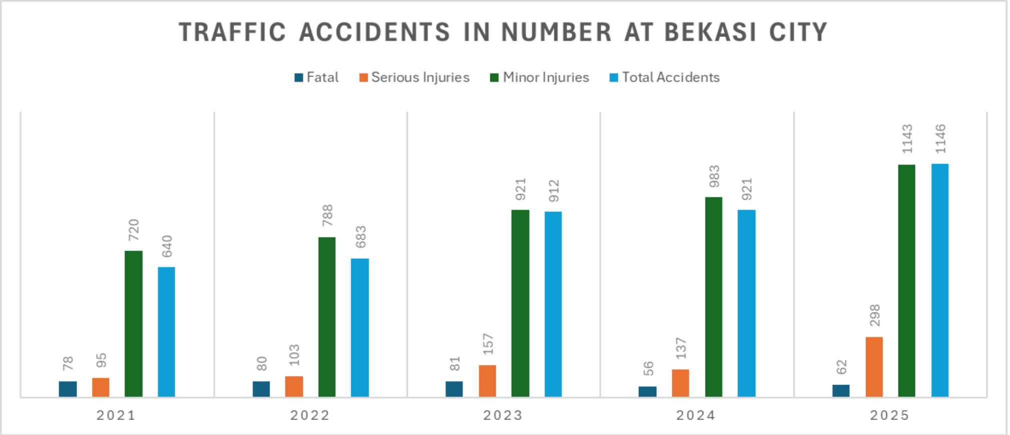

Figure 1. Traffic Accidents in Number at Bekasi City (2021-2025)
Source: Indonesia National Traffic Corp Police, 2026

Overall, despite a temporary decline in fatalities in 2024, the significant increase in the number of accidents, along with the sharp rise in severe and minor injuries in 2025, indicates that road safety risks in Bekasi City remain very high. This condition suggests that existing improvements are not yet structural in nature, thereby requiring more comprehensive interventions, including enhancements in road safety systems and an evaluation of the effectiveness of the driving license (SIM) testing system as a tool to ensure driver competence. Urban road environments with high traffic density and complex road networks are consistently associated with elevated accident risk, as driver competence in processing hazards is particularly challenged under such conditions (McCarty et al., 2025; Najaf et al., 2018).

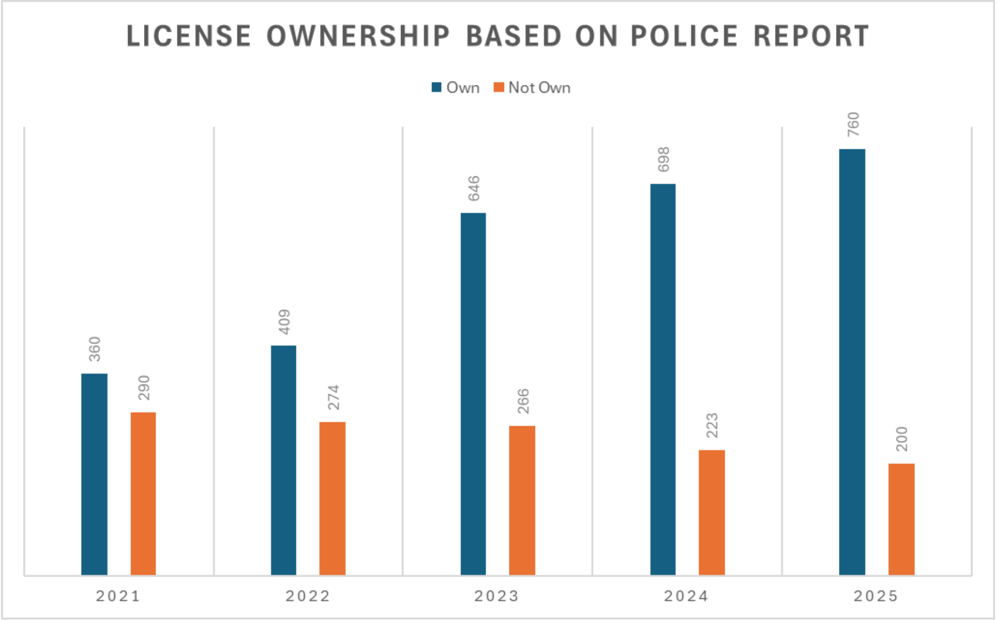

Figure 2. License Ownership Based on Police Report at Bekasi City (2021-2025)
Source: Indonesia National Traffic Corp Police, 2026

In the context of road safety, a driving license (SIM) plays a crucial role as a legal instrument that signifies an individual's eligibility to operate a motor vehicle. A SIM should not merely serve an administrative function but must also represent the driver's technical competence and understanding of traffic rules and ethics. WHO (2024) emphasizes that the quality of driving license testing significantly contributes to driving safety and driver discipline. High-quality driving license testing that integrates cognitive and on-road assessments has been positively correlated with improved urban traffic safety outcomes, though further research is needed to standardize multi-modal testing protocols (Hafetz et al., 2025; Scott et al., 2023).

