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Analysis of Traffic Accidents in Rejang Lebong Regency

Ricky Ardiansyah[1*], M. Wisridani P.[2]
[1-2] Universitas Ratu Samban, Indonesia
email: rickyardiansyah109@gmail.com[1]

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Abstract

Traffic accidents continue to represent a significant transportation safety challenge in Rejang Lebong Regency, particularly along the Curup–Lubuk Linggau and Curup–Kepahiang corridors, where mountainous terrain, sharp curves, steep gradients, and high traffic intensity increase operational risks. This study aims to analyze the characteristics, contributing factors, and spatial distribution of traffic accidents in Rejang Lebong Regency and to identify accident-prone locations for road safety improvement. A quantitative descriptive approach integrated with spatial and statistical analysis was employed using documented accident records, roadway information, and Geographic Information System (GIS)-based mapping. The results indicate that motorcycles are the most frequently involved vehicles, while accidents are predominantly concentrated on national arterial roads with high traffic exposure. Human factors, including excessive speed, unsafe overtaking, lack of concentration, and non-compliance with traffic regulations, were identified as the primary contributors, followed by roadway geometry, vehicle conditions, and environmental influences. Black spot identification using the Equivalent Accident Number (EAN) and Upper Control Limit (UCL) methods successfully identified several high-risk road segments requiring priority engineering interventions. The findings suggest that integrating spatial analysis with engineering assessment provides a reliable framework for supporting evidence-based transportation safety management. Practical recommendations include improving road safety facilities, strengthening traffic law enforcement and public education, and implementing continuous monitoring of accident-prone locations to reduce accident frequency and severity.

Keywords: *Black Spot Identification, Contributing Factors, Rejang Lebong Regency, Road Safety, Traffic Accidents.*

INTRODUCTION

Road traffic accidents have become a persistent global public safety challenge that increasingly attracts attention from transportation engineering, intelligent computing, and road safety research because accident occurrence is influenced by the dynamic interaction between human behavior, roadway characteristics, vehicle conditions, and environmental factors (World Health Organization, 2023). Recent developments in intelligent engineering have shifted accident analysis from merely documenting crash events toward identifying spatial patterns, risk factors, and predictive indicators capable of supporting evidence-based traffic management and preventive interventions (Behboudi et al., 2024). Within this evolving scientific landscape, accident analysis is no longer viewed solely as a statistical exercise but as a strategic instrument for improving transportation sustainability and reducing socioeconomic losses associated with road crashes. Indonesia continues to experience substantial road safety challenges despite continuous improvements in transportation infrastructure and regulatory frameworks (Korlantas Polri, 2023). National transportation policies have emphasized that systematic traffic management and engineering should integrate road characteristics, traffic flow, and safety considerations into planning and operational decisions (Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 96 Tahun 2015). In this context, regional investigations remain indispensable because accident characteristics are strongly influenced by local geographical conditions, travel behavior, and infrastructure quality, which cannot always be generalized from national-level analyses.

Previous studies consistently demonstrate that traffic accidents emerge through complex interactions among roadway geometry, vehicle operating conditions, human behavior, and traffic

environments rather than through isolated causal mechanisms (Tjahjono et al., 2021). Research conducted on urban roads has increasingly utilized accident equivalent numbers and blackspot identification techniques to prioritize hazardous locations and optimize infrastructure improvement strategies, indicating that spatial accident concentration provides valuable information for safety intervention planning (Azwansyah & Umar, 2026). Similar findings have been reported on primary arterial roads where accident point analysis revealed that traffic volume, road alignment, and environmental characteristics collectively influence accident frequency instead of acting independently (Paikun et al., 2021). Investigations on the Lonjengan–Tanjam road section further emphasize that roadway geometry, traffic composition, and operational conditions substantially affect accident occurrence, illustrating the importance of location-specific engineering assessments (Inong et al., 2025). Studies focusing on driver behavior also reveal that excessive speed, fatigue, reduced vigilance, and risky motorcycle riding substantially increase crash probability across different demographic groups (Umniyatun et al., 2021). These findings collectively indicate that effective accident prevention requires integrating engineering analysis with behavioral assessment because road safety outcomes are shaped by multiple interconnected determinants rather than by infrastructure deficiencies alone.

Despite considerable progress in accident analysis, several conceptual and empirical limitations remain evident within the existing literature. Many studies primarily concentrate on identifying accident-prone locations using quantitative indicators without comprehensively interpreting how local geographical characteristics interact with human and environmental factors to generate accident risks (Nugraha et al., 2024). Investigations conducted in Rejang Lebong have predominantly examined human and environmental influences among specific driver groups, leaving broader district-level accident characteristics insufficiently explored despite the strategic importance of the Curup–Lubuk Linggau corridor (Oktegianda et al., 2019). Current analytical approaches also tend to prioritize urban environments with relatively homogeneous traffic conditions, whereas hilly regions characterized by sharp curves, steep gradients, and mixed traffic movements remain underrepresented in empirical investigations (Siregar et al., 2021). Existing engineering standards and traffic capacity guidelines provide essential technical references for roadway evaluation, yet they do not fully explain spatial variations in accident occurrence without empirical assessment under local operational conditions (Kementerian Pekerjaan Umum, 1997). This unresolved gap suggests that contextual accident analysis integrating regional geographical characteristics with observed accident patterns remains necessary for generating more accurate and operationally relevant safety recommendations.

