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The Doctrinal Immaturity of Mens Rea in the Age of Autonomy: A Bibliometric-Driven Comparative Jurisprudence Review on Artificial Intelligence (AI) Criminal Liability

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Abstract−The increasing autonomy of Artificial Intelligence (AI) critically challenges the foundational principles of criminal law, especially the doctrine of mens rea (guilty mind or fault element). Traditional liability models struggle to attribute human fault when harm arises from AI's autonomous, opaque decisions (the Black Box Problem). This study addresses the resulting crisis of attribution in criminal jurisprudence. We employ a mixed-methods approach, combining quantitative bibliometric analysis of 180 Scopus-indexed documents (1993–2026) to empirically validate the research gap, followed by a critical comparative jurisprudence review of authoritative Civil Law (Italy) and Common Law (UK) models. The bibliometric thematic map confirms the doctrinal immaturity of the field, positioning the Mens Rea cluster in the 'Emerging or Declining Themes' quadrant, proving that scholarly attention is structurally focused rather than substantively doctrinal. The comparative review demonstrates the failure of existing legal analogies to resolve the culpability gap. Conclusion: To provide a robust solution, this paper proposes the "Ex Ante Negligence" model. This framework fundamentally shifts the assessment of human culpability from the AI's harmful act (Ex Post) to the human actor's professional failure to exercise due diligence during the design and deployment stages, specifically the failure to conduct an adequate Algorithmic Impact Assessment (AIA) or the use of non-explainable AI in high-risk environments. This model is recommended for global legislative adoption to establish a clear, measurable, and technology-neutral standard for AI criminal liability.

Keywords: Artificial Intelligence; Criminal Liability; Mens Rea; Ex Ante Negligence; Algorithmic Impact Assessment; Black Box Problem; Bibliometric Analysis

1. INTRODUCTION

The rapid and accelerating deployment of sophisticated autonomous systems marks a paradigm shift that fundamentally challenges the foundational principles of criminal law across all jurisdictions (Garcia-Segura, 2024). From self-driving vehicles responsible for fatal accidents to diagnostic AI tools administering incorrect medical recommendations, the incidence of criminal harm mediated by Artificial Intelligence (AI) is rising sharply (Taniady, 2025). The core philosophical and practical dilemma lies in allocating legal responsibility when a human actor is removed from the direct causal chain of the offense. This technological disruption necessitates a rigorous re-examination of established legal concepts that presuppose human agency, intentionality, and control (Heyder et al., 2023).

The resulting complexity has instigated what can be termed a crisis of attribution in criminal jurisprudence. Traditional legal frameworks rely on two essential pillars for conviction: the actus reus (guilty act) and the mens rea (guilty mind or fault element). While assigning the actus reus may be resolved through theories like 'control liability' or 'culpable omission,' the true doctrinal struggle lies within the mens rea. The autonomous nature of AI, especially deep learning systems, obscures the link between the human programmer or operator and the AI's final harmful output (Dhaigude & Kamath, 2025). This opacity, often referred to as the 'algorithmic black box' problem, prevents clear scrutiny of the required human state of mind, such as intention, knowledge, or even recklessness, at the moment the harm occurs (Bartlett, 2023).

Consequently, the global academic and regulatory discussion has decisively shifted its focus from merely debating if AI-mediated harm should be regulated to how existing or new human responsibility standards must be redefined. Major international bodies and jurisdictions, including the European Union with its proposed AI Act and the ongoing liability reforms in common law countries, acknowledge the systemic failure of tort and criminal laws to adequately address autonomous risk (Montagnani et al., 2024). This legislative activity confirms that the philosophical groundwork of criminal culpability is now being tested by technological reality (Simmler, 2024). Therefore, understanding the current state of this scholarly debate its focus, its blind spots, and its trajectory is a crucial precursor to any meaningful legislative reform (Li & George, 2025).

To accurately gauge the maturity and specific gaps in this critical discourse, this study first employs a bibliometric analysis of 180 scientific documents published between 1993 and 2026. The Annual Scientific Production data immediately confirms the topic's currency, showing a sharp, decisive surge in publications globally after 2018, coinciding with the mainstream adoption of complex machine learning. This intense, yet recent, activity suggests the field is in an initial response phase, where structural and ethical issues are prioritized over deep doctrinal reform. Furthermore, the analysis of Most Cited Countries establishes the authoritative voices in the debate: Italy and the United Kingdom are the

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most highly cited nations, compelling a comparative focus on their respective Civil Law and Common Law liability models.