As shown in Figure 2, data on driving license ownership among drivers involved in traffic accidents in Bekasi City, based on police reports for the period 2021-2025, indicate a consistent increase in the proportion of drivers holding a SIM. The number of drivers with a SIM was recorded at 409 in 2022, rising significantly to 646 in 2023 and further increasing to 698 in 2024, with an estimated increase to approximately 760 in 2025. In contrast, in 2021, the figure was relatively lower, at around 360 drivers. This trend suggests that, in recent years, a growing proportion of accident perpetrators are drivers who are legally licensed.

Conversely, the number of drivers without a SIM has shown a gradual decline. In 2022, there were 274 drivers without a SIM, decreasing to 266 in 2023 and further to 223 in 2024, with an estimated decline to around 200 in 2025. In 2021, this figure was higher, at approximately 290 drivers. This decrease indicates an improvement in administrative compliance regarding SIM ownership, likely influenced by stronger law enforcement and increased public awareness.

However, these findings also reveal that the increase in SIM ownership is not directly proportional to a reduction in traffic accidents. The fact that the majority of accident perpetrators are licensed drivers suggests that legal compliance does not necessarily reflect adequate driving competence. In other words, possessing a SIM is not yet a reliable indicator of safe driving behavior. This gap between license ownership and actual safe driving behavior has also been documented in broader transportation research, where passing a licensing test does not guarantee real-world driving competence particularly where institutional supervision is weak (Baran et al., 2026; Sun et al., 2019).

This condition highlights the need for a more in-depth evaluation of the SIM testing system, including its test materials, assessment methods, and passing standards. The testing process should not only focus on administrative requirements but also ensure that drivers possess the necessary knowledge, skills, and behavior aligned with road safety principles. Therefore, this study is relevant in examining the relationship between the quality of SIM testing and driver behavior, as well as its implications for road safety in Bekasi City.

Nevertheless, several issues within the SIM testing system in Indonesia persist. The International Center for Automotive Policy (2021) notes a mismatch between SIM test results and actual driving skills in real-world conditions. Weak supervision and the widespread use of intermediaries in the licensing process further exacerbate this issue, potentially lowering overall road safety standards. Research consistently identifies a discrepancy between driving test performance and actual on-road driver behavior, with many licensed drivers continuing to exhibit unsafe driving practices even after formal certification (Baran et al., 2026; Sundström, 2011).

Traffic conditions in Bekasi City also exhibit a high level of complexity. As part of the Greater Jakarta (Jabodetabek) metropolitan area, Bekasi experiences dense daily mobility. According to the Bekasi Metro Police (2022), the city has a relatively high accident rate compared to surrounding areas, with driver behavior identified as the primary contributing factor. Considering the high accident rate and the potential role of the SIM testing system as a safety control instrument, it is necessary to conduct a comprehensive assessment of the quality of SIM testing in Bekasi City. This study aims to evaluate the extent to which the current SIM testing system contributes to driver behavior and road safety, as well as to provide recommendations for improving its effectiveness in reducing traffic accidents.

2. Literature Review

2.1. Driving License System in Indonesia

The driving license system in Indonesia, known as Surat Izin Mengemudi (SIM), functions as a legal instrument that certifies an individual's eligibility to operate motor vehicles on public roads. Beyond its administrative role, the SIM is intended to ensure that drivers possess adequate knowledge, technical skills, and behavioral competencies necessary for safe driving. The system is regulated under national traffic laws and implemented by the Indonesian National Police through standardized testing procedures, including both theoretical and practical examinations.

In Indonesia, driving licenses are categorized based on the type of vehicle operated, with the most common categories being SIM A and SIM C. SIM A is designated for drivers of passenger cars and light vehicles with a maximum permissible weight of up to 3,500 kilograms. This category primarily represents private car users and requires competencies related to vehicle control, traffic regulation compliance, and safe maneuvering in various road conditions. The dominance of motorcycle users in Indonesian traffic underscores the importance of ensuring that SIM C testing adequately measures the specific hazard perception and behavioral demands of two-wheeled vehicle operation in dense urban conditions (Halim et al., 2025; Puspasari et al., 2026).