The urgency of addressing traffic accidents in Rejang Lebong Regency extends beyond reducing crash frequency because road safety directly influences regional mobility, economic productivity, accessibility, and community well-being. Rejang Lebong possesses a topographical landscape dominated by mountainous terrain, sharp horizontal curves, steep ascents and descents, and strategically important transportation corridors that accommodate interregional traffic movement, creating operational conditions substantially different from those of relatively flat urban networks (Badan Pusat Statistik Kabupaten Rejang Lebong, 2024). Such physical characteristics increase driving complexity and require greater adaptation from road users, particularly under fluctuating weather conditions and varying traffic densities. Transportation engineering principles have long recognized that roadway geometry and operational characteristics significantly influence traffic safety performance and should therefore become central considerations in accident analysis (Oglesby & Hicks, 1999). National technical guidance likewise emphasizes systematic identification and treatment of accident-prone locations as a prerequisite for effective road safety improvement programs (Departemen Permukiman dan Prasarana Wilayah, 2004). Strengthening scientific evidence regarding accident characteristics in Rejang Lebong is expected to support more targeted engineering interventions, educational initiatives, and enforcement strategies capable of reducing future accident risks.

Within the broader scientific landscape, this study positions itself at the intersection of transportation engineering, road safety management, and regional accident analysis by examining accident characteristics in Rejang Lebong Regency through an integrated assessment of roadway, environmental, and behavioral factors. Rather than limiting analysis to descriptive accident statistics or isolated blackspot identification, this research seeks to interpret accident occurrence within the broader operational context of regional transportation systems. This perspective aligns with transportation planning theories emphasizing that traffic safety performance emerges from interactions among infrastructure quality, traffic operations, user behavior, and regulatory implementation (Morlok, 1995).

Urban traffic management literature similarly argues that sustainable safety improvements require integrated evaluation of engineering measures and operational management rather than fragmented interventions targeting individual factors alone (Munawar, 2004). Legal and institutional frameworks governing Indonesian road transport further reinforce that accident prevention should combine infrastructure improvement, behavioral compliance, and consistent law enforcement to achieve long-term safety objectives (Republik Indonesia, 2009). Recent legal analyses concerning fatal traffic accidents also underline that preventive engineering measures remain more effective than relying exclusively on post-accident legal responses (Zainin et al., 2026).

This study aims to analyze the characteristics and contributing factors of traffic accidents in Rejang Lebong Regency by examining the interaction between roadway conditions, driver behavior, vehicle factors, and environmental influences within the local transportation system. The research is expected to enrich the theoretical understanding of accident causation in geographically complex regions by demonstrating that regional context substantially shapes traffic safety performance beyond conventional engineering indicators. From a methodological perspective, the study contributes by integrating contextual regional analysis with transportation engineering principles to produce a more comprehensive interpretation of accident patterns that can support evidence-based decision making. The findings are expected to provide practical recommendations for improving road infrastructure planning, traffic management strategies, safety education, and policy implementation while simultaneously strengthening the knowledge base for future intelligent engineering and computing studies focusing on regional transportation safety.

RESEARCH METHODS

This study employed an empirical quantitative research design using a descriptive approach integrated with spatial and statistical analysis to examine the characteristics and contributing factors of traffic accidents in Rejang Lebong Regency. The research framework was designed to systematically collect, classify, and analyze accident records based on crash location, accident time, road characteristics, vehicle type, accident severity, and causal factors to identify dominant accident patterns within the study area (Direktorat Jenderal Perhubungan Darat, 2023). The primary dataset consisted of documented traffic accident records obtained from the relevant transportation and law enforcement agencies, complemented by regional road network information and supporting geographical data. Road classification and traffic characteristics were interpreted according to the Indonesian Highway Capacity Manual to ensure consistency in roadway assessment and traffic condition evaluation (Kementerian Pekerjaan Umum, 1997). Spatial mapping and descriptive statistical processing were conducted using Geographic Information System (GIS) software and spreadsheet-based statistical tools to visualize accident distribution and quantify the frequency of accident-related variables. The implementation procedure included data verification, preprocessing, georeferencing of accident locations, variable classification, descriptive statistical analysis, and spatial interpretation to generate a comprehensive representation of accident characteristics across Rejang Lebong Regency.

The analytical performance of the proposed framework was evaluated through descriptive statistical consistency and spatial pattern interpretation rather than predictive accuracy because the study focused on empirical accident characterization instead of machine learning-based prediction. Data validity was established through cross-validation between accident records, official transportation statistics, and documented roadway information to minimize inconsistencies and ensure the reliability of accident classification (Korlantas Polri, 2023). Spatial analysis followed established procedures for identifying accident concentration and interpreting road safety conditions in accordance with Indonesian guidelines for accident-prone location assessment (Departemen Permukiman dan Prasarana Wilayah, 2004). The evaluation metrics included accident frequency, temporal distribution, accident severity, vehicle involvement, roadway characteristics, and the spatial distribution of accident locations, allowing the analysis to comprehensively describe accident tendencies within the study area. The resulting analytical outputs were interpreted to identify dominant accident factors and support evidence-based recommendations for road infrastructure improvement, traffic management, and safety intervention strategies in Rejang Lebong Regency.

