

Spatial Factors Influencing the Suitability of JPJ Enforcement Sites in Malaysia: A Review and Expert Perspective from Johor, Malaysia

Muhammadiyah Md Isnen^a, Abdul Rauf Abdul Rasam^{a,b}

^aMalaysia Institute of Transport (MITRANS), Universiti Teknologi MARA, Shah Alam, Malaysia

^bFaculty of Built Environment, Universiti Teknologi MARA, Shah Alam, Malaysia

Corresponding author: 2024679556@student.uitm.edu.my

Abstract: The suitability of Road Transport Department (JPJ) enforcement sites in Malaysia is possibly affected by inconsistent spatial factors and unclear regional enforcement criteria. This paper reviews the critical spatial factors influencing the suitability of enforcement sites by the JPJ in Malaysia. Using a review of relevant academic studies, official reports and selected local expert opinion, the research identifies how spatial criteria determine operational effectiveness and enforcement impact. The key factors examined include road accident blackspots, traffic violation hotspots, heavy vehicle and logistics routes, public complaints on traffic offences, infrastructure and strategic access, digital enforcement readiness, population density, commercial hubs, and officer safety. The findings underscore the need to integrate multi-criteria spatial analysis to optimise site selection, enhance enforcement resource allocation, and improve road safety outcomes in Malaysia. The paper further discusses implications for policy and technological integration to support dynamic, data-driven enforcement strategies.

Keywords: *GIS-AHP MCDM, JPJ Enforcement sites, review and expert opinion, spatial factors, suitability sites*

1. Introduction

Effective selection of traffic enforcement sites is crucial to enhancing road safety and promoting compliance with traffic laws. The Road Transport Department Malaysia (JPJ) is responsible for enforcing traffic regulations, with a particular focus on high-risk locations, including overloaded vehicles and motorcycle violations. The suitability of enforcement sites depends on spatial factors that dictate where enforcement activities can maximize impact. These include accident blackspots, traffic violation hotspots, heavy vehicle routes, infrastructure accessibility, digital enforcement readiness, population density, commercial activity hubs, and officer safety. This report reviews current literature on these spatial factors to provide evidence-based guidance for JPJ enforcement site selection.

The suitability of JPJ enforcement sites in Malaysia is influenced by inconsistent spatial factors such as accident density, road hierarchy, traffic volume, and land-use proximity (Alhajri et al., 2024; Hussein, 2023). Contradictions emerge due to variations in enforcement priorities and unclear spatial criteria across regions. Studies highlight the absence of standardized geospatial parameters for hotspot identification, while data integration challenges between agencies and manual reporting systems (Malay Mail, 2022; JSPT, 2022) further limit enforcement accuracy and policy consistency in spatial site selection.

Spatial analysis and expert evaluation remain the primary methods to determine JPJ enforcement site suitability in Malaysia. Techniques such as hotspot mapping, kernel density analysis, and spatial overlay are used to identify accident-prone zones and environmental risk factors (Alhajri et al., 2024; Rahman et al., 2020). Expert consultation from enforcement officers

enhances contextual validation, ensuring practical feasibility in site selection (GovInsider, 2015). Integrating AI-assisted tools (Siborgs, 2025) and digital reporting systems like MyJPJ (Chan, 2025) further supports precise spatial-based enforcement planning.

Therefore, to identify the influential spatial factors affecting the suitability of JPJ enforcement sites in Johor, Malaysia, using a review and expert perspectives. The main objective of the study are:

- i. To determine the possible spatial factors influencing the suitability of JPJ enforcement sites in Malaysia based on previous review of studies.
- ii. To analyse the main spatial factors influencing the suitability of JPJ enforcement sites in Johor, Malaysia based on the local expert opinions.

This study aligns with the findings of Alhajri et al. (2024) and Rahman et al. (2020), which underscore the importance of integrating spatial risk criteria, geospatial mapping, and evidence-based location assessment in determining enforcement site suitability. By combining localized insights from enforcement experts with spatial analytical models, the research aims to optimize the placement of JPJ enforcement sites, enhance operational efficiency, and contribute to a more data-driven, proactive, and regionally adaptive traffic enforcement framework in Malaysia.