On the other hand, SIM C is issued for motorcycle riders, who represent the majority of road users in Indonesia. A naturalistic driving study confirms that motorcycles account for approximately 85% of motorized vehicles on Indonesian roads (Halim et al., 2025). In recent developments, SIM C has also been further classified into subcategories based on engine capacity, reflecting the need for more specific competency standards. This distinction is echoed in recent research comparing private riders and motorcycle taxi riders, which identified different riding behavior patterns between the two groups, reinforcing the rationale for differentiated competency standards based on rider type or vehicle characteristics (Puspasari et al., 2026).

The theoretical component of the SIM test is designed to evaluate drivers' understanding of traffic rules, road signs, hazard perception, and safe driving principles. Recent developments introduced by the Indonesian National Police emphasize a more structured and modular approach, incorporating dimensions such as hazard perception, driving insight, and safety knowledge. These components reflect international best practices, where cognitive and behavioral aspects are increasingly recognized as critical determinants of road safety. International evidence confirms that knowledge-based assessments, when well-designed and validated, can meaningfully predict driver behavior particularly in identifying drivers who lack adequate hazard awareness (Pradhan et al., 2006; Walshe et al., 2022).

Despite these regulatory frameworks, several studies highlight persistent challenges in the effectiveness of the SIM system in Indonesia. One key issue is the discrepancy between the results of driving tests and actual driver behavior in real-world conditions. This concern aligns with international literature, which notes that traditional testing methods focused mainly on basic operational skills are insufficient for capturing the multifaceted demands of urban driving, and that multi-modal assessment approaches are needed (Scott et al., 2023; Hafetz et al., 2025).

Another critical issue involves institutional and procedural weaknesses, including inconsistent enforcement, limited supervision, and the prevalence of informal practices in the licensing process. The use of intermediaries or "brokers" in obtaining driving licenses has been frequently reported, potentially undermining the integrity of the system and lowering the overall standard of driver qualification. Such practices reduce the effectiveness of the SIM as a tool for ensuring road safety and contribute to systemic risks in traffic environments. Driver behavior profiling research further indicates that behavioral outcomes in real-world conditions are shaped by a broader set of cognitive, experiential, and environmental factors that static written tests cannot fully capture (Al-Rababah et al., 2026; Kumar et al., 2025).

From a broader perspective, the role of driving license systems in improving road safety has been widely acknowledged in international literature. The World Health Organization (WHO) emphasizes that rigorous licensing systems, including high-quality testing and enforcement mechanisms, are essential components of road safety strategies. Graduated Driver Licensing (GDL) programs provide evidence of this, demonstrating significant crash reductions among young drivers when combined with nighttime driving and passenger restrictions and supported by active enforcement (Fell et al., 2011; Fohr et al., 2005).

In the Indonesian context, however, the increasing number of traffic accidents despite rising levels of SIM ownership suggests that the current system may not fully achieve its intended objectives. This condition indicates that the SIM system may function more as an administrative requirement rather than an effective behavioral control mechanism. Consequently, there is a growing need to re-evaluate the quality of SIM testing, particularly in terms of its ability to measure real-world driving competence and influence driver behavior.

Drawing upon prior studies, it can be concluded that while the SIM system in Indonesia has established a formal framework for driver certification, its effectiveness in enhancing road safety remains limited. Thus, further research is required to examine the relationship between the quality of SIM testing and driver behavior, also to identify potential improvements that can strengthen the role of the licensing system in reducing traffic accidents.

2.2. Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) is a statistical method used to determine whether there are significant differences between the means of more than two groups. This method was first introduced by Fisher (1934) and has since been widely applied in various fields, including social sciences, engineering, education, and health studies. The fundamental principle of ANOVA is to compare the variability between groups with the variability within groups. If the between-group variability is significantly greater than the within-group variability, it can be concluded that there is a meaningful difference among the groups being compared.

$$MS_{within} = \frac{SS_{within}}{df_{within}}$$

$$MS_{between} = \frac{SS_{between}}{df_{between}}$$

$$F = \frac{MS_{between}}{MS_{within}}$$

Where:
F = ANOVA test statistic
MS_between (Mean Square Between) = average variance between groups
MS_within (Mean Square Within) = average variance within groups
SS_between (Sum of Squares Between) = sum of squared differences between each group mean and the overall mean
SS_within (Sum of Squares Within) = sum of squared differences between each observation and its group mean
df_between (degrees of freedom between groups) = (k – 1)
df_within (degrees of freedom within groups) = (N – k)

In the context of transportation research, particularly studies examining the relationship between the quality of driving license (SIM) testing and driver safety, ANOVA can be applied to analyze whether there are significant differences in theoretical safety understanding among drivers with different characteristics. For instance, researchers can compare theory test scores between drivers who possess a SIM and those who do not, or between drivers with varying levels of driving experience.