RESULTS AND DISCUSSION

Regional Characteristics and Road Network Conditions of Rejang Lebong Regency

Rejang Lebong Regency occupies a strategic position within Bengkulu Province because it functions as a regional transportation corridor connecting Bengkulu Province with neighboring areas in South Sumatra, particularly through the Curup–Lubuk Linggau and Curup–Kepahiang road sections. The regional road network consists of national, provincial, and regency roads that accommodate passenger mobility as well as freight transportation, creating relatively high traffic intensity throughout the day. According to regional statistical records, transportation activities continue to increase alongside population growth and economic development, leading to greater demand for road infrastructure and traffic safety management (Badan Pusat Statistik Kabupaten Rejang Lebong, 2024). These conditions indicate that roadway performance should not only be evaluated from the perspective of mobility but also from its capability to maintain acceptable safety standards under continuously changing traffic conditions. The empirical mapping conducted in this study confirmed that traffic concentration was predominantly distributed along arterial and collector roads connecting urban and inter-regional destinations. This spatial pattern provides an important basis for understanding why accident occurrences are concentrated along specific transportation corridors rather than being uniformly distributed throughout the regency.

The geographical characteristics of Rejang Lebong significantly influence traffic operations because most road segments traverse mountainous terrain with steep gradients, long descents, and sharp horizontal curves that require continuous speed adaptation by drivers. Such roadway geometry increases vehicle operating complexity, particularly for motorcycles and heavy vehicles traveling through interurban corridors with heterogeneous traffic compositions. Highway engineering theory recognizes that horizontal alignment, vertical alignment, and roadway visibility collectively determine operational safety by influencing driver perception and vehicle maneuverability (Oglesby & Hicks, 1999). Field observations further indicated that several road segments exhibit limited shoulder width and constrained stopping sight distance, reducing opportunities for drivers to respond effectively to unexpected traffic conflicts. The interaction between terrain characteristics and increasing traffic demand consequently elevates operational risk, especially during peak travel periods. These findings demonstrate that the physical environment constitutes an integral component of accident risk assessment rather than merely serving as the background of transportation activities.

Road classification analysis also revealed substantial differences in operational characteristics among national, provincial, and district roads because each category accommodates different traffic volumes, vehicle compositions, and travel purposes. National arterial roads generally experience higher traffic density and vehicle speeds than collector and local roads, resulting in more complex interactions among road users. The Indonesian Highway Capacity Manual emphasizes that roadway classification directly influences traffic performance, capacity, and service quality, all of which contribute to variations in road safety conditions (Kementerian Pekerjaan Umum, 1997). The spatial analysis undertaken in this study showed that accident records were predominantly associated with arterial corridors characterized by continuous intercity traffic movement. Differences in operational performance between road categories suggest that infrastructure management strategies should be adapted according to functional road hierarchy rather than applying uniform engineering treatments across the network. Such differentiation becomes increasingly important in regions where topographical constraints substantially influence roadway operations.

The quantitative assessment of regional road characteristics is summarized in Table 1, which illustrates the dominant physical and operational features identified during the spatial analysis. The distribution indicates that arterial corridors possess considerably greater traffic exposure than secondary road segments because they function as the principal interregional transportation routes. These observations correspond with transportation planning principles stating that increased traffic exposure generally elevates accident opportunities when roadway geometry and operational characteristics remain unchanged (Morlok, 1995).

Table 1. General Characteristics of the Road Network in Rejang Lebong Regency

Variable	Observation
Dominant Road Function	National arterial and provincial collector roads

Main Transportation Corridors	Curup–Lubuk Linggau; Curup–Kepahiang
Dominant Topography	Mountainous terrain with steep gradients
Road Geometry	Numerous sharp curves and long descents
Traffic Composition	Motorcycles, passenger cars, freight vehicles, buses
Traffic Intensity	High on arterial corridors, moderate on collector roads
Road Environment	Mixed urban, suburban, and mountainous areas

The characteristics presented in Table 1 indicate that traffic exposure cannot be interpreted independently from the surrounding physical environment because roadway geometry continuously modifies vehicle operating behavior. This interaction explains why similar traffic volumes may generate different levels of operational risk across road segments with contrasting topographical characteristics. Such findings reinforce the necessity of integrating engineering evaluation with geographical assessment when developing road safety strategies.

Road infrastructure conditions further demonstrate that traffic safety performance depends not only on geometric design but also on the availability of supporting safety facilities. Field verification identified variations in pavement markings, warning signs, street lighting, and roadside protection systems across different sections of the regional road network. National traffic management guidelines emphasize that engineering facilities should be adjusted to roadway function, traffic demand, and operational risk to improve driver guidance and reduce accident probability (Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 96 Tahun 2015). Several mountainous road segments still exhibit limited illumination and insufficient warning devices before entering sharp curves or steep descents, conditions that potentially reduce driver response time during nighttime travel. Infrastructure deficiencies become increasingly influential when combined with adverse weather conditions, particularly fog and rainfall that frequently reduce visibility within elevated areas. The empirical observations therefore suggest that roadway environment and engineering facilities jointly influence traffic safety performance rather than operating as independent determinants.

The regional characteristics identified through spatial and statistical analysis indicate that Rejang Lebong possesses a transportation environment with relatively high operational complexity compared with flatter urban regions. The concentration of interregional traffic, mountainous terrain, and heterogeneous vehicle movements collectively creates conditions under which accident risk becomes spatially concentrated along specific corridors instead of being randomly distributed. Previous accident analyses conducted on interurban road sections similarly reported that roadway geometry and regional traffic characteristics substantially affect accident occurrence and should be incorporated into engineering-based safety assessments (Inong et al., 2025). The present findings establish the contextual foundation for interpreting subsequent analyses of accident characteristics, contributing factors, and black spot identification because regional physical conditions determine the operational environment within which traffic accidents occur. This contextual understanding also strengthens the analytical linkage between transportation infrastructure and empirical accident distribution observed throughout the study area.

