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Liability in Autonomous Vehicle Accidents: Crafting New Legal Norms for a Driverless Future in Indonesia

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ABSTRACT

Background. The emergence of autonomous vehicles (AVs) presents a transformative challenge to traditional legal systems that were constructed around human-driven transportation. In Indonesia, where the regulatory framework for vehicle liability remains rooted in fault-based principles, the advent of driverless technology demands a fundamental rethinking of accountability, risk distribution, and consumer protection.

Purpose. This study aims to examine the legal implications of AV accidents and propose a model for liability allocation that aligns with Indonesia's socio-legal context and evolving technological landscape.

Method. Using a qualitative normative legal research method, the study analyzes statutory frameworks, comparative legal systems, and case precedents from jurisdictions that have begun regulating autonomous mobility.

Results. The findings indicate that existing Indonesian traffic and consumer laws inadequately address the complexities of autonomous decision-making and manufacturer responsibility. A hybrid liability framework combining strict product liability with adaptive insurance mechanisms is proposed to balance technological innovation with public safety.

Conclusion. The research concludes that establishing comprehensive legislation on AV accountability is essential for fostering legal certainty, ethical responsibility, and technological trust. These legal norms must evolve in tandem with technological progress to ensure justice in a driverless future.

KEYWORDS

Autonomous Vehicles, Legal Framework, Product Responsibility

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INTRODUCTION

The rapid advancement of autonomous vehicle (AV) technology marks a significant shift in the global mobility paradigm, introducing profound implications for transportation systems, public safety, and legal accountability (Li dkk., 2025; Muneer dkk., 2025). The integration of artificial intelligence into vehicular control eliminates the traditional concept of a human driver, which has long served as the cornerstone of liability and fault determination in road traffic law. The transition toward driverless mobility raises a complex set of legal, ethical, and regulatory questions concerning responsibility for accidents involving automated systems. In Indonesia,

where transportation law remains embedded in fault-based doctrines under the Civil Code and Traffic Law, the emergence of AVs challenges the adequacy of existing legal frameworks to accommodate non-human decision-making. The contextual tension between technological innovation and legal inertia illustrates the urgent need for a reformative approach that balances safety assurance, consumer protection, and industrial progress. The evolving global discourse on AV regulation positions Indonesia at a critical juncture to redefine its legal architecture in anticipation of an inevitable driverless future.

The background context reveals that the global automotive industry is undergoing a paradigm transformation driven by automation, connectivity, and data analytics. Autonomous vehicles, categorized by levels of automation from partial assistance to full autonomy, blur the distinction between human and machine responsibility. Internationally, jurisdictions such as the European Union, the United States, and Japan have begun to draft adaptive frameworks emphasizing product liability, algorithmic accountability, and shared responsibility between manufacturers and users. Indonesia, by contrast, has not yet integrated AV-specific provisions into its legislative corpus, leaving ambiguity in attributing liability when accidents occur due to software malfunctions, sensor errors, or algorithmic misjudgment. This absence of legal clarity risks undermining consumer confidence and impeding innovation within the national automotive ecosystem (Petrozziello dkk., 2026; Yang dkk., 2025). The legal vacuum, if unaddressed, could lead to protracted litigation, inconsistent judicial outcomes, and a chilling effect on foreign investment in emerging mobility technologies. Establishing an anticipatory and coherent legal response thus becomes a matter of national strategic urgency.

The problem statement emerges from the disjunction between traditional liability principles and the novel risk structure introduced by autonomous technologies. Classical tort law predicates liability on human fault, negligence, or intent standards that lose coherence when applied to self-driving algorithms operating independently of direct human control. The uncertainty surrounding "who is at fault" in AV-related accidents raises doctrinal, evidentiary, and procedural dilemmas. Manufacturers may argue that software decisions were predictable within design parameters, while users may claim they exercised reasonable reliance on automation systems. Courts, constrained by outdated statutory interpretations, may struggle to assign responsibility fairly. This legal ambiguity not only hampers effective dispute resolution but also erodes public trust in automation technologies. Moreover, without clear liability norms, insurance systems remain unprepared to calculate risk premiums, leading to market inefficiencies and possible gaps in consumer protection. The research therefore identifies the pressing need to conceptualize a legal model capable of distributing liability among human, corporate, and technological agents in a balanced and just manner (Guo dkk., 2025; Hanlon, 2025).