ANOVA is generally classified into several types, including One-Way ANOVA, Two-Way ANOVA, and Repeated-Measures ANOVA. One-Way ANOVA is used when there is a single independent factor, such as driving experience. Two-Way ANOVA is applied when there are two independent factors, for example, type of driving license and level of driving experience. Repeated-Measures ANOVA is used when measurements are taken multiple times on the same subjects, such as before and after a safety training program.

Before conducting ANOVA, several assumptions must be satisfied. These include the normality of data distribution, homogeneity of variances across groups, and independence of observations. Normality is commonly tested using the Shapiro-Wilk test, while homogeneity of variances is assessed using Levene's test. If these assumptions are violated, alternative approaches such as Welch ANOVA or non-parametric tests like the Kruskal-Wallis test can be employed.

In practice, ANOVA produces an F-statistic, which represents the ratio of between-group variance to within-group variance. A higher F-value, combined with a p-value less than 0.05, indicates that there are statistically significant differences between the groups. When significant results are obtained, post-hoc tests such as Tukey HSD or Games-Howell are conducted to identify which specific groups differ from one another.

The application of ANOVA in this study is highly relevant for identifying whether theoretical understanding of driving license tests differs significantly among groups of drivers with different backgrounds. For example, it can determine whether licensed drivers demonstrate a better understanding of safety theory compared to unlicensed drivers, or whether driving experience influences theoretical comprehension. Therefore, the results of the ANOVA analysis can provide empirical evidence to support improvements in the design of theoretical driving tests, ultimately contributing to enhanced road safety

3. Methods

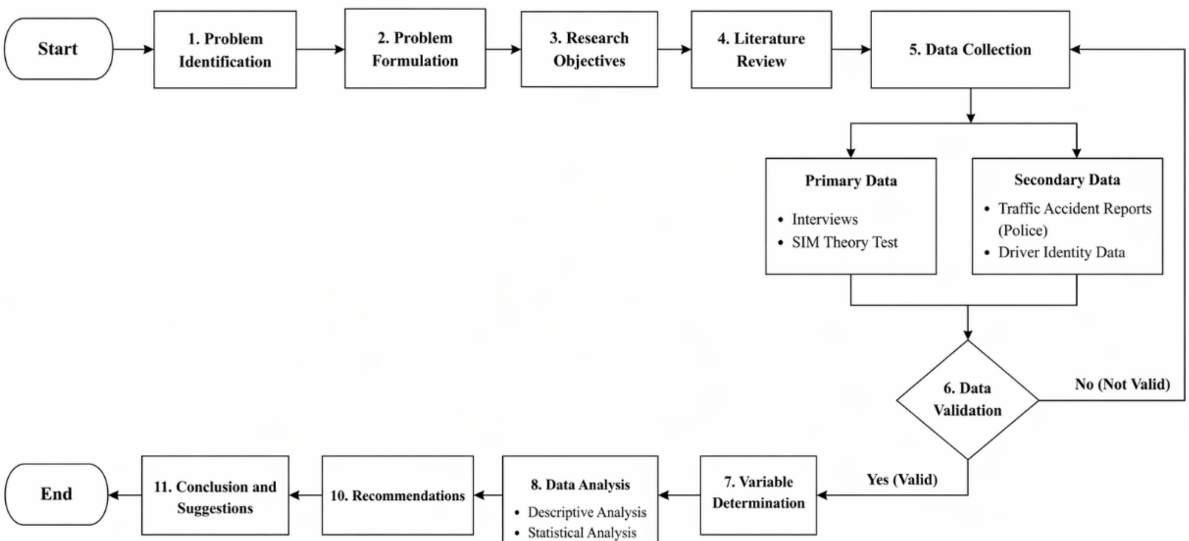

Figure 3. Flowchart Research

As shown in figure 3, this study begins with the problem identification stage, which is based on the increasing trend of traffic accidents and the indication of weaknesses in the driving license (SIM) testing system. The identified problems are then formulated into clear research questions, followed by the establishment of research objectives. To support the theoretical foundation, a literature review is conducted to develop a comprehensive conceptual framework. The data collection process consists of both primary and secondary data. Primary data are obtained through interviews and theoretical SIM testing to capture drivers' understanding and behavior. Meanwhile, secondary data are collected from traffic accident reports, particularly from police records, including information on accident cases and the identity of drivers involved.