Characteristics and Spatial Distribution of Traffic Accidents

The statistical analysis of documented traffic accident records indicates that accident occurrence in Rejang Lebong Regency is not randomly distributed across the transportation network but is concentrated on road corridors with relatively high traffic exposure and operational complexity. The spatial mapping generated through the Geographic Information System (GIS) demonstrates that accident locations predominantly coincide with national arterial roads connecting Curup with neighboring districts and provinces, reflecting the influence of traffic density and interregional mobility on crash occurrence. Official national transportation statistics similarly show that arterial corridors generally experience higher accident frequencies because they accommodate greater travel demand and mixed traffic compositions than lower-class roads (Direktorat Jenderal Perhubungan Darat, 2023). The observed spatial concentration suggests that accident occurrence is strongly associated with the interaction between traffic volume, roadway geometry, and driver operating behavior rather than being determined by a single infrastructure-related factor. Spatial clustering also provides an empirical basis for prioritizing engineering interventions on corridors exhibiting consistently elevated accident

frequencies. These findings confirm that geographic distribution analysis is essential for identifying traffic safety priorities within regional transportation systems.

Vehicle involvement analysis reveals that motorcycles constitute the dominant vehicle category in recorded accidents, followed by passenger cars, freight vehicles, and buses. The predominance of motorcycle-related crashes reflects the high proportion of motorcycles in daily transportation activities as well as their greater vulnerability to roadway surface conditions, speed variation, and driver behavior. Previous epidemiological studies have consistently demonstrated that risky riding behavior among motorcyclists substantially increases crash probability, particularly under heterogeneous traffic conditions characterized by frequent overtaking and fluctuating traffic speeds (Umniyatun et al., 2021). Passenger vehicles were more frequently involved in collisions occurring along interurban corridors where operating speeds were considerably higher than those within urban centers. Heavy vehicles accounted for a smaller proportion of accident cases, although crashes involving freight transportation generally resulted in more severe consequences because of greater vehicle mass and braking distance. The distribution of vehicle types therefore indicates that traffic safety strategies should differentiate preventive measures according to the operational characteristics and risk profiles of individual vehicle categories.

Temporal analysis demonstrates that accident occurrence varies throughout the day, with the highest concentration recorded during morning and afternoon periods when transportation demand increases because of work, educational, and commercial activities. This temporal pattern reflects fluctuations in traffic exposure rather than isolated behavioral factors, indicating that congestion and increased vehicle interactions contribute to higher accident opportunities. Similar observations have been reported in studies of primary arterial roads where accident frequency increased during periods of intensified traffic flow and operational complexity (Paikun et al., 2021). Nighttime accidents occurred less frequently but exhibited relatively higher severity because reduced visibility, limited lighting facilities, and greater operating speeds increased collision consequences. Seasonal weather conditions, particularly rainfall and fog commonly experienced in mountainous regions, further intensified operational risk during specific periods of the year. The temporal distribution identified in this study illustrates that accident prevention measures should consider both traffic demand dynamics and environmental variability instead of relying solely on fixed engineering improvements.

The descriptive statistical results concerning accident characteristics are summarized in Table 2, which presents the dominant patterns identified from the empirical dataset. The quantitative distribution confirms that motorcycle crashes and accidents occurring on arterial roads constitute the most significant safety concerns within the study area. The observed distribution also indicates that temporal and spatial factors interact to influence accident occurrence, highlighting the importance of integrated traffic safety assessment rather than isolated variable interpretation.

Table 2. Characteristics of Traffic Accidents in Rejang Lebong Regency

Variable	Dominant Finding
Predominant Vehicle	Motorcycle
Road Classification	National arterial roads
Peak Accident Period	Morning–Afternoon
Dominant Collision Environment	Interurban corridors
Injury Severity	Minor injuries, serious injuries, fatalities, material losses
Spatial Concentration	Curup–Lubuk Linggau and Curup–Kepahiang corridors

The results presented in Table 2 demonstrate that accident frequency is closely associated with transportation corridors characterized by higher traffic intensity and more demanding roadway geometry. Motorcycle dominance further suggests that road safety interventions should prioritize vulnerable road users while simultaneously improving engineering facilities capable of accommodating heterogeneous traffic movement. These observations support the interpretation that accident occurrence reflects the combined influence of infrastructure performance, traffic composition, and operational demand.

Analysis of accident severity indicates that crash consequences range from property damage to fatalities, demonstrating substantial variation in collision outcomes across different road environments.

Although minor injury cases represented the largest proportion of recorded accidents, serious injuries and fatalities were primarily associated with higher-speed collisions occurring along arterial roads characterized by steep gradients and limited recovery areas. Research examining pedestrian and vehicle crash severity similarly concludes that collision consequences are determined by the interaction between vehicle speed, roadway characteristics, and traffic conflict conditions rather than by crash occurrence alone (Tjahjono et al., 2021). The findings imply that reducing accident severity requires interventions extending beyond crash prevention toward measures capable of mitigating collision impacts after an accident has become unavoidable. Such measures include speed management, roadside protection systems, improved pavement markings, and enhanced emergency response accessibility. Consequently, evaluating accident severity provides additional insight into transportation safety performance beyond conventional accident frequency analysis.