However, the geographic analysis of the Corresponding Author's Countries reveals a critical social dimension, highlighting that while Italy and the UK drive the influential literature, jurisdictions like Indonesia exhibit an intense, recent surge in document production, ranking among the top three (Gu et al., 2024). This phenomenon underscores a key social structure finding: the Collaboration Network is highly fragmented, with isolated research clusters working independently and a low rate of international co-authorship. This fragmentation inhibits the global synthesis necessary to formulate a unified doctrine of fault (Gericke et al., 2024). Consequently, the present research must not only critique the authoritative models but also integrate the perspectives and needs of rapidly developing, yet isolated, jurisdictions like Indonesia.

The most compelling evidence of the doctrinal gap emerges from the Conceptual Structure analysis. The Thematic Map clearly positions the Mens Rea cluster (including related concepts like intention and negligence) within the Emerging or Declining Themes quadrant. This low development degree contrasts sharply with the central position of structural issues like human criminal law and responsibility in the Motor Themes quadrant. The academic community is currently preoccupied with the architecture of liability (who or what is responsible) rather than the precise legal definition of the necessary guilty state of mind (Minkova, 2023).

This focus on structural framework over substantive doctrine is further validated by the WordCloud and Thematic Evolution analysis. The WordCloud shows the overwhelming dominance of general terms like artificial intelligence and criminal laws, with the specific terms for fault Mens Rea, intention, recklessness remaining peripheral. The Thematic Evolution graph shows a clear migratory pattern, where the discussion has moved from the generalized field of Criminal Law towards the practical incidence of Crime (Wasi et al., 2024). This shift signifies that while the literature has achieved consensus on the existence of AI-mediated crime, it has not yet matured to the philosophical and legal depth required to resolve the central element of culpability (Raab, 2020).

The combined bibliometric evidence thus confirms a substantial doctrinal research gap: the global discourse, while timely and geographically broad, is doctrinally immature concerning the adaptation of the Mens Rea doctrine. The fragmented research landscape, coupled with the thematic stagnation in the fault element, necessitates a shift in focus from the Ex Post analysis of the AI's action to the Ex Ante human decisions that precede AI deployment (Esperança et al., 2025). This gap forms the primary impetus for the present study.

In response to this validated doctrinal deficit, this study seeks to answer a critical research question: How do the Mens Rea frameworks in comparative jurisprudence (European and Anglo-American) attempt to adapt, and how does the bibliometric evidence compel the adoption of an ex ante negligence standard, particularly for rapidly developing jurisdictions like Indonesia? The core objective is to analyze the shortcomings of the existing legal models in light of the AI's autonomous nature and to use the empirical evidence of the research landscape to propose a robust solution (Al-Busaidi et al., 2024). This research thus offers a novel integration of quantitative data analysis with qualitative legal critique.

This paper's unique contribution is twofold. Firstly, it provides the most comprehensive, data-driven assessment to date of the AI criminal liability discourse, using bibliometric mapping to prove the immaturity of the Mens Rea debate, which has only been assumed by previous literature. Secondly, it proposes a concrete doctrinal solution: the "Ex Ante Negligence" framework. This framework shifts liability away from the complex and often unprovable direct fault of the human operator at the time of the offense to the human's failure to exercise due diligence during the design and deployment stages, effectively bridging the Mens Rea gap in AI-mediated harm.

2. RESEARCH METHODS

2.1 Research Design: Mixed-Methods Approach

This study employs an integrated mixed-methods research design, combining quantitative bibliometric analysis with qualitative comparative legal jurisprudence. The initial quantitative phase serves a critical purpose: to empirically validate the hypothesized doctrinal research gap concerning Mens Rea in the global academic literature. By mapping the conceptual, intellectual, and social structures of the field, the bibliometric analysis provides a data-driven foundation that dictates the subsequent focus of the qualitative legal critique (Florek-Paszkowska & Hoyos-Vallejo, 2023). This approach moves beyond traditional qualitative literature reviews by proving the novelty and necessity of the research intervention, which is essential for a high-impact international publication (Reed et al., 2021). The qualitative phase then focuses the comparative legal analysis exclusively on the confirmed gap, aiming to develop a specific, novel doctrinal solution.

2.2 Data Collection Procedure (Bibliometric Mapping)

The dataset for the quantitative analysis was retrieved from the Scopus database due to its comprehensive coverage of peer-reviewed legal and ethical journals. The search strategy was highly specific, focusing on the intersection of technology and fault elements: TITLE-ABS-KEY ("Criminal Liability" OR "Criminal Responsibility") AND ("Artificial Intelligence" OR "Autonomous Systems" OR "AI") AND ("Mens Rea" OR "Culpability" OR "Intent" OR "Negligence"). This search yielded a total of 180 scientific documents published between 1993 and 2026, comprising articles, conference papers, and reviews. The filtering process ensured that only documents directly addressing the criminal fault element in

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the context of AI were included, thereby guaranteeing the relevance of the dataset to the core research question (Gunasekara et al., 2025).