2. Literature Review: Influential Criteria of Suitable JPJ Enforcement Sites

Effective selection of traffic enforcement sites is critical to improving road safety and ensuring law compliance globally and in Malaysia. Internationally, spatial enforcement targeting such as policing hotspots and density-based patrols that has proven effective in reducing accident rates (City Auditor, 2023; Yasanthi et al., 2024). In Malaysia, however, enforcement site selection often lacks geospatial integration and relies heavily on manual or experience-based judgment (Azami et al., 2024).

The absence of uniform spatial models results in uneven enforcement coverage and inefficiencies in addressing high-risk zones. Studies stress the importance of GIS and AI technologies in supporting data-driven decision-making for enforcement placement (Siborgs, 2025; ARS Traffic Tech, n.d.). Therefore, adopting spatially optimized enforcement strategies is essential to enhance transparency, fairness, and road safety outcomes in Malaysia's evolving transport system. Besides this, unclear spatial risk factor contribution to the suitable JPJ enforcement sites is a main agenda in Malaysia towards improving road safety and accidents case management.

Empirical research emphasizes the importance of targeting road accident blackspots, which are locations with a high frequency of collisions, to reduce crash rates through focused enforcement and infrastructure improvements (Hussein, 2023; Azami et al., 2024). Spatial analysis using GIS identifies traffic violation hotspots, allowing enforcement efforts to concentrate on frequent offense clusters such as speeding and illegal parking (Rahman et al., 2020; GovInsider, 2015). Heavy vehicle and logistics routes require specific monitoring strategies due to their unique regulatory demands and impact on road infrastructure (Karim, 2014; Luo, 2022).

Public complaints collected via apps like e-Aduan@JPJ provide real-time, localized intelligence helpful in prioritizing enforcement activities (Malay Mail, 2022; JSPT, 2022). Digital enforcement readiness including Automated Enforcement Systems (AES) and AI-driven technologies enhances detection accuracy and resource efficiency (ARS Traffic Tech; Siborgs, 2025). Population density and proximity to commercial hubs correlate with traffic volume, thereby influencing enforcement priorities (Cox, 2012; Kopczevska, 2024). Lastly, officer safety is a

critical consideration ensuring enforcement sustainability in potentially hazardous environments (City Auditor, 2023; Yasanthi et al., 2024).

Although the studies cover various individual spatial factors, there remains a gap in comprehensive multi-criteria approaches that integrate these elements for enforcement site suitability. Thus, accurate and precise selection of traffic enforcement sites enhances road safety, minimizes accident hotspots, and optimizes enforcement resources need to be conducted systematically. Spatially informed decision-making enables JPJ to focus on high-risk areas, improving public compliance and reducing fatality rates (Alhajri et al., 2024; Rahman et al., 2020). In Johor, integrating GIS and AI-based tools (Siborgs, 2025) supports proactive intervention and efficient monitoring, aligning enforcement strategies with evidence-based spatial patterns and promoting safer, more sustainable transport management.

3. Research Method

This study adopts a qualitative method integrating a literature review and expert interviews. The literature review synthesizes 14 relevant academic studies and official reports published over recent years, focusing on spatial factors influencing enforcement site suitability in Malaysia (**Table 1**). Complementing this, semi-structured interviews were conducted with seven JPJ enforcement experts from Johor to capture firsthand practical insights, challenges, and contextual considerations that are not always reflected in published sources (**Table 2**). Interviews were audio-recorded with consent and analysed thematically to identify core patterns and eight themes.

The experts selected for this study on the spatial factors influencing the suitability of JPJ enforcement sites in Malaysia are highly qualified based on their extensive professional experience and expertise. The group consists of individuals with service durations ranging between 16 and 21 years, which provides a substantial foundation of practical knowledge and institutional insight into JPJ enforcement practices. Therefore, the inclusion of these experts provides a reliable and informed basis for analysing and reviewing spatial factors impacting JPJ enforcement site suitability in Malaysia.

The themes include road accident blackspots, traffic violation hotspots, heavy vehicle and logistics routes, public complaints on traffic offences, infrastructure and strategic access, digital enforcement readiness, population density, commercial hubs, and officer safety. The combination of literature and expert perspectives strengthens the validity and depth of the study, enabling a more comprehensive understanding of enforcement site selection criteria and operational realities. Triangulation of data sources further enhances the robustness of findings.