All collected data undergo a data validation process to ensure consistency, completeness, and reliability. If the data are found to be invalid, the process returns to the data collection stage for refinement. Once the data meet the required standards, the study proceeds to the variable determination stage, where key variables are defined and structured for analysis. The analysis phase consists of two main approaches, namely descriptive analysis and statistical analysis. Descriptive analysis is used to illustrate general patterns and characteristics of the data, while statistical analysis is applied to examine the relationships between variables.

The results of the analysis are then interpreted to provide meaningful insights into the relationship between the quality of SIM testing, driver behavior, and traffic safety. Based on these findings, the study formulates recommendations aimed at improving the effectiveness of the SIM testing system. Finally, the research concludes with conclusions and suggestions, which summarize the key findings and provide directions for future research and policy improvements.

3.1. Study Design and Data Collection

This study employs a quantitative approach to analyze the relationship between the quality of driving license (SIM) testing, driver behavior, and traffic safety in Bekasi City. The research design integrates both primary and secondary data to provide a comprehensive analysis. Primary data were collected through two main approaches: structured interviews and a theory-based SIM test questionnaire. The questionnaire consists of 60 multiple-choice questions adapted from the official SIM training modules issued by the Indonesian National Police. These questions are designed to measure three key dimensions: hazard perception, driving insight, and safety knowledge. Each response is coded as binary data (1 = correct, 0 = incorrect) to enable statistical analysis.

The study involved a total of 120 respondents, consisting of 60 car drivers (SIM A) and 60 motorcycle riders (SIM C). Respondents were selected to represent varying demographic and driving experience backgrounds, including age, gender, driving experience, and licensing status. Secondary data were obtained from traffic accident reports, including the number of accidents, severity levels, and driver characteristics. These data were used to provide contextual support for analyzing traffic safety conditions in Bekasi City. All collected data underwent a validation process to ensure completeness and consistency prior to analysis.

3.2. Data Analysis Method

The data analysis in this study consists of descriptive and inferential statistical methods. Descriptive analysis is used to present the characteristics of respondents, including age distribution, gender, driving experience, and licensing status. The results are visualized using graphs and charts to illustrate general patterns in the data. Inferential analysis is conducted using Analysis of Variance (ANOVA) to determine whether there are significant differences in safety knowledge, hazard perception, and driving behavior among different groups of drivers.

The independent variables include driver characteristics such as driving experience, licensing status, and frequency of taking the SIM test, while the dependent variables consist of scores derived from the SIM theory test.

Before performing ANOVA, statistical assumptions such as normality and homogeneity of variance are tested using appropriate methods, including the Shapiro-Wilk test and Levene's test. If the assumptions are satisfied, the ANOVA test is conducted to evaluate the differences between groups. A significance level of 0.05 is used as the threshold for determining statistical significance. If significant differences are found, further analysis using post-hoc tests (such as Tukey HSD) is conducted to identify specific group differences. All statistical analyses are performed using statistical software.

4. Results and Discussion

4.1. Research Results

4.1.1. Results of Car Driving License (A)

Based on the results of the Analysis of Variance (ANOVA) using the General Linear Model (GLM) approach for the SIM A group, the overall model demonstrates a statistically significant effect on hazard perception and safety knowledge, but not on driving behavior. This is indicated by the significance values of the corrected model, which are 0.000 for both hazard perception and safety knowledge, and 0.102 for driving behavior.

These findings suggest that the independent variables collectively are able to explain variations in cognitive aspects of driver competence, particularly in understanding risks and safety concepts. However, they do not significantly account for variations in actual driving behavior, indicating that behavioral outcomes may be influenced by additional factors beyond those included in the model.