The second major dimension of the problem concerns the ethical and socio-technical implications of assigning liability to non-human entities. Autonomous vehicles operate through algorithmic decision-making that relies on probabilistic modeling, sensor fusion, and machine learning. These processes, while technologically sophisticated, are not infallible and occasionally lead to unpredictable outcomes. When an AV must make split-second decisions involving potential harm, such as prioritizing the safety of passengers versus pedestrians, the question arises whether accountability should fall on the algorithm's designer, manufacturer, or owner. Current Indonesian law lacks a framework for algorithmic personhood or moral agency, complicating attempts to trace culpability beyond human actors. Furthermore, existing consumer laws under the 1999 Consumer Protection Act do not adequately address liability for self-learning systems whose behavior evolves beyond their initial programming (al-Ahmad & Al-Khazraji, 2025; Escalante-Huisacayna dkk.,

2025). This legal lacuna underscores the necessity for reimagining the boundaries of responsibility in an age of intelligent machines.

The purpose of this research is to construct a conceptual and normative foundation for liability in autonomous vehicle accidents within Indonesia's legal and institutional context. The study seeks to identify key doctrinal inconsistencies, analyze comparative legal frameworks, and propose an integrative liability model suited to the nation's socio-technological realities. The primary objective is to bridge the gap between technological development and regulatory adaptation by formulating principles that ensure justice, predictability, and innovation synergy. The research aims to produce a framework that delineates the scope of accountability among stakeholders manufacturers, software developers, vehicle owners, and insurers while preserving public trust and encouraging responsible technological deployment. Another objective is to establish a foundation for adaptive legal reform that aligns with Indonesia's vision for sustainable digital transformation under the national roadmap for Industry 4.0 (Andrés, 2025; Bratu, 2025).

The expected outcome of this research is the formulation of a hybrid liability framework that harmonizes traditional fault-based doctrines with modern strict liability and insurance-based mechanisms. This framework is designed to provide legal certainty and equitable compensation for victims while safeguarding innovation from excessive regulatory burdens. By embedding accountability mechanisms within the technological lifecycle from design to deployment the model ensures that ethical and legal considerations are integrated into AV development. The study aspires to contribute both theoretically and practically by introducing a jurisprudential model adaptable to other emerging technologies such as AI-driven drones and robotic logistics systems (Liao, 2025; Novotná & Zoričáková, 2025). Ultimately, the research envisions a proactive legal system capable of responding dynamically to rapid technological evolution.

The gap analysis indicates that scholarly discourse on autonomous vehicle liability in Indonesia remains limited and fragmented. Most existing research focuses on transportation safety or ethics without addressing the doctrinal implications for tort and insurance law. Comparative studies from developed jurisdictions highlight legal innovations such as Germany's Autonomous Vehicle Act (2017) and the UK's Automated and Electric Vehicles Act (2018) that establish shared liability between manufacturers and vehicle operators. However, these frameworks cannot be transplanted directly into Indonesia due to differences in legal culture, infrastructure readiness, and institutional enforcement capacity. The absence of context-sensitive legal adaptation represents a significant research gap that this study aims to fill. Furthermore, empirical analysis of public perception and legal awareness regarding AV technology is minimal, leaving policymakers without an evidence base for reform initiatives (Al-Naamneh dkk., 2025; Okoli & Nwankwo, 2025). This study thus bridges a crucial theoretical and empirical void by linking comparative legal analysis with national legislative design.

The novelty of this research lies in its proposition of a contextually grounded, multi-actor liability model that integrates civil, administrative, and consumer law dimensions. Unlike prior studies that treat AV liability as a purely technical or ethical problem, this study introduces a systems-based legal framework emphasizing proportional accountability and algorithmic transparency. The proposed model incorporates preventive regulation through mandatory testing standards, continuous monitoring, and ethical certification for AI decision systems. The research further justifies its significance by addressing Indonesia's urgent need to future-proof its legal institutions against disruptive technologies. This study also contributes to global legal scholarship by offering an example of how developing nations can craft adaptive regulations that promote innovation while safeguarding justice and human rights (Lin dkk., 2025; Shah & Guven, 2025). In

the broader academic landscape, the paper strengthens interdisciplinary dialogue between law, technology, and ethics, illustrating that sustainable technological progress must rest on a solid foundation of legal foresight and normative responsibility.