Table 1: First data collection method: 14 relevant academic studies and official reports

No	Study Title or Topic	Focus Area/Factor	Key Points/Justification	Source/Year
1	Assessing Road Accident Black Spots in Perak	Road accident blackspots	Black spots ranking and low-cost countermeasures to improve road safety using RTC data	Hussein, 2023
2	Policing Hotspots in Malaysia	Traffic violation hotspots	Hotspots approach for crime/traffic enforcement using data from calls, CCTV, patrols	GovInsider, 2015

No	Study Title or Topic	Focus Area/Factor	Key Points/Justification	Source/Year
3	Truck Routing Enforcement	Heavy vehicle & logistics routes	Route restriction and monitoring strategies for heavy vehicles to protect infrastructure	ITS Int., 2015
4	Public Complaints via e-Aduan@JPJ App	Public complaints on traffic offences	Use of mobile app for public reporting of traffic violations with GPS tagging	Malay Mail, 2022
5	ARS T&TT Traffic Enforcement Systems	Infrastructure, digital enforcement readiness	Automation, non-intrusive sensors, digital processing for traffic rule enforcement	ARS Traffic Tech
6	Digital Forensics Readiness in Public Sector	Digital enforcement readiness	Factors affecting readiness for digital forensics to support enforcement in public sector	Md Tahir, 2016
7	Urban Travel and Population Density	Population density & commercial hubs	Relationship between urban density and traffic congestion, access, and economic outcomes	Wendell Cox, 2012
8	Effects of Traffic Patrol on Road Safety	Officer safety & enforcement effectiveness	Relationship between traffic enforcement level and road safety outcomes	City Auditor, 2023
9	Spatial Analysis of Traffic Violation Hotspots	Traffic violation hotspots	Use of GIS and spatial statistics to identify traffic violation clusters in urban areas	Rahman et al., 2020
10	Effectiveness of Vehicle Weight Enforcement	Heavy vehicle & logistics routes	Weigh-in-motion technology to enforce vehicle weight limits effectively	Karim, 2014
11	Public Reporting of Traffic Violations	Public complaints on traffic offences	Social media and official channels for public traffic offence reporting	JSPT, 2022
12	AI Traffic Enforcement for Smart Cities	Digital enforcement readiness	Use of AI, real-time sensors, and smart cameras for automatic detection of violations	Siborgs, 2025
13	Digital Forensic Readiness Components	Digital enforcement readiness	Overview of digital forensic readiness framework for operational units	Saleh, 2013

No	Study Title or Topic	Focus Area/Factor	Key Points/Justification	Source/Year
14	Population Density and Business Location	Population density & commercial hubs	Study showing joint effect of population density and business agglomeration on location decisions	Kopczewska, 2024
15	Determinants of Traffic Safety Enforcement Behavior	Officer safety & enforcement	Behavioral factors influencing compliance with traffic enforcement regulations	Yasanthi et al., 2024
16	Road Crash Dynamics in Malaysia	Road accident blackspots	Geographical and severity pattern analysis of crashes in Malaysia	Azami et al., 2024
17	Spatial Analysis of Road Traffic Accident in Muscat	Road accident blackspots	Identification of high-risk accident areas using spatial analysis	Alhajri, B., et, al. (2024).
18	Heavy-Duty Truck Routing Strategy	Heavy vehicle & logistics routes	Strategy for reducing community exposure by optimizing truck routing paths	Luo, 2022
19	Reporting Traffic Offences Using MyJPJ App	Public complaints on traffic offences	Guide to reporting offences via official mobile app	Chan, 2025
20	Traffic Enforcement System Case Studies Worldwide	Infrastructure & strategic access	Various case studies of enforcement systems on speed, red light, weigh-in-motion, restricted zones	ARS Traffic Tech