Table 1. Test Between Subjects of Car Driving License

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III SS	df	Mean Square	F	Sig.
Corrected Model	Hazard Perception	.204[a]	7	.029	33.406	.000
	Safety Knowledge	.233[b]	7	.033	9.758	.000
	Driving Behavior	.635[c]	7	.091	1.823	.102
Intercept	Hazard Perception	.205	1	.205	235.046	.000
	Safety Knowledge	.353	1	.353	103.327	.000
	Driving Behavior	.047	1	.047	.944	.336
Gender	Hazard Perception	.003	1	.003	2.877	.096
	Safety Knowledge	.005	1	.005	1.499	.226
	Driving Behavior	.018	1	.018	.355	.554
Age	Hazard Perception	.002	1	.002	2.089	.154
	Safety Knowledge	.000	1	.000	.045	.834
	Driving Behavior	.025	1	.025	.493	.486
DrivingExperience	Hazard Perception	.002	1	.002	2.297	.136
	Safety Knowledge	.007	1	.007	1.986	.165
	Driving Behavior	.013	1	.013	.269	.606
LicenseOwnership	Hazard Perception	.076	1	.076	87.007	.000
	Safety Knowledge	.024	1	.024	6.989	.011
	Driving Behavior	.001	1	.001	.029	.866
DrivingSchool	Hazard Perception	.015	1	.015	16.762	.000
	Safety Knowledge	.071	1	.071	20.859	.000

Tests of Between-Subjects Effects						
Source	**Dependent Variable**	**Type III SS**	**df**	**Mean Square**	**F**	**Sig.**
TestFrequency	Driving Behavior	.405	1	.405	8.147	.006
	Hazard Perception	.000	1	.000	.172	.680
	Safety Knowledge	.001	1	.001	.191	.664
TestTakenYear	Driving Behavior	.024	1	.024	.478	.492
	Hazard Perception	.000	1	.000	.190	.664
	Safety Knowledge	.000	1	.000	.051	.821
Error	Driving Behavior	.047	1	.047	.941	.336
	Hazard Perception	.045	52	.001		
	Safety Knowledge	.177	52	.003		
	Driving Behavior	2.587	52	.050		
Total	Hazard Perception	15.855	60			
	Safety Knowledge	25.307	60			
	Driving Behavior	12.782	60			
Corrected Total	Hazard Perception	.249	59			
	Safety Knowledge	.410	59			
	Driving Behavior	3.222	59			

[a] R Squared = .818 (Adjusted R Squared = .794)
[b] R Squared = .568 (Adjusted R Squared = .510)
[c] R Squared = .197 (Adjusted R Squared = .089)

When examined at the level of individual variables, driving license ownership demonstrates a significant effect on hazard perception (Sig. = 0.000) and safety knowledge (Sig. = 0.011), but does not show a meaningful influence on driving behavior (Sig. = 0.866). This indicates that legal licensing is more closely associated with an improved understanding of safety-related aspects, yet it does not necessarily translate into safer driving practices in real-world conditions.

Furthermore, formal driving training exhibits a significant contribution across all dependent variables, including hazard perception (Sig. = 0.000), safety knowledge (Sig. = 0.000), and driving behavior (Sig. = 0.006). These findings suggest that structured training plays a more comprehensive role, not only in enhancing cognitive understanding but also in shaping safer driving behavior.

In contrast, other variables such as gender, age, driving experience, test frequency, and the year of the last driving test do not demonstrate statistically significant effects, as all significance values exceed 0.05. This implies that these characteristics do not substantially differentiate driver competence within the SIM A group.

Based on the coefficient of determination (R^2), the model shows a very strong explanatory power for hazard perception ($R^2 = 0.818$) and a moderate level for safety knowledge ($R^2 = 0.568$). However, for driving behavior, the R^2 value is relatively low at 0.197, indicating that the model explains only a limited portion of behavioral variation. The relatively low adjusted R^2 further suggests that additional factors beyond those included in the model are likely influencing driving behavior.

4.1.2. Results of Motorcycle Driving License (C)

To examine the influence of driver characteristics on safety-related outcomes, this study applies ANOVA within the framework of the GLM using a univariate approach. ANOVA is used to determine whether there are statistically significant differences in hazard perception, safety knowledge, and driving behavior across groups of drivers with different characteristics. The independent variables analyzed in this study include gender, age, driving experience, driving license ownership, formal driving training, frequency of taking the driving test, and the year of the last test. Meanwhile, the dependent variables consist of hazard perception, safety knowledge, and driving behavior, which represent key dimensions of driver competence.

The results of the analysis are presented in the Tests of Between-Subjects Effects, which provide F-values and significance levels (Sig.) for each independent variable. A significance level (α) of 0.05 is used as the threshold to determine whether the differences between groups are statistically significant. By means of ANOVA, this study aims to identify which factors significantly shape driver competence and to evaluate whether the current driving license (SIM) system reflects meaningful differences in drivers' safety understanding and behavior.

