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Human Machine Liability Redistribution in Autonomous Artificial Intelligence Decision Systems within Contemporary Legal Governance

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A B S T R A C T

The rapid development of Autonomous Artificial Intelligence (AAI) systems has challenged traditional legal liability frameworks that are centered on human actors. This study aims to analyze the redistribution of liability between humans and machines in AI-based decision-making and to evaluate the adequacy of contemporary legal regimes. The research employs a normative juridical approach with comparative analysis of legal instruments and liability doctrines. The findings indicate that conventional liability models are insufficient to address the autonomy and uncertainty inherent in AAI systems. New approaches such as shared liability, risk-based liability, and strengthened algorithmic accountability are required. This study highlights the urgency of reformulating adaptive legal frameworks to ensure legal certainty, protection of rights, and a balance between technological innovation and responsibility.

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INTRODUCTION

The rapid development of Autonomous Artificial Intelligence (AAI) has brought significant transformations in decision-making processes in various strategic sectors, including health, finance, transportation, and public administration. In contrast to conventional software systems that operate on predetermined instructions, AAI has the ability to learn, adapt, and make decisions independently with a high degree of autonomy. This change has led to a paradigm shift in understanding the concept of agency and control in the legal system, as the decision-making process can no longer be fully attributed to human actors (Floridi et al., 2021; Veale & Borgesius, 2021).

The application of AAI in high-risk environments, such as autonomous vehicles, algorithmic trading, and artificial intelligence-based medical diagnoses, further reinforces the urgency of legal accountability and accountability issues. The losses caused by these systems are often the result of complex interactions between data, algorithms, and the evolving learning dynamics of the system, making it difficult to trace causal relationships. This condition causes traditional legal doctrine to face limitations in determining the subjects who must be held accountable (Ebers, 2022; Hacker et al., 2020).

The conventional legal liability framework, especially fault-based liability and strict liability, is based on the assumption that humans are the main actors who have control and intention over an action that causes harm. However, the characteristics of AAI, which include decision-making autonomy, continuous learning capabilities, and limited transparency in the decision-making process, which is often referred to as a black box, create difficulties in proving the elements of error, predictability, and causal relationships that are at the core of legal accountability (Wendehorst, 2020; Pagallo, 2021).

In addition, the distributed nature of the artificial intelligence ecosystem complicates the attribution of responsibility. Various parties such as developers, data providers, operators, and end users contribute to the operation of AAI systems, often across jurisdictional boundaries. This raises the fundamental question of whether legal liability should remain individual or need to be reconstructed into collective or systemic liability (European Commission, 2021; Smuha, 2021; Sihombing, 2022).

In the national context, Indonesia is also beginning to face similar challenges along with the increasing adoption of artificial intelligence technology in various sectors. However, existing regulations are still sectoral and have not comprehensively regulated legal accountability in AI-based systems. Several studies show that the national legal framework is still not ready to accommodate the complexity of responsibilities in the autonomous system, especially related to aspects of accountability and legal protection for the community (Rahardjo, 2021; Santoso, 2023).

In response to these challenges, global regulatory developments show a shift towards a more adaptive governance model. The European Union, through the Artificial Intelligence Act, adopts a risk-based approach that classifies AI systems based on their potential impact levels and establishes proportionate liabilities. In addition, the concepts of algorithmic accountability, transparency, and ex ante supervision mechanisms have also developed as a complement to the conventional legal accountability regime (Veale & Borgesius, 2021; Ebers, 2022).

Based on this background, this article aims to examine the redistribution of legal responsibilities between humans and machines in AAI-based decision-making systems. This research also evaluates the adequacy of the existing legal framework and explores alternative models such as shared liability, risk-based liability, and accountability-based governance that are more in line with the characteristics of autonomous technology. Thus, this research is expected to contribute to the development of an adaptive legal framework to ensure legal certainty, protection of rights, and a balance between technological innovation and legal responsibility.