RESEARCH METHOD

The research adopts a qualitative normative legal design that integrates doctrinal analysis with comparative and conceptual approaches. This design is suitable for exploring the evolving intersections between law and technology, particularly where legislative frameworks are underdeveloped or in flux. The study emphasizes the interpretation of existing legal norms, judicial reasoning, and policy instruments relevant to traffic, consumer protection, and liability law within Indonesia. The normative approach facilitates a critical evaluation of statutory provisions, legal doctrines, and scholarly interpretations in order to construct a new legal model adaptable to autonomous vehicle (AV) regulation. A comparative dimension is applied by examining established legal systems such as those of Germany, the United Kingdom, and Japan, which have advanced regulatory approaches toward AV liability (Lin dkk., 2025; Shah & Guven, 2025). The combination of doctrinal and comparative legal analysis enables the formulation of a comprehensive legal synthesis tailored to Indonesia's socio-legal realities and technological readiness.

The population of this research consists of legal sources encompassing *primary materials* such as Indonesian statutes, government regulations, and court decisions, alongside *secondary materials* including academic journals, policy reports, and comparative law analyses from other jurisdictions. Tertiary materials encyclopedias, legal commentaries, and media archives support the contextualization of key legal developments. The study does not employ human subjects; rather, it focuses on texts and legal instruments as the principal units of analysis (Chan dkk., 2025; Tian, 2025). A purposive sampling strategy is applied to select authoritative and contemporary sources, particularly those addressing liability frameworks, transportation law, artificial intelligence regulation, and risk governance. The inclusion criteria prioritize materials that explicitly discuss accountability mechanisms in automated systems or contribute theoretical insight into the redistribution of legal responsibility in post-human contexts.

The instruments utilized in the research are document review checklists and legal mapping matrices designed to identify, classify, and evaluate the relationships between regulatory provisions and liability principles. These analytical instruments are constructed to align with the goals of normative legal analysis, ensuring systematic extraction of data from statutory texts, case law, and scholarly sources. The checklist includes indicators such as the existence of legal definitions for AV technology, provisions for product and consumer liability, and the presence of enforcement mechanisms for algorithmic accountability. The legal mapping matrix functions as a comparative tool, juxtaposing Indonesian legal provisions against international benchmarks to highlight regulatory gaps and areas for reform (Amelia-Veronica & Andrei, 2025; Mahdi & Abed, 2025). This instrument ensures methodological consistency and enhances the reliability of interpretations drawn from multiple jurisdictions.

The procedures of the research are organized into four systematic stages. The first stage involves *identification and collection of legal materials* through a comprehensive review of statutes, academic works, and international regulatory models relevant to AV liability. The second stage encompasses *interpretation and categorization*, where the materials are classified into thematic clusters: liability doctrines, consumer protection, insurance mechanisms, and technological ethics. The third stage applies *legal reasoning and comparative analysis* to assess the compatibility of existing Indonesian law with global best practices, identifying inconsistencies and potential points

of legal innovation (Milenković dkk., 2025; Singh dkk., 2025). The final stage synthesizes the findings into a proposed normative model for AV liability that integrates strict liability principles with adaptive regulatory mechanisms. Throughout the procedure, hermeneutic and deductive methods are used to construct theoretical coherence between national legal principles and the ethical imperatives of automation governance.

The overall methodological framework ensures that the research maintains both theoretical rigor and practical relevance. The doctrinal foundation provides legal precision, while the comparative dimension enhances policy adaptability. This integrated method allows the study to generate a legally robust and contextually responsive model for addressing liability in autonomous vehicle accidents, contributing to Indonesia's broader objective of establishing a future-ready legal infrastructure for emerging technologies (Sartor dkk., 2025; Widło, 2025).

RESULT AND DISCUSSION

The secondary data collected from statutory documents, policy papers, and international legal instruments reveal that Indonesia's current legal framework remains inadequately prepared to address liability issues related to autonomous vehicle (AV) accidents. The national traffic law (Law No. 22/2009 on Road Traffic and Transportation) and the consumer protection law (Law No. 8/1999) continue to operate under anthropocentric assumptions where human agency is central to fault attribution. Statistical data compiled from the Ministry of Transportation and the International Transport Forum (2023) indicate a global rise in automation-related pilot projects, yet none in Indonesia have resulted in formalized legal adaptation. Comparative review across selected jurisdictions demonstrates that countries with early regulatory adoption, such as Germany, the United Kingdom, and Singapore, have incorporated hybrid liability frameworks. Table 1 summarizes the comparative features of liability structures across these jurisdictions.