Table 2. Test Between Subjects of Motorcycle Driving License

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III SS	df	Mean Square	F	Sig.
Corrected Model	Hazard Perception	.594[a]	7	.085	17.035	.000
	Safety Knowledge	.311[b]	7	.044	12.802	.000
	Driving Behavior	.223[c]	7	.032	9.541	.000
Intercept	Hazard Perception	.029	1	.029	5.803	.020
	Safety Knowledge	.017	1	.017	4.964	.030
	Driving Behavior	.015	1	.015	4.460	.040
Gender	Hazard Perception	.000	1	.000	.091	.764
	Safety Knowledge	.008	1	.008	2.166	.147
	Driving Behavior	.002	1	.002	.600	.442
Age	Hazard Perception	.065	1	.065	13.136	.001
	Safety Knowledge	.056	1	.056	16.174	.000
	Driving Behavior	.020	1	.020	6.113	.017
DrivingExperience	Hazard Perception	.022	1	.022	4.517	.038
	Safety Knowledge	.026	1	.026	7.371	.009
	Driving Behavior	.008	1	.008	2.422	.126
LicenseOwnership	Hazard Perception	.151	1	.151	30.343	.000
	Safety Knowledge	.050	1	.050	14.316	.000
	Driving Behavior	.078	1	.078	23.206	.000
DrivingSchool	Hazard Perception	.001	1	.001	.175	.677
	Safety Knowledge	.003	1	.003	.944	.336
	Driving Behavior	.005	1	.005	1.467	.231
TestFrequency	Hazard Perception	.000	1	.000	.078	.781
	Safety Knowledge	.009	1	.009	2.468	.122
	Driving Behavior	.002	1	.002	.522	.473
TestTakenYear	Hazard Perception	.001	1	.001	.275	.602
	Safety Knowledge	.001	1	.001	.315	.577
	Driving Behavior	9.157E-5	1	9.157E-5	.027	.869
Error	Hazard Perception	.259	52	.005		
	Safety Knowledge	.180	52	.003		
	Driving Behavior	.174	52	.003		
Total	Hazard Perception	49.543	60			
	Safety Knowledge	37.465	60			
	Driving Behavior	18.602	60			
Corrected Total	Hazard Perception	.852	59			
	Safety Knowledge	.491	59			
	Driving Behavior	.397	59			

[a] R Squared = .696 (Adjusted R Squared = .655)
[b] R Squared = .633 (Adjusted R Squared = .583)
[c] R Squared = .562 (Adjusted R Squared = .503)

Based on the results of the ANOVA using the GLM, the overall model shows a statistically significant effect on all dependent variables, namely hazard perception, safety knowledge, and driving behavior. This is indicated by the significance values of the corrected model, which are all below the 0.05 threshold (Sig. = 0.000). These findings confirm that the independent variables collectively contribute to explaining variations in driver competence. From a partial analysis, several independent variables demonstrate significant effects. The variable age shows a strong and statistically significant influence on all three dependent variables, with significance values of 0.001 for hazard perception, 0.000 for safety knowledge, and 0.017 for driving behavior. This indicates that differences in age are associated with variations in drivers' ability to perceive hazards, understand safety concepts, and exhibit safe driving behavior.

Similarly, driving experience significantly affects hazard perception (Sig. = 0.038) and safety knowledge (Sig. = 0.009), although its effect on driving behavior is not statistically significant (Sig. = 0.126). This suggests that driving experience contributes more to cognitive aspects of driving rather than directly influencing behavioral outcomes. The variable driving license ownership (SIM C) shows a highly significant effect across all dependent variables, with significance values of 0.000. This finding indicates that licensed motorcycle riders tend to have better hazard perception, higher safety knowledge, and more appropriate driving behavior compared to those without a license. This highlights the importance of licensing as a key factor in shaping driver competence among motorcycle users.

On the other hand, variables such as gender, formal driving training, test frequency, and year of last test do not show statistically significant effects, as their significance values are above 0.05. This suggests that these factors do not play a dominant role in differentiating driver competence within the SIM C group. The coefficient of determination (R^2) indicates that the model has strong explanatory power. The R^2 values are 0.696 for hazard perception, 0.633 for safety knowledge, and 0.562 for driving behavior. These values indicate that more than half of the variation in driver competence can be explained by the independent variables included in the model.