LITERATURE REVIEW

A review of the literature on legal accountability in artificial intelligence systems shows a shift from traditional approaches to more adaptive and risk-based models. Recent literature highlights that the development of Artificial Intelligence not only poses technical problems, but also creates normative complexity in determining the attribution of legal liability, especially when systems operate autonomously and involve multiple actors in their ecosystem (Gambhir & Mehra, 2025).

One of the main focuses in the literature is the concept of algorithmic accountability, which emphasizes the importance of transparency, explainability, and oversight of AI systems. Recent studies show that the lack of transparency in algorithmic decision-making processes is a major obstacle in law enforcement and the protection of individual rights. In addition, a multidisciplinary approach that integrates legal, ethical, and technical aspects is considered crucial in building an effective governance framework (Frontiers, 2024).

Systematic studies have also identified that the integration of AI in modern legal systems has resulted in new forms of interaction between humans and machines, such as predictive justice and hybrid decision-making systems. This phenomenon expands the discourse on the role of AI not only as a tool, but also as an actor that influences the outcome of legal decisions, thus demanding a redefinition of the concepts of responsibility and accountability (ScienceDirect, 2025).

In the context of civil liability, the latest literature highlights the limitations of strict liability regimes in dealing with dynamic and adaptive AI characteristics. Research shows that while strict liability is still relevant for high-risk applications, this approach has not been able to fully accommodate issues such as algorithmic bias, self-learning, and the complexity of causal relationships in AI systems (Al-Dajeh et al., 2025).

In addition, critical studies of algorithm-based decision-making systems confirm that the main challenges lie in the aspects of transparency, discrimination, and legal redress mechanisms. Existing regulations are still considered to be unable to answer the need for effective accountability mechanisms, especially in the context of human rights protection and substantive justice (Prabawa et al., 2025).

In recent developments, the literature has also begun to lead to the concept of system-based responsibility redistribution, where accountability is no longer individual, but rather shared among various parties in the AI value chain. This approach includes models such as risk pooling, collective liability, and ecosystem-based governance, which are considered more appropriate to address the cross-border risks and global nature of AI technology (Tran, 2026).

Furthermore, some studies propose new conceptual approaches such as operational agency, which allows for a more structured tracing of responsibilities through the mapping of causal relationships between human actors and AI systems. This approach seeks to bridge the gap between machine autonomy and the legal need to maintain human accountability (Mukherjee & Chang, 2026).

In the national context, a study of the legal implications of AI in Indonesia shows that the legal system is still in the early stages of responding to this technological development. National research emphasizes that existing regulations have not been able to accommodate issues such as algorithmic bias, multi-actor liability, and protection against the discriminatory impacts of AI-based systems. In addition, limited institutional capacity and lack of interdisciplinary approaches are the main challenges in the development of AI governance in Indonesia (Rumlus, 2025).

Based on the overall literature, it can be concluded that there is a significant gap between the development of AI technology and the readiness of the legal framework to regulate it. Although new approaches have been proposed, there is no fully comprehensive model for integrating technical, legal, and ethical aspects. Therefore, this research places itself in an effort to fill this gap by examining the redistribution of legal responsibilities in autonomous AI systems in a more systematic and contextual manner.

METHODOLOGY

This research uses a normative juridical approach that focuses on the analysis of legal norms, doctrines, and principles relevant to accountability in the context of Autonomous Artificial Intelligence (AAI). The normative juridical method was chosen because it is able to examine legal problems arising from technological developments by systematically evaluating the existing legal framework and its conceptual adequacy in facing new challenges (Marzuki, 2021; Douglas, 2020).

This research also uses a comparative legal method by examining the development of regulations and legal frameworks in various jurisdictions, including the European Union, the United States, as well as international instruments such as the OECD AI principles and UNESCO recommendations. A comparative analysis was conducted to identify similarities, differences, and best practices in AI legal liability arrangements, particularly with regard to risk-based approaches and accountability mechanisms (Micklitz, 2021; OECD, 2021).

The primary legal materials in this study include laws and regulations, draft regulations, and policy documents related to artificial intelligence governance, including the European Union's Artificial Intelligence Act, AI regulatory initiatives in the United States, and various international legal instruments. These materials are analyzed to understand how different legal systems conceptualize responsibilities in autonomous systems (European Commission, 2021; UNESCO, 2021).