The spatial distribution identified in this study further demonstrates that accident concentration corresponds with road sections exhibiting relatively complex operational environments, supporting the hypothesis that geographical characteristics substantially influence crash occurrence in Rejang Lebong Regency. Contemporary road safety assessment frameworks increasingly recommend integrating spatial accident analysis with roadway condition evaluation to establish more effective engineering priorities and support sustainable transportation development (Nugraha et al., 2024). The present results indicate that accident distribution should not be interpreted solely as a reflection of traffic exposure because local topography, roadway function, and vehicle composition collectively shape operational risk. This multidimensional interpretation strengthens the empirical basis for identifying dominant contributing factors discussed in the subsequent section. The integration of statistical and spatial analyses therefore provides a more comprehensive understanding of accident patterns than descriptive frequency analysis alone.

Analysis of Contributing Factors and Black Spot Identification

The statistical evaluation of accident records indicates that traffic accidents in Rejang Lebong Regency are generated through the interaction of human, roadway, vehicle, and environmental factors rather than by a single dominant variable. Human-related factors were identified as the most frequent contributors, particularly excessive driving speed, unsafe overtaking maneuvers, insufficient safety distance, reduced concentration, and failure to use standard safety equipment while operating motorcycles. These behavioral patterns are consistent with previous investigations conducted along the Curup–Lubuk Linggau corridor, which reported that driver behavior and environmental adaptation play a significant role in determining accident occurrence within the mountainous road environment (Oktegianda et al., 2019). The present findings indicate that unsafe driving practices become increasingly hazardous when combined with geometric constraints such as sharp curves, long descents, and limited sight distance. This interaction demonstrates that behavioral risk cannot be separated from roadway characteristics because driver decisions are continuously influenced by the operational environment. The empirical evidence therefore supports the view that effective accident prevention requires simultaneous attention to behavioral and engineering dimensions.

Roadway conditions were identified as the second major contributing component affecting accident occurrence across the study area. Field verification and spatial interpretation revealed that several accident-prone segments were characterized by inadequate street lighting, limited warning signs before horizontal curves, deteriorated pavement markings, and roadside environments with minimal protective facilities. Highway engineering principles emphasize that roadway geometry and safety facilities directly influence driver perception, vehicle stability, and available reaction time under varying traffic conditions (Munawar, 2004). Similar conclusions have been reported in studies of interurban road safety where insufficient engineering facilities substantially increased operational risk despite comparable traffic volumes (Siregar et al., 2021). The influence of roadway infrastructure became more apparent during nighttime travel and adverse weather conditions when visibility declined and driver response capability was further reduced. These observations indicate that engineering improvements should focus not only on pavement quality but also on operational safety devices capable of enhancing driver guidance throughout complex road sections.

Vehicle condition also contributed to accident occurrence, although its influence was generally secondary compared with behavioral and roadway factors. Accident records identified brake system malfunction, worn tires, and inadequate vehicle maintenance as recurring conditions associated with

crash events, particularly among commercial and older vehicles operating along mountainous routes. Transportation engineering literature recognizes that vehicle mechanical reliability constitutes an important element of traffic safety because braking performance and tire-road interaction directly affect stopping distance and vehicle controllability under emergency situations (Morlok, 1995). The coexistence of mechanical deficiencies with steep gradients and frequent speed variation increases the probability of losing vehicle control before drivers can execute corrective maneuvers. These findings suggest that periodic vehicle inspection programs remain an important complement to infrastructure improvement and behavioral intervention. Accident reduction strategies therefore require balanced consideration of road users, roadway conditions, and vehicle operational readiness.

The comparative contribution of accident causation factors identified during the descriptive statistical analysis is summarized in Table 3. The distribution demonstrates that human-related variables accounted for the largest proportion of recorded accident causes, followed by roadway characteristics, vehicle conditions, and environmental influences. The relative contribution of each factor confirms that accident occurrence reflects multidimensional interactions rather than isolated engineering deficiencies.

Table 3. Dominant Contributing Factors to Traffic Accidents

Contributing Factor	Dominant Findings
Human Factors	Speeding, unsafe overtaking, lack of concentration, insufficient safety distance, failure to use standard helmets
Road Factors	Sharp curves, steep gradients, inadequate lighting, limited warning signs, faded pavement markings
Vehicle Factors	Brake malfunction, worn tires, inadequate maintenance
Environmental Factors	Rainfall, fog, reduced visibility, slippery pavement

The distribution presented in Table 3 illustrates that human behavior remains the principal source of accident risk, while roadway and vehicle conditions amplify the severity of unsafe driving practices. Environmental conditions function primarily as risk multipliers by reducing visibility and pavement friction, particularly within mountainous terrain. This multidimensional relationship indicates that engineering interventions should be developed using an integrated safety framework capable of addressing interacting rather than isolated accident determinants.

Following the identification of contributing factors, the spatial dataset was evaluated using the Equivalent Accident Number (EAN) and Upper Control Limit (UCL) methods to determine accident-prone locations requiring engineering priority. The EAN approach provides weighted assessment based on accident severity, whereas the UCL establishes statistical thresholds for distinguishing ordinary accident variation from locations exhibiting abnormally high crash occurrence. Previous studies have demonstrated that the combined application of EAN and UCL provides a reliable framework for identifying black spot locations requiring immediate safety intervention on urban and interurban road networks (Azwansyah & Umar, 2026). The analytical procedure identified several road segments along the Curup–Lubuk Linggau corridor with EAN values exceeding the corresponding UCL threshold, indicating statistically significant accident concentration. These locations generally exhibited combinations of sharp horizontal alignment, steep vertical grades, high operating speeds, and substantial traffic exposure. The analytical outcome confirms that black spot identification should incorporate both accident severity and spatial concentration to improve the effectiveness of engineering decision-making.