4.2. Discussion

The findings of this study reveal that the determinants of driver competence differ across cognitive and behavioral dimensions, as well as between SIM A (car drivers) and SIM C (motorcycle riders). Across both groups, several variables particularly age, driving experience, and driving license ownership show meaningful associations with hazard perception and safety knowledge. These results indicate that cognitive aspects of driving competence are influenced by a combination of maturity and exposure to driving conditions. In contrast, driving behavior appears less consistently explained by the tested variables, especially in the SIM A group, suggesting that behavioral outcomes are more complex and influenced by situational and contextual factors beyond individual characteristics.

This pattern is consistent with international literature, which highlights that cognitive competence assessed through testing does not always transfer directly into safe on-road behavior, particularly when licensing systems emphasize theoretical knowledge over behavioral application (Hafetz et al., 2025; Sundström, 2011). The relatively low R^2 for driving behavior in the SIM A group ($R^2 = 0.197$) reflects this limitation which the model captures knowledge well but explains only a small proportion of behavioral variation.

A notable distinction between the two groups lies in the role of formal driving training and licensing. For SIM A drivers, formal driving training demonstrates a strong and consistent influence across all dimensions, including driving behavior, indicating that structured learning plays a critical role in shaping both knowledge and practice. This supports evidence from driver training research, which finds that structured, supervised training environments produce more durable improvements in driver behavior than knowledge-based testing alone (Pradhan et al., 2006; Sun et al., 2019). Meanwhile, in the SIM C group, driving license ownership emerges as a dominant factor influencing hazard perception, safety knowledge, and behavior. This finding aligns with research on motorcycle rider behavior, which identifies licensing as a key differentiator in hazard recognition and behavioral compliance, particularly given the higher real-time risk exposure of two-wheeled vehicle operation (Puspasari et al., 2026; Halim et al., 2025).

Despite these differences, a common pattern emerges: cognitive competence does not always translate into safe driving behavior. This gap suggests the current SIM testing system places greater emphasis on theoretical knowledge than behavioral application. In line with international frameworks including WHO guidelines and validated assessment research, effective licensing systems should integrate behavioral assessment and real-world driving scenarios such as simulator-based evaluations and structured on-road tests into the certification process (Mullen et al., 2011; Walshe et al., 2022). Machine learning-based driver profiling approaches further demonstrate that integrating multi-source data including cognitive scores, physiological indicators, and driving history produces significantly more accurate assessments of driver competence than written tests alone (Al-Rababah et al., 2026; Kumar et al., 2025).

Therefore, improving the quality of SIM testing in Indonesia requires not only strengthening theoretical components but also enhancing mechanisms that ensure the transfer of knowledge into consistent and safe driving behavior.

5. Conclusion

This study concludes that the influence of driver characteristics on safety-related outcomes differs across SIM A and SIM C groups and across cognitive and behavioral dimensions. For SIM A drivers, the overall model shows a significant effect on hazard perception and safety knowledge (Sig. = 0.000), but not on driving behavior (Sig. = 0.102). Driving license ownership significantly affects hazard perception (Sig. = 0.000) and safety knowledge (Sig. = 0.011), while formal driving training significantly influences all variables, including driving behavior (Sig. = 0.006). The model demonstrates strong explanatory power for hazard perception ($R^2 = 0.818$) and moderate for safety knowledge ($R^2 = 0.568$), but relatively weak for driving behavior ($R^2 = 0.197$). In contrast, for SIM C riders, the model is significant across all dependent variables (Sig. = 0.000), with age showing consistent influence on hazard perception (Sig. = 0.001), safety knowledge (Sig. = 0.000), and driving behavior (Sig. = 0.017). Driving experience also significantly affects hazard perception (Sig. = 0.038) and safety knowledge (Sig. = 0.009), while license ownership significantly influences all variables (Sig. = 0.000). The explanatory power of the model is strong, with R^2 values of 0.696, 0.633, and 0.562 for hazard perception, safety knowledge, and driving behavior, respectively.

Based on these findings, it is recommended that the improvement of the driving license (SIM) system should prioritize bridging the gap between knowledge and behavior. Although cognitive competence is relatively high (accuracy scores ranging from 78% to 92%), behavioral outcomes remain less consistently explained, particularly for SIM A drivers. Therefore, the licensing system should incorporate more behavior-oriented assessments, including real-world driving simulations and stricter practical evaluations. In addition, formal driving training should be expanded and standardized, given its significant impact on both knowledge and behavior. Strengthening these aspects is expected to enhance the effectiveness of the SIM system as a tool not only for administrative validation but also for ensuring safe driving practices.

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