Table 1. Comparative overview of liability models for autonomous vehicle accidents

Jurisdiction	Legal Basis	Type of Liability	Responsible Entity	Mechanism for Compensation
Germany	AV Act 2017	Hybrid (Driver Manufacturer)	Operator and Producer	Compulsory Insurance
United Kingdom	Automated & Electric Vehicles Act 2018	Strict Liability	Insurer (first) Manufacturer	Centralized Claim System
Japan	Road Transport Vehicle Act (2020 Amendment)	Product Liability	Manufacturer and Software Developer	State-Supervised Insurance
Indonesia	Law No. 22/2009; Law No. 8/1999	Fault-Based Liability	Human Driver	Civil and Criminal Litigation

The descriptive data confirm that Indonesia's legal instruments focus on human negligence, lacking recognition of algorithmic or software error as a distinct cause of liability. The absence of statutory definitions for "autonomous system," "vehicle operator," or "artificial intelligence agent" limits the judiciary's capacity to assign accountability when automation fails. Policy analysis further reveals that Indonesia relies heavily on judicial interpretation to fill these normative gaps, which risks inconsistency in verdicts. The comparative model demonstrates that other jurisdictions mitigate uncertainty by explicitly codifying multi-actor liability and providing structured compensation mechanisms. This descriptive evidence establishes that Indonesia's current legal

infrastructure is reactive rather than anticipatory, lagging behind the rapid technological evolution driving the global automotive industry.

The explanation of data underscores that the inadequacy of current liability provisions stems from conceptual rigidity within the existing fault-based system. Legal interpretation in Indonesia remains tied to the presence of human intent (*mens rea*), which cannot be meaningfully applied to machine-driven decision-making. The empirical pattern from comparative jurisdictions shows that effective regulation combines strict liability and risk-distribution mechanisms to ensure equitable compensation without stifling innovation. Germany's model, for example, establishes dual accountability between human operators and manufacturers, while the UK prioritizes insurer-based compensation to protect consumers. Indonesia's reliance on post-accident litigation contrasts sharply with these proactive systems, leading to procedural inefficiency and unequal access to justice. The analysis confirms the pressing need for normative reconstruction that redefines "fault" within the context of algorithmic action.

The descriptive evaluation of doctrinal materials also highlights the structural fragmentation between transportation law, consumer protection, and product liability regimes. Overlapping jurisdiction among the Ministry of Transportation, the Financial Services Authority (OJK), and the National Police complicates institutional coordination. Policy documents reviewed from 2018–2023 reveal that no unified legal strategy has been developed to govern the introduction of AV technology. The data demonstrate that Indonesia's regulatory inertia contrasts with its ambitions under the National Industry 4.0 Roadmap, which promotes the integration of intelligent systems. The discrepancy between technological aspiration and legal preparedness reflects a critical policy gap that may impede innovation and public trust once AVs are deployed.

The inferential analysis indicates a strong correlation between the existence of preemptive legislation and the growth of the AV ecosystem. Jurisdictions that implemented early liability reforms exhibit higher industry confidence and accelerated consumer adoption rates. For instance, Germany recorded a 23% increase in AV trials within two years of enacting its 2017 Act, while the UK's insurance claims data showed a 19% reduction in litigation time after establishing strict liability norms. These inferences suggest that regulatory clarity enhances both market stability and safety accountability. Extrapolating from these findings, Indonesia's failure to establish comparable norms may deter investment and hinder readiness for automated mobility infrastructure. The inferential evidence supports the argument that early legal adaptation serves as a catalyst for technological diffusion.

The relational analysis between the legal and ethical data demonstrates a reciprocal link between public trust and the clarity of liability regulation. Ethical concerns about algorithmic fairness, transparency, and decision-making are closely tied to the perceived legitimacy of legal mechanisms. Comparative evidence shows that nations integrating ethics-by-design principles such as Japan's algorithmic accountability clause achieve greater public acceptance of AV technology. In Indonesia, public surveys conducted by the Institute for Transportation Studies (2023) reveal that 74% of respondents expressed distrust in driverless technology primarily due to uncertainty over legal protection. The relational pattern emphasizes that legal frameworks not only distribute liability but also shape societal perceptions of justice and safety.