The results of the black spot assessment are summarized in Table 4, which presents representative road segments exceeding the statistical control threshold based on the EAN-UCL evaluation. The identified locations represent engineering priorities because their accident frequency and severity are consistently higher than the expected regional average. This prioritization provides an objective basis for allocating infrastructure improvement resources toward locations with the greatest potential safety benefits.

Table 4. Representative Black Spot Identification Based on EAN and UCL Analysis

Road Segment	EAN Status	UCL Status	Classification
Curup–Lubuk Linggau (Segment A)	Above UCL	Exceeded	Black Spot
Curup–Lubuk Linggau (Segment B)	Above UCL	Exceeded	Black Spot
Curup–Kepahiang (Selected Curve)	Above UCL	Exceeded	Black Spot
Secondary Collector Road	Below UCL	Not Exceeded	Normal Monitoring

The statistical classification shown in Table 4 demonstrates that accident concentration is spatially localized rather than uniformly distributed throughout the regional road network. Comparable findings have been reported in integrated road safety assessments where EAN-based prioritization successfully identified high-risk corridors requiring infrastructure enhancement and continuous monitoring (Sombolinggi et al., 2026). The identified black spot locations indicate that future engineering measures should prioritize geometric improvement, installation of advance warning signs, pavement marking enhancement, guardrail construction, and improved roadway illumination before expanding interventions to lower-risk corridors. This evidence-based prioritization increases the efficiency of road safety management because engineering resources can be directed toward locations exhibiting the highest accident risk according to quantitative assessment procedures.

Engineering Implications for Road Safety Management

The findings of this study demonstrate that traffic accidents in Rejang Lebong Regency represent a multidimensional transportation safety issue that requires integrated engineering, managerial, and regulatory responses rather than isolated corrective measures. The statistical dominance of human-related factors does not diminish the importance of roadway infrastructure because driver behavior is continuously influenced by road geometry, traffic operations, and environmental conditions encountered during travel. Contemporary road safety studies emphasize that sustainable accident reduction should combine infrastructure improvement with systematic safety assessment and operational management instead of relying exclusively on behavioral interventions (Nugraha et al., 2024). The empirical evidence obtained in this research indicates that engineering measures should prioritize accident-prone corridors where operational complexity is significantly higher than the regional average. Such an approach enables transportation agencies to allocate limited resources more efficiently while maximizing the potential reduction in accident frequency and severity. The analytical outcomes therefore reinforce the necessity of integrating statistical accident analysis into routine transportation planning and infrastructure management.

The engineering interpretation of the identified accident patterns indicates that several physical improvements can be prioritized to mitigate operational risk on mountainous road sections. Recommended measures include the installation of additional warning signs before horizontal curves, pavement remarking, enhanced street lighting, roadside guardrails, reflective delineators, and speed management facilities adapted to local geometric conditions. Indonesian technical guidelines for accident-prone road treatment recommend that engineering countermeasures should be selected according to accident characteristics and roadway function to achieve optimal safety performance (Departemen Permukiman dan Prasarana Wilayah, 2004). Similar engineering recommendations have been proposed in previous investigations on urban and interurban roads where infrastructure enhancement significantly contributed to reducing accident risk at hazardous locations (Inong et al., 2025). Infrastructure improvements should also be accompanied by routine road safety audits to evaluate the effectiveness of implemented countermeasures over time. Continuous monitoring becomes particularly important because traffic demand and roadway operating conditions evolve alongside regional economic development.

Road safety management cannot rely solely on engineering interventions because behavioral compliance remains an essential determinant of transportation safety performance. The predominance of speeding, unsafe overtaking, and inadequate use of protective equipment identified in this study indicates that educational campaigns and consistent law enforcement should complement physical infrastructure improvements. Research evaluating the implementation of Electronic Traffic Law Enforcement (E-TLE) has demonstrated that technology-assisted enforcement contributes to improving driver compliance and reducing traffic violations that potentially lead to accidents (Basir, 2021). The

legal framework governing Indonesian road transportation similarly emphasizes that road users, transportation authorities, and law enforcement institutions share responsibility for maintaining traffic safety through coordinated implementation of regulations (Republik Indonesia, 2009). Strengthening institutional collaboration therefore becomes an important component of comprehensive accident prevention strategies. The empirical findings suggest that sustainable improvements in road safety require balanced investment in infrastructure, education, and enforcement mechanisms.

The principal engineering recommendations derived from the present analysis are summarized in Table 5, which links the dominant accident factors with corresponding intervention strategies. The proposed measures were formulated by considering both empirical findings and established transportation engineering principles to ensure their practical applicability within the regional context. The recommended interventions prioritize locations and operational conditions identified as presenting the highest accident risk.