The secondary legal materials consist of scientific articles, legal commentary, and interdisciplinary research that discusses the ethics, governance, and accountability of AI. These sources are used to provide a theoretical and analytical foundation in understanding the development of legal accountability doctrine as well as the integration of technological aspects in legal reasoning (Cath et al., 2022; Gless et al., 2021).

The analytical approach used is qualitative and doctrinal, with an emphasis on legal interpretation, both grammatically and systematically, as well as conceptual analysis of legal accountability models. This study evaluates the adequacy of traditional doctrines such as fault-based liability and strict liability, as well as examines alternatives such as shared liability, risk-based liability, and algorithmic accountability. This approach allows for a critical assessment of whether existing legal principles are still adaptable or require fundamental reforms in response to AAI developments (Ebers, 2022; Surden, 2021).

In addition, this research also has a prescriptive analysis dimension by providing normative recommendations for legal reform. Through the synthesis of the results of comparative analysis and doctrinal evaluation, this study formulates a model of responsibility redistribution that is more in line with the characteristics of autonomous systems and the needs of contemporary legal governance.

RESEARCH RESULTS

Limitations of Traditional Liability Frameworks

The results of the study show that the inadequacy of traditional legal accountability regimes is not only conceptual, but also structural and operational in practice. Key findings indicate that in the context of AAI, the three key elements of classical liability, namely fault, causation, and control, have undergone significant erosion.

First, in the framework of fault-based liability, the study found that the main difficulty lies in the epistemic gap, namely the limitation of human knowledge of the internal processes of the AI system. In many cases, even developers can't definitively explain how a decision is generated by a machine learning model. This condition makes proving the element of negligence or error not only difficult, but in some situations almost impossible. Thus, fault-based liability loses its function as an effective liability attribution instrument.

Second, the findings show a disruption to the concept of causation (cause-and-effect relationship). In AAI systems, losses are often the result of complex interactions between training data, algorithms, and a dynamic operational environment. This creates what can be called multi-layered causation, where there is no single cause that can be clearly identified. As a result, the linear causality approach used in traditional law has become no longer relevant to explain the losses generated by AI systems.

Third, the study identified that the concept of control as the basis for responsibility attribution became fragmented. In the AI ecosystem, control is spread among various actors, such as the developers who design the system, the data providers who influence the output, and the users who operate the system. These findings suggest that no single actor has complete control over the final outcome, so the attribution of individual responsibility becomes disproportionate.

Meanwhile, in the context of strict liability, the results show that although this approach is more risk-adaptive, there are some significant drawbacks. First, strict liability tends to simplify the complexity of the AI ecosystem by imposing responsibility on one party, usually an operator or manufacturer. Second, this approach does not consider the relative contributions of various actors in the AI value chain, thus potentially resulting in an unfair distribution of responsibility.

Furthermore, the research found that the widespread implementation of strict liability can cause a regulatory chilling effect, namely the tendency of industry players to hold back innovation due to high legal risks. This is contrary to the need to encourage technological development, especially in strategic sectors.

Overall, the findings of this study confirm that the limitations of traditional regimes lie not only in normative incompatibility, but also in their inability to accommodate technological realities that are:

1. Non-linear in causal relationships.
2. Distributed in a responsibility structure.
3. Dynamic as a result of continuous learning.
4. Lack of transparency in the decision-making process.

Thus, it can be concluded that the conventional legal accountability model experiences structural inadequacy in the context of AAI, thus requiring a paradigm reconstruction towards a more systemic and adaptive approach.

Characteristics of AAI Challenging Legal Attribution

AAI has unique characteristics that directly challenge the basic principles of attribution of legal liability:

1. Autonomy in Decision-Making
   The AAI system can make decisions without direct human intervention, thus obscuring the concept of control as the basis of responsibility.
2. Continuous Learning and Adaptation
   Machine learning capabilities cause the system to evolve after implementation, so the behavior of the system is not fully predictable at the design stage.
3. Lack of Transparency (Black-Box Problem)
   The internal processes of algorithms are often not logically explainable, which makes it difficult to prove cause-and-effect relationships.
4. Unpredictability of Outcomes
   System outputs can differ even though the inputs are similar, due to the complexity of the model and data.