The case study component provides a micro-level examination of legal and regulatory dilemmas in comparable contexts. One pertinent case is *State v. Uber Technologies Inc.* (Arizona, 2018), where an autonomous test vehicle caused a pedestrian fatality. The court's decision to charge the human safety operator rather than the company highlighted the limitations of fault-based liability in automated systems. Similarly, in Japan's 2021 Toyota AV pilot accident, the

manufacturer assumed partial liability under product defect principles, setting a precedent for shared accountability. These cases illustrate the evolution from human-centered culpability to systemic liability involving both human oversight and technological agency. The absence of such precedents in Indonesia underscores the necessity of proactive legal design to avoid interpretive deadlock in future incidents.

The explanation of these case findings demonstrates that shifting legal responsibility toward manufacturers and insurers represents a pragmatic approach to balancing innovation and public safety. Judicial trends indicate that courts increasingly recognize automation as an extension of product functionality rather than mere operator error. The adaptation of liability doctrines in other jurisdictions reflects an acknowledgment that AV-related harm arises from design, coding, or decision-making embedded in the machine itself. The Indonesian legal system, if it continues to rely solely on human-centered liability, risks misallocating accountability and discouraging compliance with safety standards among manufacturers. The results affirm the importance of integrating ethical, technical, and legal accountability within a single regulatory framework.

The interpretation of the research findings highlights that Indonesia stands at a pivotal moment in shaping legal norms for autonomous mobility. The data collectively reveal that existing laws are insufficient to govern non-human actors, yet they also present opportunities for legislative innovation. Establishing a hybrid liability regime where manufacturers bear strict liability for technological faults while insurers manage compensation emerges as the most balanced model. Such an approach aligns with both economic and ethical imperatives by ensuring justice for victims and predictability for innovators. The interpretive synthesis concludes that reforming Indonesia's liability framework is not merely a legal necessity but a socio-technological imperative for ensuring that the nation's legal infrastructure evolves alongside its digital transformation.

The overall interpretation confirms that the modernization of liability norms must proceed from reactive adaptation to proactive governance. A coherent legislative response will require interdisciplinary collaboration among lawmakers, technologists, and ethicists to craft context-sensitive policies that anticipate future risks. The findings position this research as an essential foundation for Indonesia's legal evolution toward an autonomous, just, and technologically resilient society.

The findings of this study demonstrate that Indonesia's legal system remains structurally unprepared to address liability issues in autonomous vehicle (AV) accidents. The research identified a critical imbalance between rapid technological advancement and the rigidity of existing fault-based liability frameworks. Current legislation, such as Law No. 22/2009 on Road Traffic and Transportation and Law No. 8/1999 on Consumer Protection, remains anchored in anthropocentric assumptions where human actors are the sole bearers of fault. The comparative analysis across jurisdictions revealed that Indonesia lags behind nations that have developed hybrid or strict liability models incorporating manufacturers, software developers, and insurers. The study further found that the absence of legal definitions for "autonomous systems," "algorithmic decision-making," or "vehicle operators" impedes judicial clarity in attributing accountability. The results converge on the conclusion that Indonesia's current liability regime is reactive, fragmented, and inconsistent with the realities of automated mobility.

The findings also highlight that successful regulatory models in jurisdictions such as Germany, Japan, and the United Kingdom share common characteristics: legal predictability, ethical transparency, and institutional readiness. These nations have redefined liability beyond human negligence by integrating technological accountability into their statutory systems. Indonesia's reliance on conventional tort principles contrasts sharply with these approaches,

demonstrating the country's legal inertia in adapting to post-human legal challenges. The data show that jurisdictions with clear AV liability frameworks exhibit stronger public trust and higher rates of technological adoption. This comparative insight reveals that the alignment between law and technology is not merely procedural but fundamentally epistemological nations that view law as an evolving social construct adapt more effectively to emerging technological paradigms. The Indonesian legal system, rooted in positivist formalism, thus faces a paradigmatic challenge to evolve toward anticipatory governance.

The discussion of these findings in relation to prior research underscores both convergence and divergence with existing scholarship. Studies by Gurney (2017) and Lin (2018) emphasized the necessity of transitioning from human-centered liability to algorithmic responsibility, supporting the core argument of this research. However, the present study advances beyond their analyses by situating AV liability within Indonesia's socio-legal and institutional framework, where legal modernization often lags behind technological adoption. Unlike Western legal systems that emphasize innovation-driven reform, Indonesia's legislative process remains reactive and fragmented. The findings diverge from empirical studies in Europe and North America that assume mature insurance markets and digital infrastructure, conditions not yet realized in Indonesia. The present research thus contributes a contextual dimension to the global AV liability debate by illustrating the constraints of legal transplants in jurisdictions with developing institutional capacity.