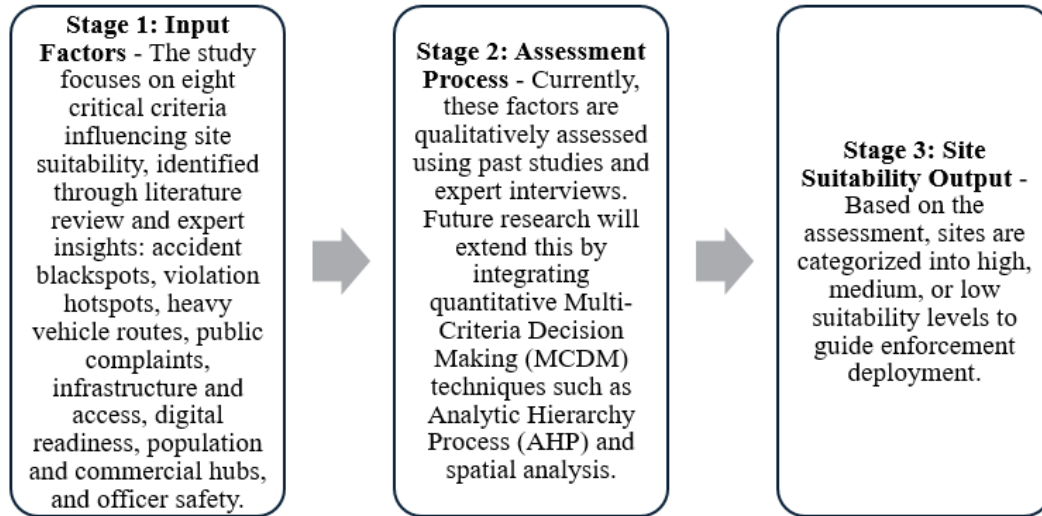
Table 2: Second data collection method: semi-structured interviews were conducted with seven JPJ enforcement experts

Expert	Position	Workplace	Area Of Expertise	Year of Work Experience
1	KP5 Enforcement Officer	SPK Sri Gading, Johor	Enforcement and Prosecution	21 years
2	KP2 Enforcement Officer	SPK Sri Gading, Johor	Enforcement	16 years
3	KP2 Enforcement Officer	SPK Sri Gading, Johor	Enforcement and Management	17 years
4	KP2 Enforcement Officer	JPJ Batu Pahat, Johor	Enforcement	17 years
5	KP2 Enforcement Officer	SPK Sri Gading, Johor	Enforcement and Management	16 years

6	KP2 Enforcement Officer	SPK Sri Gading, Johor	Enforcement	17 years
7	KP2 Enforcement Officer	JPJ Batu Pahat, Johor	Enforcement and Management	17 years

3.2 Research Framework

This study evaluates the suitability of JPJ enforcement sites through a structure three-stage framework:



This framework in provides a clear pathway from factor identification to actionable site prioritization, ensuring the study's findings are practical and well-structured.

4. Research and Discussion

4.1 The possible spatial factors influencing the suitability of JPJ enforcement sites in Malaysia based on a previous review of studies.

The review identified eight primary spatial factors influencing the suitability of JPJ enforcement sites in Malaysia, each reflecting the dynamic interplay between spatial risk patterns, infrastructural accessibility, and digital readiness in traffic enforcement (**Table 3**). The integration of these factors is crucial to ensure enforcement efforts are data-driven, spatially optimized, and contextually relevant to Malaysia's evolving road safety landscape.

Firstly, road accident blackspots remain the most critical spatial indicator for prioritizing enforcement deployment. High-frequency crash zones identified through spatial mapping and kernel density analysis provide evidence-based targets for resource allocation (Hussein, 2023; Azami et al., 2024). Similar spatial risk assessments conducted in Oman demonstrated how identifying recurrent accident clusters enhances preventive enforcement strategies (Alhajri et al., 2024). Focusing enforcement efforts in such high-risk locations directly contribute to reducing fatality rates and improving traffic flow efficiency.

Table 3: Eight primary spatial factors influencing the suitability of JPJ enforcement sites in Malaysia