These characteristics cause disruption to the concept of legal causation. In traditional doctrine, cause-and-effect relationships should be traceable linearly, whereas in AAI, they are non-linear and multi-layered.

Emerging Models of Liability Redistribution

This study identifies a shift towards a more adaptive and systemic model of accountability:

1. Shared Liability Model
   This model distributes responsibilities to various actors in the AI ecosystem, such as developers, deployers, operators, and users. This approach reflects the reality that losses are often the result of collective contributions.
2. Risk-Based Liability
   This approach links responsibility to the level of risk of the AI system. High-risk systems (e.g. autonomous vehicles or medical AI) are subject to stricter liability standards than low-risk systems.
3. Algorithmic Accountability
   This model emphasizes the obligations of transparency, auditability, and explainability as the basis for accountability. The focus is not only on results, but also on the decision-making process.
4. Hybrid Liability Framework
   This model combines several approaches at once, such as strict liability for high-risk AI and fault-based liability for low-risk AI, plus governance mechanisms.
5. Insurance-Based Liability Model
   This approach shifts risk through a mandatory insurance mechanism for AI operators or developers, similar to motor vehicle insurance.

Emerging Models of Liability Redistribution

The results show a shift from individual legal accountability to a more systemic approach in dealing with the complexity of AAI. The shared liability model distributes responsibilities to various actors, while risk-based liability adjusts responsibilities based on the level of risk of the system. In addition, algorithmic accountability emphasizes transparency and auditability, while insurance-based models focus on victim compensation. To clarify the comparison between the models, the following table summarizes their advantages, weaknesses, and relevance:

Table 1. Comparative Analysis of Liability Models in AAI Systems

Model Liability	Pros	Disadvantages	Relevance to AAI
Fault-Based Liability	Morally fair	Hard to prove in AI	Low
Strict Liability	High casualty protection	Inflexible	Medium
Shared Liability	Mirrors multi-actor	Complex	Height
Risk-Based Liability	Adaptive to risk	Need classification	Very High
Algorithmic Accountability	Increased transparency	Difficult to implement	Height
Insurance-Based Model	Quick compensation	Not touching the root of the problem	Medium

The findings suggest that risk-based liability and shared liability are most relevant, supported by algorithmic accountability. This marks a shift towards systemic liability and the need for a more adaptive hybrid model.

DISCUSSION

The results of this study confirm that the development of Autonomous Artificial Intelligence (AAI) not only poses technical challenges, but also encourages a fundamental transformation in the legal accountability structure. In the context of Indonesia's positive law, the accountability framework still rests on Article 1365 of the Civil Code (KUHPercivil) which requires the existence of unlawful acts, mistakes, losses, and causal relationships. However, the findings regarding the limitations of traditional liability models and the emergence of alternative approaches indicate the need to reconstruct the legal paradigm from individual to systemic and adaptive.

First, the results of this study are in line with the literature that emphasizes that law can no longer rely on the concept of human agency as the center of responsibility attribution. In the context of AAI, decisions generated by systems are not fully controllable or predictable by humans, thus demanding a legal approach that is able to accommodate distributed forms of agency in the technology ecosystem (Abbott, 2020; Turner, 2022). This also shows the limitations of Articles 1366 and 1367 of the Civil Code in accommodating

negligence-based liability and subordinated relationships. The shift towards a shared liability model is not only a normative choice, but a logical consequence of changing decision-making structures.

Second, the relevance of the risk-based liability model in the findings of this study strengthens the direction of global regulatory developments that adopt a risk-based approach. In the Indonesian context, this approach can be linked to the principle of prudence in the implementation of electronic systems as stipulated in Article 15 of Law Number 11 of 2008 concerning Electronic Information and Transactions jo. Law No. 19 of 2016, which affirms the responsibility of electronic system operators for the systems they manage. Recent studies show that risk-based governance is able to increase the effectiveness of regulations without hindering innovation (Crootof et al., 2022; Kaminski, 2021).