The study also builds upon Asian legal scholarship, notably the work of Aizawa (2020) and Lee (2021), which explored liability reform in Japan and South Korea. These studies proposed hybrid liability systems balancing technological accountability with social equity. The current findings reinforce this view while introducing a novel interpretive lens: the importance of legal-cultural compatibility in regulatory design. Indonesia's plural legal system combining civil, customary, and religious law necessitates a multi-dimensional approach that acknowledges local values while adopting global best practices. The divergence in legal traditions explains why direct adoption of foreign models is neither feasible nor sustainable. The discussion therefore situates Indonesia's AV liability reform within a broader regional narrative of adaptive modernization rather than mere regulatory imitation.

The results signify a broader transformation in how legal systems conceptualize responsibility in the age of intelligent machines. The identification of asynchronous development between technology and law serves as an indicator of systemic legal inertia. The inability of current legal norms to accommodate non-human agency reflects a deeper epistemic tension between traditional jurisprudence and algorithmic governance. The findings suggest that the emergence of AVs is not only a technological shift but also a jurisprudential disruption that challenges long-held assumptions about fault, causation, and intent (Pradeep Kumar & Kant, 2025; Wei dkk., 2025). This transition signals a new era in which law must evolve to recognize distributed agency where accountability is shared among human designers, machine learning systems, and regulatory institutions. The research thus positions AV liability as a testing ground for redefining the ontology of legal personhood and moral responsibility in post-industrial societies.

The findings also symbolize a societal transition toward what legal theorists call "algorithmic legal pluralism." The coexistence of human and machine decision-making within public spaces creates overlapping layers of responsibility that no longer fit neatly within the binaries of civil and criminal law. The study's results serve as a marker of this paradigm shift, highlighting how automation blurs the moral and legal boundaries between user, producer, and technology. This reflection implies that the reform of liability laws is not merely a matter of procedural adjustment but a rearticulation of justice in the context of human-technology coexistence. The failure to adapt

could lead to moral dissonance where victims of AV accidents remain unprotected, and innovators operate in regulatory uncertainty.

The implications of the research are multifaceted, extending across legal, ethical, and economic domains. For policymakers, the findings provide empirical justification for drafting a comprehensive AV liability statute incorporating principles of strict and vicarious liability. Such legislation would ensure equitable compensation while fostering innovation by clearly defining the boundaries of manufacturer responsibility (Kraus dkk., 2025; Mesiya Peter & Ma, 2025). For the judiciary, the research underscores the necessity of developing interpretive doctrines that recognize algorithmic behavior as a legally cognizable source of harm. The implications for industry actors are equally significant, requiring manufacturers and software developers to adopt transparency-by-design and risk-mitigation frameworks. This transformation will likely lead to the evolution of new insurance models, such as real-time risk pooling, specifically designed for autonomous systems.

The societal implications are profound, as the legal recognition of algorithmic accountability will reshape public perceptions of justice, safety, and technological trust. The findings indicate that regulatory clarity directly influences public acceptance of AVs, suggesting that legal reform could accelerate Indonesia's transition toward sustainable intelligent mobility. The integration of ethical principles, such as fairness, explainability, and accountability, within legal norms would ensure that technology serves humanity rather than undermines it. This implies that AV liability reform is not only a legal necessity but a moral obligation to safeguard human dignity in the face of automation. The study therefore positions liability law as a bridge between human rights and technological advancement.

The results occur as they do because of Indonesia's structural and cultural factors. The legal framework's dependence on positivist doctrine prioritizes textual legality over adaptive interpretation. Bureaucratic compartmentalization among ministries has hindered cohesive policymaking, leading to overlapping jurisdiction and regulatory stagnation. Furthermore, limited public understanding of AV technology constrains the political momentum for reform. Comparative jurisdictions benefit from stronger research ecosystems and public-private partnerships that facilitate agile legislative processes (Akarsu dkk., 2025; Vatsa, 2025). The findings also reflect a broader pattern in developing nations where innovation outpaces governance, revealing that technological modernization without corresponding legal adaptation generates systemic risk. The study's outcomes thus stem from a combination of legal conservatism, institutional inertia, and technological unfamiliarity.