Author & Year	8 Criteria							
	Road Accident Blackspots	Traffic Violation Hotspots	Heavy Vehicle & Freight Routes	Public Complaints	Infrastructure & Strategic Access	Digital Enforcement Technologies	Population & Commercial Density	Officer Safety & Comfort
Hussein, 2023 - Assessing Road Accident Black Spots in Perak	✓							
GovInsider, 2015 - How do policing hotspots work in Malaysia?		✓						
ITS International, 2015 - The weighty problem of truck routing enforcement			✓					
Malay Mail, 2022 - Public Complaints via e-Aduan@JPJ App				✓				
ARS Traffic Tech - Traffic Enforcement Systems					✓	✓		
Md Tahir, 2016 - Digital forensics readiness in public sector						✓		
Wendell Cox, 2012 - Urban Travel and Population Density							✓	
City Auditor, 2023 - Effects of Traffic Patrol on Road Safety								✓
Rahman et al., 2020 - Spatial Analysis of Traffic Violation Hotspots		✓						
Karim, 2014 - Effectiveness of Vehicle Weight Enforcement			✓					
JSPT, 2022 - Public Reporting of Traffic Violations				✓				
Siborgs, 2025 - AI Traffic Enforcement for Smart Cities						✓		
Saleh, 2013 - Digital Forensic Readiness Components						✓		
Kopczewska, 2024 - Population Density and Business Location							✓	
Yasanthi et al., 2024 - Determinants of Traffic Safety Enforcement Behaviour								✓
Azami et al., 2024 - Road Crash Dynamics in Malaysia	✓							
Planning Malaysia, 2024 - Spatial Analysis of Road Traffic Accident	✓							

Luo, 2022 - Heavy-Duty Truck Routing Strategy	✓
Chan, 2025 - Reporting Traffic Offences Using MyJPJ App	✓
ARS Traffic Tech - Traffic Enforcement System Case Studies Worldwide	✓

Secondly, traffic violation hotspots offer operational precision for targeting habitual offenses, such as speeding or illegal overtaking, at specific locations (Rahman et al., 2020; GovInsider, 2015). These localized enforcement zones improve response time and resource efficiency while reinforcing public deterrence. Complementing this, heavy vehicle and logistics routes demand particular attention due to their association with road wear, cargo overloading, and safety risks (Karim, 2014; Luo, 2022). Strategic enforcement along these corridors ensures compliance with route restrictions and axle weight regulations, mitigating infrastructure damage and environmental impact. Public complaints on traffic offences, as supported by the e-Aduan@JPJ and MyJPJ applications, further enhance enforcement responsiveness through crowdsourced intelligence (Malay Mail, 2022; JSPT, 2022; Chan, 2025). This participatory approach strengthens the link between citizens and enforcement agencies, enabling real-time data collection for spatial verification of recurring problem areas.

Moreover, infrastructure and strategic access significantly determine the practicality of site selection. Adequate road shoulders, lighting, and safe pull-over spaces facilitate efficient and safe enforcement operations (ARS Traffic Tech, n.d.). Digital enforcement readiness, including AI-assisted monitoring systems and automatic violation detection, is equally important in enhancing enforcement precision and reducing manpower dependency (Siborgs, 2025; Saleh, 2013; Md Tahir, 2016). Demographic and spatial exposure factors, particularly population density and commercial activity hubs, indicate areas of higher vehicle interaction and increased accident probability (Cox, 2012; Kopczewska, 2024). These densely developed zones often necessitate sustained enforcement presence. Finally, officer safety and comfort underpin the long-term sustainability of enforcement operations, influencing both performance and morale (City Auditor, 2023; Yasanthi et al., 2024).

The complexity and interdependence of these factors justify adopting a multi-criteria decision-making (MCDM) approach integrating spatial, environmental, and operational variables. By combining expert insights with GIS-based analysis, Malaysia can achieve an adaptive, technology-supported, and spatially balanced strategy for JPJ enforcement site selection, aligning enforcement placement with empirical risk patterns and national road safety priorities.

4.2 The main spatial factors influencing the suitability of JPJ enforcement sites in Johor, Malaysia, based on the local expert opinions and Justification

The experts selected for this study are highly experienced officers with 16 to 21 years of service in enforcement and prosecution (**Table 4**). Their long-standing involvement in field operations, case handling, and policy implementation equips them with deep institutional knowledge of road safety and spatial enforcement practices in Malaysia. Their insights bridge the gap between theoretical understanding and real-world enforcement challenges, providing a robust foundation for evaluating the spatial, technological, and operational factors that influence the suitability of JPJ enforcement sites.

A central finding from both literature and expert interviews is the paramount importance of accident blackspots. Consistent with Hussein (2023), Alhajri et al. (2024), and Azami et al. (2024), experts agreed that enforcement resources must be prioritized in high-crash areas identified through spatial analysis. These blackspots represent zones of heightened risk where data-driven enforcement can significantly reduce collision frequencies and fatalities. The experts highlighted that integrating GIS-based accident mapping supports a proactive rather than reactive enforcement strategy, improving the precision and impact of resource deployment.