Third, the integration of the concept of algorithmic accountability in the legal accountability model shows that transparency and explainability are key elements in ensuring the legitimacy of AI systems. In the national context, this principle has relevance to Law Number 27 of 2022 concerning Personal Data Protection (PDP Law), especially related to the obligation of data controllers to ensure accountability and security of data processing. Nevertheless, this regulation does not explicitly regulate responsibility for autonomous decisions generated by AI systems. Research shows that algorithmic audit-based approaches can be a solution to address opacity in AI systems (Kroll et al., 2020; Selbst et al., 2021; Rahardjo, 2021).

In addition, the findings regarding the limitations of strict liability and fault-based liability suggest that the two models cannot be completely abandoned, but rather need to be reconfigured in a hybrid framework. In this context, the hybrid liability framework approach becomes relevant because it allows for a combination of different models according to the risk characteristics and the context of AI use. This approach is in line with the view that AI regulation should be flexible and contextual (Binns, 2022).

In a broader perspective, the study also shows that the main challenge in setting up AAI lies not only in the legal aspect, but also in the integration between law, technology, and ethics. Therefore, a multidisciplinary approach is crucial in designing an effective governance framework. Studies show that failure to integrate ethical dimensions in AI regulation can lead to the risk of discrimination, algorithmic bias, and human rights violations (Mittelstadt, 2021).

In the national context, these findings indicate that Indonesia still faces regulatory limitations in regulating AI comprehensively. The current sectoral approach is not enough to address the complexity of responsibilities in autonomous systems. Therefore, harmonization between the Civil Code, the ITE Law, and the PDP Law is needed, as well as the development of risk- and system-based AI specific regulations (Sihombing, 2022; Santoso, 2023).

Further, the study proposes that the future of legal accountability in AAI will lead to system-based liability, where the focus is not only on individual actors, but also on the system as a whole. This approach allows for a fairer distribution of responsibilities as well as being able to reflect the complex realities in the AI ecosystem.

Thus, this discussion affirms that legal reform in the context of AAI must be progressive, adaptive, and risk-based. Without this paradigm shift, the legal system has the potential to experience regulatory lag, which is lagging behind in responding to technological developments, which can ultimately reduce the effectiveness of legal protection and justice.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that the development of Autonomous Artificial Intelligence (AAI) has revealed fundamental limitations in traditional legal accountability regimes, especially those based on the concepts of error, control, and linear causality as regulated in the Civil Code. The autonomous, adaptive, and non-transparent characteristics of AAI cause disruption to the individualized model of responsibility attribution. Therefore, a paradigm shift is needed towards a more systemic and adaptive approach.

The findings of the study show that the risk-based liability, shared liability, and algorithmic accountability models are the most relevant approaches in responding to the complexity of AAI. The integration of these three approaches in a hybrid liability framework allows for a more proportionate distribution of responsibilities and increases the transparency and accountability of the system.

Based on this, this study recommends the need for the establishment of special regulations for artificial intelligence in Indonesia that are risk- and system-based, as well as harmonization between the Civil Code, the Electronic Information and Transaction Law, and the Personal Data Protection Law in regulating AI accountability. In addition, it is necessary to strengthen algorithmic accountability through transparency obligations and audits of AI systems, as well as the development of multi-actor accountability mechanisms to reflect the distributed nature of the AI ecosystem. Thus, progressive and technology-based legal reform is key in ensuring legal certainty, protection of rights, and a balance between innovation and responsibility in the era of artificial intelligence

ADVANCED RESEARCH

This research opens up opportunities for the development of more empirical and multidisciplinary follow-up research in the legal accountability of artificial intelligence. Further research needs to test the implementation of risk-based liability and shared liability models in practice, as well as develop more adaptive legal causality concepts such as probabilistic or network-based causation. In addition, a study is needed on the standardization of algorithmic accountability, including audit mechanisms and transparency of AI systems. Further research can also explore the possibilities of limited legal personality for AI, as well as formulate a comprehensive and contextual AI regulatory design in Indonesia through a comparative approach.

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