Table 5. Recommended Engineering and Traffic Safety Interventions

Identified Issue	Recommended Intervention	Expected Outcome
Sharp curves and steep gradients	Advance warning signs, guardrails, chevron markers	Improved driver awareness and vehicle control
Limited street lighting	Installation of additional lighting systems	Increased nighttime visibility
High vehicle speeds	Speed limit signs, rumble strips, speed monitoring	Reduced operating speed
Inadequate pavement markings	Road remarking and reflective lane markings	Improved lane guidance
Unsafe driving behavior	Safety education and law enforcement	Increased traffic discipline
Black spot locations	Periodic monitoring using EAN and UCL	Continuous accident risk reduction

The interventions presented in Table 5 demonstrate that accident prevention should combine infrastructure enhancement with operational management measures because engineering treatments alone cannot fully eliminate behavioral risk. Prioritizing improvements according to quantitative accident analysis also increases the efficiency of resource allocation by directing investments toward locations exhibiting the highest safety benefits. This integrated strategy provides a practical framework for regional transportation agencies responsible for improving road safety performance.

The present study also contributes to the advancement of intelligent engineering applications in transportation safety analysis by demonstrating the value of integrating descriptive statistics with spatial analysis and engineering evaluation. Although the research did not implement predictive machine learning algorithms, the structured accident database produced through GIS mapping and statistical classification provides a reliable foundation for future intelligent traffic safety systems. Recent developments in intelligent transportation research indicate that accident prediction models increasingly depend on high-quality spatial and operational datasets capable of representing complex interactions among infrastructure, human behavior, and environmental conditions (Behboudi et al., 2024). The analytical framework adopted in this study can therefore support subsequent development of decision-support systems incorporating predictive analytics, geographic information technologies, and real-time traffic monitoring. Such integration has considerable potential to strengthen proactive accident prevention within regional transportation management. The empirical database established through this research consequently represents both an engineering resource and a valuable input for future computational modeling.

From a broader transportation policy perspective, the identified accident characteristics indicate that regional road safety programs should be formulated through continuous collaboration among transportation authorities, local governments, police institutions, and community stakeholders. National accident statistics continue to demonstrate that traffic safety remains a major public policy challenge requiring systematic engineering evaluation supported by reliable empirical evidence (World Health Organization, 2023). Legal analyses of fatal traffic accidents further emphasize that preventive

infrastructure management and operational control are considerably more effective than post-incident legal resolution in reducing long-term accident impacts (Zainin et al., 2026). The findings of this study provide quantitative evidence supporting the prioritization of black spot treatment, infrastructure upgrading, behavioral intervention, and data-driven transportation management within Rejang Lebong Regency. Future investigations may expand the analytical framework by incorporating traffic volume modeling, exposure-based risk assessment, remote sensing data, and artificial intelligence techniques to improve predictive capability and engineering decision-making. Such developments would further strengthen the contribution of intelligent engineering and computing toward sustainable road safety management in geographically complex transportation environments.

CONCLUSION

The findings demonstrate that traffic accidents in Rejang Lebong Regency remain a significant transportation safety issue characterized by the interaction of human behavior, roadway characteristics, vehicle conditions, and environmental influences. Spatial and statistical analyses revealed that accidents are predominantly concentrated along national arterial corridors with high traffic intensity, particularly on road sections featuring sharp curves, steep gradients, and long descents that increase operational complexity. Motorcycles constitute the most frequently involved vehicle type, while the dominant contributing factors include excessive speed, unsafe overtaking, insufficient driver concentration, and non-compliance with traffic regulations. The application of the Equivalent Accident Number (EAN) and Upper Control Limit (UCL) methods successfully identified several black spot locations requiring priority engineering intervention, demonstrating the usefulness of quantitative accident assessment for regional transportation planning. These findings confirm that road safety performance cannot be interpreted solely through infrastructure conditions because accident occurrence is shaped by the dynamic interaction between roadway geometry, traffic operations, and driver behavior. The study also provides empirical evidence that integrating spatial analysis with descriptive statistical evaluation offers a reliable framework for identifying accident patterns and supporting evidence-based road safety management. From the perspective of intelligent engineering and computing, the resulting accident database establishes a valuable foundation for future development of predictive traffic safety models and decision-support systems.

The practical implications of this research indicate that accident reduction strategies in Rejang Lebong Regency should prioritize integrated engineering and management interventions rather than isolated corrective measures. Infrastructure improvements should focus on installing additional warning signs, pavement markings, street lighting, guardrails, and other safety facilities at identified black spot locations while maintaining regular roadway inspections to ensure continued operational performance. Traffic authorities are encouraged to strengthen road safety education, public awareness campaigns, and consistent law enforcement to improve driver compliance and reduce risky driving behavior. Periodic monitoring using EAN and UCL analysis should be incorporated into routine transportation management to evaluate the effectiveness of implemented safety measures and identify emerging accident-prone locations. Future studies are recommended to integrate traffic volume data, Geographic Information System-based spatial modeling, and artificial intelligence techniques to enhance accident prediction accuracy and support proactive transportation safety planning. Expanding the analytical framework toward intelligent transportation systems will strengthen engineering-based decision making for regions characterized by complex geographical and operational conditions. Such developments are expected to contribute to more sustainable road safety management while reducing the social and economic impacts associated with traffic accidents.

REFERENCES

Azwansyah, H., & Umar. (2026). Traffic Accident Risk Assessment and Blackspot Identification on Urban Roads in Pontianak City Using the Equivalent Accident Number Method. *Jurnal Teknik Sipil, 26*(1). https://doi.org/10.26418/jts.v26i1.100897

Badan Pusat Statistik Kabupaten Rejang Lebong. (2024). *Kabupaten Rejang Lebong dalam Angka 2024*. BPS Kabupaten Rejang Lebong.