Table 4: local expert opinions and Justification the main spatial factors influencing the suitability of JPJ enforcement sites

Criterion	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Acceptance
Accident blackspots	/	/	/	/	/	/	/	Highly accepted
Traffic violation hotspots	/	/	/	/	/	/	/	Highly accepted
Heavy vehicle routes	/	/	/	/	/	/	/	Highly accepted
Population density	/	/	/	/	/	/		Accepted
Commercial hubs	/	/	/	/	/		/	Accepted
Public complaints	/	/	/	/	/	/		Accepted
Digital readiness	/	/	/	/	/		/	Accepted
Officer safety	/	/	/	/	/	/		Accepted

Notes: Acceptance = Respond of experts who consider the criterion acceptable or relevant to the study

The second key factor identified is traffic violation hotspots, where frequent offenses such as speeding and red-light running cluster spatially. This aligns with Rahman et al. (2020) and GovInsider (2015), which emphasize that hotspot policing enhances efficiency and deterrence by focusing on localized non-compliance patterns. Experts observed that deploying enforcement units

at these recurrent violation zones yields higher compliance rates and strengthens public perception of law enforcement visibility.

Heavy vehicle and logistics routes emerged as another crucial factor, reflecting findings by Karim (2014) and Luo (2022). These routes often experience safety and infrastructure challenges due to overloaded trucks, high vehicle volume, and extended travel times. Experts stressed the need for spatial monitoring and regulation along these corridors to ensure compliance with designated routes and vehicle weight limits. Their practical experiences affirm that targeted enforcement in these areas not only prevents road damage but also improves safety for all road users.

The role of public complaints and digital reporting channels, such as the e-Aduan@JPJ and MyJPJ apps (Malay Mail, 2022; JSPT, 2022; Chan, 2025), was also strongly emphasized. Experts acknowledged that crowdsourced complaint data complements official enforcement statistics by providing real-time feedback on emerging traffic issues. This participatory mechanism enhances responsiveness and ensures that enforcement activities remain aligned with public concerns, a finding consistent with current governance models encouraging citizen engagement in road safety (GovInsider, 2015).

Digital enforcement readiness represents a growing dimension of site suitability. According to Siborgs (2025) and ARS Traffic Tech (n.d.), AI-driven enforcement tools and automated detection systems significantly enhance operational efficiency by reducing manpower dependency. Experts recognized that areas with robust digital infrastructure such as stable connectivity and surveillance camera networks enable sustained, remote monitoring, improving both cost-effectiveness and enforcement coverage. This digital transformation aligns with Malaysia's broader push toward smart mobility and data-driven governance (Md Tahir, 2016; Saleh, 2013).

Operational feasibility factors, particularly infrastructure accessibility and officer safety, were also identified as vital determinants. Consistent with City Auditor (2023) and Yasanthi et al. (2024), experts emphasized that enforcement site selection must consider adequate parking space, lighting, and escape routes to ensure personnel safety and comfort. These human-centred aspects enhance enforcement morale and sustain long-term field effectiveness.

Finally, both literature and expert consensus support adopting a multi-criteria decision-making (MCDM) approach to integrate these interrelated spatial and operational factors. As recommended by Alhajri et al. (2024), combining spatial data analytics with expert judgment produces a balanced, evidence-based framework for enforcement site selection. This approach acknowledges that no single factor whether accident rate, digital readiness, or officer safety can independently determine site suitability. Instead, their intersection provides a holistic foundation for optimizing resource allocation, maximizing safety outcomes, and strengthening the strategic effectiveness of JPJ's enforcement operations in Johor and across Malaysia.

5. Conclusion

This study concludes that the effective selection of JPJ enforcement sites requires integrating spatial, operational, and technological considerations to improve road safety and enforcement efficiency. Accident blackspots and traffic violation hotspots remain the most critical determinants, as they represent areas of high crash and offence frequencies. Prioritizing these sites supports data-driven enforcement strategies that can reduce collisions and enhance compliance. Heavy vehicle and logistics routes also require focused monitoring to ensure regulatory adherence and protect road infrastructure. Population density and commercial hubs contribute to higher traffic

exposure and therefore, must be included in site selection decisions. Public complaints from apps such as e-Aduan@JPJ and MyJPJ provide dynamic data to identify emerging enforcement needs. Digital enforcement readiness through AI and automated systems enhances operational accuracy, while officer safety and accessibility remain essential for sustainable implementation. Overall, the findings emphasize that a multi-criterion, integrated approach, combining geospatial data, digital innovation, public participation, and human-centred factors that is essential for optimizing JPJ enforcement site suitability. Such integration ensures efficient resource allocation, reduces accident risks, and strengthens Malaysia's overall road safety framework.