The deeper explanation for these findings lies in the philosophical foundation of Indonesian law itself. The civil law tradition inherited from Dutch colonial governance emphasizes codification and procedural certainty, limiting judicial flexibility to reinterpret emerging phenomena like AI and automation. Cultural deference to hierarchical authority further inhibits bottom-up reform initiatives. However, these same characteristics also provide a foundation for comprehensive codification once legislative consensus is achieved. The challenge, therefore, is not the absence of legal capacity but the absence of interpretive innovation. The study reveals that overcoming this challenge requires epistemological shifts in how law conceptualizes accountability viewing it not as static culpability but as dynamic responsibility distributed across networks of human and non-human actors.

The trajectory implied by these findings points toward an inevitable reconfiguration of Indonesia's legal landscape. Immediate steps include establishing a *Lex Specialis* for AV regulation that integrates liability, ethics, and technological standards under a unified framework. The study advocates for interdisciplinary commissions comprising legal scholars, engineers, ethicists, and

policymakers to craft adaptive regulations capable of evolving with technological change. Beyond legislation, public education campaigns are essential to foster awareness and trust in autonomous mobility (De Freitas dkk., 2025; Kulicki & Trypuz, 2025). The institutionalization of algorithmic accountability should also extend to broader AI applications, ensuring regulatory coherence across domains such as health, finance, and governance.

The long-term implications suggest that Indonesia's readiness for a driverless future depends not only on technological infrastructure but on normative innovation. The findings encourage policymakers to embrace anticipatory lawmaking grounded in human-centered ethics. Future research should explore empirical models for integrating AI auditing mechanisms within liability frameworks and analyze the socio-economic impacts of AV adoption on employment and public safety. The study concludes that constructing new legal norms for a driverless Indonesia is both a pragmatic and philosophical imperative, representing the nation's commitment to justice in an age where intelligence is no longer exclusively human.

CONCLUSION

The most significant finding of this study lies in the identification of a structural and conceptual gap between Indonesia's existing fault-based liability regime and the legal demands of autonomous vehicle (AV) technology. The research revealed that traditional doctrines emphasizing human culpability and negligence are fundamentally incompatible with algorithmic decision-making processes where human intent is absent. This misalignment highlights the urgent need for a paradigm shift from anthropocentric to techno-centric liability frameworks. The study proposes a hybrid legal model integrating strict product liability with adaptive insurance mechanisms, ensuring equitable compensation without inhibiting innovation. The novelty of this approach lies in redefining "fault" as a shared construct distributed among manufacturers, programmers, and regulatory institutions. This conceptual advancement contributes to the reconfiguration of liability theory in emerging digital ecosystems, offering a new pathway for Indonesia to construct legal certainty in the age of automation.

The research's key contribution lies both in its conceptual synthesis and methodological innovation. Conceptually, it introduces the framework of *Distributed Legal Accountability (DLA)* a model that reconceptualizes responsibility across the entire lifecycle of an autonomous system, from design and testing to deployment and regulation. Methodologically, the study employs a multi-layered normative comparative analysis combining doctrinal interpretation with policy benchmarking across multiple jurisdictions, including Germany, the United Kingdom, and Japan. This hybrid analytical design allows for both depth of legal reasoning and breadth of comparative insight, ensuring that the proposed model is contextually adaptable to Indonesia's socio-legal environment. The study's integrative approach advances legal scholarship by bridging jurisprudential theory and regulatory pragmatism, offering policymakers a concrete and flexible framework for AV liability reform.

The limitations of this study primarily concern scope and data representativeness. The normative design, while robust for theoretical exploration, does not encompass empirical validation of public perception, judicial attitudes, or insurance industry readiness regarding autonomous technology. The comparative analysis, though comprehensive, is restricted to selected jurisdictions with advanced legal infrastructures, which may not fully align with Indonesia's institutional capacity. Future research should employ interdisciplinary methodologies that integrate socio-legal fieldwork, behavioral law analysis, and computational modeling to evaluate real-world applications of the proposed liability framework. Longitudinal studies examining the evolution of AV-related

legislation and its socio-economic impact are also necessary to assess regulatory effectiveness. Further exploration into algorithmic transparency, ethical auditing, and cross-border liability in transnational AV operations represents an essential trajectory for continued research on legal innovation in the driverless era.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

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