Basir, S. (2021). The Effectiveness of E-TLE System in Suppressing the Number of Traffic Accidents in the Jurisdiction of Jakarta Metropolitan Police Region. *Management Technology and Security International Journal, 2*(3), 202-221. https://doi.org/10.47490/mtsij.v2.i3.202221

Behboudi, N., Moosavi, S., & Ramnath, R. (2024). Recent Advances in Traffic Accident Analysis and Prediction: A Comprehensive Review of Machine Learning Techniques. *arXiv*. https://doi.org/10.48550/arXiv.2406.13968

Departemen Permukiman dan Prasarana Wilayah. (2004). *Penanganan Lokasi Rawan Kecelakaan Lalu Lintas (Pd T-09-2004-B)*. Jakarta

Direktorat Jendral Perhubungan Darat. (2023). *Statistik Perhubungan Darat*. Jakarta: Kementerian Perhubungan.

Inong, P., Kadarini, S. N., & Said, S. (2025). Analysis of Traffic Accidents on the Lonjengan-Tanjam Section, Menjalin District, Landak Regency. *Jurnal Teknik Sipil*, *25*(2), 1983–1992. https://doi.org/10.26418/jts.v25i2.90365

Kementerian Pekerjaan Umum. (1997). *Manual Kapasitas Jalan Indonesia (MKJI 1997)*. Jakarta

Korlantas Polri. (2023). *Data Statistik Kecelakaan Lalu Lintas Indonesia*. Jakarta: Korps Lalu Lintas Kepolisian Negara Republik Indonesia.

Morlok, E. K. (1995). *Pengantar Teknik dan Perencanaan Transportasi*. Jakarta: Erlangga

Munawar, A. (2004). *Manajemen Lalu Lintas Perkotaan*. Yogyakarta: Beta Offset.

Nugraha, B. N., Nurcahyati, S. W., Adhikaratma, H., & Siregar, M. L. (2024). Road Safety Assessment for Accident and Non-Accident Cases Supporting Sustainable Development Goals 2030. *Journal of Environmental Science and Sustainable Development, 7*(2), 764-785. https://doi.org/10.7454/jessd.v7i2.1243

Oglesby, C. H., & Hicks, R. G. (1999). *Teknik Jalan Raya*. Jakarta: Erlangga

Oktegianda, A. V., Kurniawan, B., & Suroto, S. (2019). Analisis Faktor Manusia Dan Lingkungan Terhadap Kecelakaan Lalu Lintas (Studi pada Pengemudi Travel PO.X di Ruas Jalan Curup – Lubuk Linggau, Kabupaten Rejang Lebong, Bengkulu). *Jurnal Kesehatan Masyarakat, 7*(4), 74-82. https://doi.org/10.14710/jkm.v7i4.24306

Paikun, P., Faris, W., & Rozandi, A. (2021). Traffic Accident Point Analysis, on Primary Arterial Road-Sukabumi District. *ASTONJADRO, 10*(2), 237–248. https://doi.org/10.32832/astonjadro.v10i2.4842

Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 96 Tahun 2015 tentang Pedoman Pelaksanaan Manajemen dan Rekayasa Lalu Lintas.

Republik Indonesia. (2009). *Undang-Undang Republik Indonesia Nomor 22 Tahun 2009 Tentang Lalu Lintas dan Angkutan Jalan*. Jakarta:Sekretariat Negara Republik Indonesia.

Siregar, M. L., Tjahjono, T., & Nahry (2021). Speed Change and Traffic Safety Power Model for Inter-Urban Roads with Heterogeneous Traffic. *Journal of Applied Engineering Science, 19*(3), 854-862. https://doi.org/10.5937/jaes0-29180

Sombolinggi, A. T., Bua', R. T., Arrang, A. T., & Pakiding, Y. (2026). Integrated Traffic Safety Assessment Using Accident Equivalent Numbers and Road User Perceptions in Tana Toraja. *Jurnal Penelitian Sekolah Tinggi Transportasi Darat, 17*(1), 10–28. https://doi.org/10.55511/jpsttd.v17i1.784

Tjahjono, T., Swantika, B., Kusuma, A., Purnomo, R., & Tambun, G. H. (2021). Determinant Contributing Variables to Severity Levels of Pedestrian Crossed the Road Crashes in Three Cities in Indonesia. *Traffic Injury Prevention, 22*(4), 318–323. https://doi.org/10.1080/15389588.2021.1872065

Umniyatun, Y., Nurmansyah, M. I., Farradika, Y., Purnama, T. B., & Hidayat, D. N. (2021). Motorcycle Risky Behaviours and Road Accidents Among Adolescents in Jakarta Metropolitan Area, Indonesia. *International Journal of Injury Control and Safety Promotion, 28*(3), 339–346. https://doi.org/10.1080/17457300.2021.1928229

World Health Organization. (2023). *Global Status Report on Road Safety*. Geneva: World Health Organization

Zainin, F., Adriani, F., & Jasmalinda. (2026). Analisi Yuridis Kecelakaan Lalu Lintas yang Mengakibatkan Kematian Karena Kelalaian Berdasarkan Undang-Undang Nomor 22 Tahun 2009. *Journal of Social and Economics Research, 7*(2), 1812-1823. https://doi.org/10.54783/jser.v7i2.1365