6. Research Implication

This study provides several practical implications for the Road Transport Department (JPJ) and related agencies. The integration of GIS-based analytics and multi-criteria evaluation (MCDM) is recommended to improve enforcement site selection and decision-making efficiency. By combining spatial risk data with expert insights, JPJ can identify and prioritize enforcement zones more systematically and transparently. This data-driven approach promotes equitable enforcement coverage and ensures resources are directed toward high-risk areas.

The adoption of digital enforcement technologies, including AI-enabled surveillance, automated detection systems, and smart cameras will enhance violation detection, minimize manpower dependency, and increase operational coverage. Integrating crowdsourced data from public complaint platforms such as e-Aduan@JPJ can further improve responsiveness and community engagement in enforcement planning.

At the policy level, establishing standardized geospatial enforcement frameworks can enhance consistency and data interoperability between agencies. This will ensure that JPJ's enforcement strategy aligns with Malaysia's broader vision for smart mobility and road safety modernization. Overall, these implications reinforce the need for evidence-based, technology-supported enforcement planning that balances operational practicality, spatial intelligence, and community collaboration to strengthen national road safety management.

7. Research Limitation

Despite the study's contributions, several limitations are acknowledged. The first concerns the limited availability of empirical, multi-criteria studies on enforcement site suitability in Malaysia. Most previous works focus on isolated spatial or operational factors rather than integrating technological and human aspects into a comprehensive framework. This restricts the scope for comparison and limits the generalizability of findings beyond localized case contexts such as Johor.

Secondly, data limitations and evolving traffic conditions create challenges in maintaining up-to-date spatial accuracy. Malaysia's rapid urban expansion, shifting logistics patterns, and seasonal variations influence enforcement site performance and demand regular data recalibration. Additionally, while expert interviews provide valuable practical insights, they may introduce subjective bias based on personal experience or localized practice.

Future research should develop and validate multi-dimensional, data-driven frameworks that integrate real-time geospatial data, AI-based monitoring, and sensor analytics for adaptive enforcement planning. Continuous validation through field testing and feedback loops is crucial to ensure model applicability. Incorporating community participation and digital reporting data can further strengthen spatial enforcement models. Therefore, while this study establishes a strong conceptual foundation, future work should expand its methodological sophistication to enhance

the precision, adaptability, and operational relevance of enforcement site selection frameworks in Malaysia.

References

- Alhajri, B., Abdul Rasam, A. R., Tarudin, N. F., Khalid, N., & Alshukaili, D. (2024). *SPATIAL ANALYSIS OF ROAD TRAFFIC ACCIDENT HOTSPOTS AND PATTERNS IN MUSCAT, OMAN: AN EXPLORATORY RISK MANAGEMENT ASSESSMENT*. *PLANNING MALAYSIA*, 22(34). <https://doi.org/10.21837/pm.v22i34.1614>
- ARS Traffic Tech. (n.d.). *Traffic enforcement systems overview*. ARS Traffic & Transport Technology Web Page. <https://ars-traffic.com/solutions/traffic-enforcement/>
- Mohd Azami, M. F. A., Misro, M. Y., & Hamidun, R. (2024). *Road crash dynamics in Malaysia: Analysis of trends and patterns*. *Heliyon*, 10(18), e37457. <https://www.sciencedirect.com/science/article/pii/S2405844024134883>
- Office of the City Auditor. (2023). *Effects of traffic patrol on road safety* (Special report). City of Austin. https://www.austintexas.gov/sites/default/files/files/Auditor/Audit_Reports/Special_Request_Effects_of_Traffic_Patrol_on_Road_Safety_Nov_2023.pdf
- GovInsider. (2015, October 20). *How do policing hotspots work in Malaysia?* Governance Insights Asia. <https://govinsider.asia/intl-en/article/how-does-hotspots-policing-in-malaysia-work>
- Meor Hussein, M. M. H., Abd Rahman, R., Mohd Saim, N. A. I., Megat Tajuddin, M. ZZ. & Md Diah, J. (2023). *Assessing Road Accident Black Spots and Countermeasures in the State of Perak*. *International Journal of Sustainable Construction Engineering and Technology*, 14(3), 57-69. <https://publisher.uthm.edu.my/ojs/index.php/IJSCET/article/view/14956>
- Siborgs, C. (2025). *AI traffic enforcement for safer, smarter cities*. *InTouch Traffic*. <https://intouchtraffic.com/blog/ai-traffic-enforcement-for-safer-smarter-cities>
- Jabatan Siasatan dan Penguatkuasaan Trafik (JSPT). (2022). *Segmen Info Trafik – saluran aduan trafik JSPT: Penerangan keperluan maklumat untuk laporan awam [Video]*. Facebook. <https://www.facebook.com/watch/?v=1104622770312363>
- Karim, M. R., Nik Ibtishamiah, M. A. R., & Hoong, A. P. (2014). *Effectiveness of vehicle weight enforcement in a developing country using weigh-in-motion sorting system*. *IATSS Research*, 37(2), 158–166. <https://doi.org/10.1016/j.iatssr.2013.12.002>
- Kopczewska, K., Kubara, M., & Kopyt, M. (2024). *Population density as the attractor of business to the place*. *Scientific Reports*, 14, 22234. <https://doi.org/10.1038/s41598-024-73341-8>
- Luo, J., Wang, C., Wallerstein, B., Barth, M., & Boriboonsomsin, K. (2022). *Heavy-duty truck routing strategy for reducing community-wide exposure to associated tailpipe emissions*. *Transportation Research Part D: Transport and Environment*, 107, 103289. <https://doi.org/10.1016/j.trd.2022.103289>

- ITS International* (2015, March 17). *The weighty problem of truck routing enforcement*. *ITS International*. <https://www.itsinternational.com/its2/feature/weighty-problem-truck-routing-enforcement>
- Malay Mail. (2022, April 23). Public can submit traffic violation complaints via e-Aduan@JPJ app, says JPJ. <https://www.malaymail.com/news/malaysia/2022/04/23/public-can-submit-traffic-violation-complaints-via-e-aduanjpj-app-says-jpj/2055297>
- Md Tahir, M. A. (2016). *Digital forensics readiness in public sector* (Master's thesis). Universiti Teknologi MARA. <https://ir.uitm.edu.my/id/eprint/63291/>
- Ministry of Transport Malaysia. (2019). *National Transport Policy 2019–2030*. Putrajaya: Ministry of Transport.
- Ministry of Transport Malaysia. (2022). *Malaysia Road Safety Plan 2022–2030*. Putrajaya: Ministry of Transport.
- Jabatan Pengangkutan Jalan Malaysia. (2022, April 1). *Aplikasi e-Aduan@JPJ*. <https://www.jpj.gov.my/e-aduanjpj/>
- Chan, M. (2025, February 25). *How to report road traffic offences on the MyJPJ app*. *paultan.org*. <https://paultan.org/2025/02/25/how-to-report-road-traffic-offences-on-the-myjpj-app/>
- Mohammed Saleh, A. A. (2013). *A digital forensic readiness component for operational unit* (Master's thesis). Universiti Teknologi Malaysia. <http://eprints.utm.my/37851/>
- Cox, W. (2012, November). Urban travel and urban population density. *Journeys*, 8–18. <http://www.demographia.com/lta-density.pdf>
- Yasanthi, R. G. N., Wickens, C. M., Jonah, B., Mehran, B., & Suggett, B. (2024). *Determinants of traffic safety enforcement behaviour among police officers: A narrative review*. *Safety Science*, 176, 107–123. <https://doi.org/10.1016/j.ssci.2024.106610>
- Rahman, M. T., Jamal, A., & Al-Ahmadi, H. M. (2020). Examining hotspots of traffic collisions and their spatial relationships with land use: A GIS-based geographically weighted regression approach for Dammam, Saudi Arabia. *ISPRS International Journal of Geo-Information*, 9(9), 540. <https://doi.org/10.3390/ijgi9090540>