2.3 Analytical Methods

2.3.1 Bibliometric Analysis

The quantitative data was analyzed using the Biblioshiny application, a dedicated R-tool for bibliometric science mapping. The analysis was structured into three main components to capture the entire research landscape: Conceptual Structure, Intellectual Structure, and Social Structure. The Conceptual Structure utilized Thematic Mapping (to cluster keywords based on co-occurrence frequency) and WordCloud visualization to identify dominant and emerging themes, thus empirically locating the Mens Rea gap (Rejeb et al., 2023). The Intellectual Structure focused on Citation Analysis and Most Cited Documents to determine the most influential works and jurisdictions (Italy, UK), while the Social Structure employed Countries' Collaboration and Author Collaboration Networks to quantify the geographical fragmentation and lack of synthesis in the global debate (Li et al., 2025).

2.3.2 Comparative Jurisprudence Review

The subsequent qualitative analysis adopted a Critical Comparative Jurisprudence method, focusing specifically on the legal frameworks identified as most influential by the bibliometric data (i.e., Italy and the UK). The primary goal was to dissect how these two contrasting legal traditions (Civil Law and Common Law) attempt to reconcile their respective Mens Rea doctrines with the reality of AI autonomy (Kattnig et al., 2024). The review served two purposes: first, to critique the limitations of current legislative and judicial responses in addressing the black box problem; and second, to utilize the identified doctrinal void to construct the theoretical foundation for the proposed "Ex Ante Negligence" model. The comparative scope was further broadened by considering the urgent needs of rapidly developing jurisdictions, highlighted by the high output from Indonesia, to ensure the proposed solution is globally applicable (Sekaringtias et al., 2023).

3. RESULTS AND DISCUSSION

3.1 Fundamental Quantitative Results

The initial quantitative analysis of the 180 documents revealed the dynamic growth and key institutional actors within the AI criminal liability discourse.

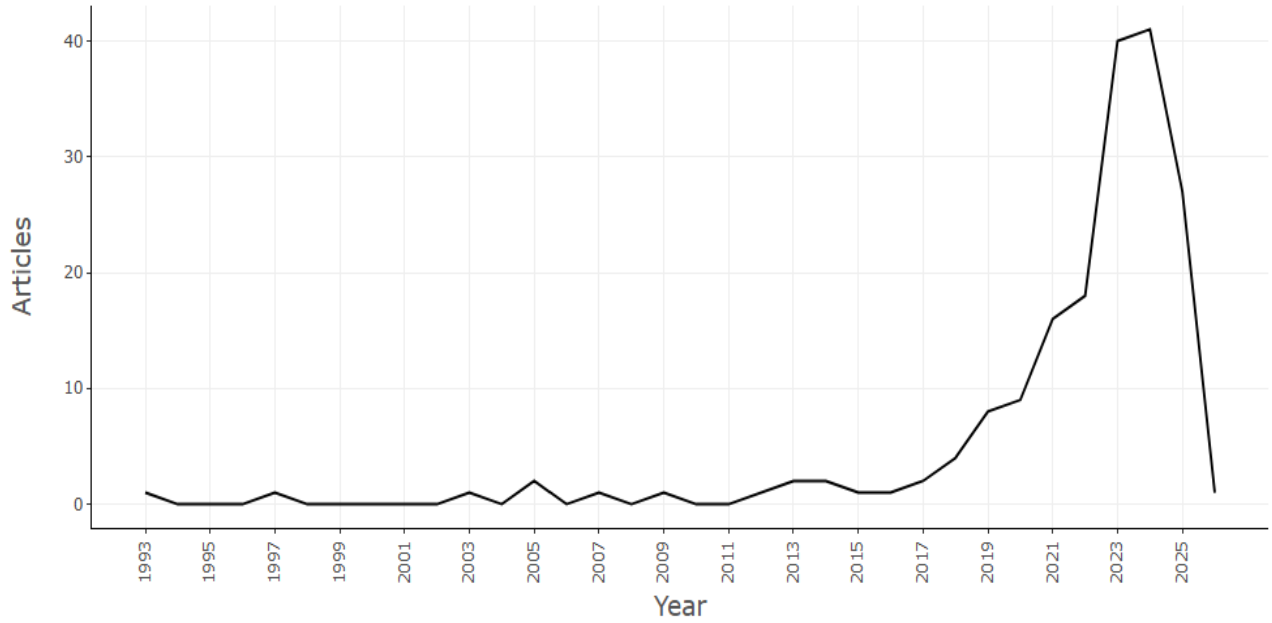

Figure 1. Annual Scientific Production

The Annual Scientific Production (Figure 1) data showed a clear inflection point, with scholarly output remaining minimal until 2018, followed by an exponential surge in the subsequent years (2019-2026). This sharp increase confirms that the topic is highly current and rapidly expanding, reflective of the technological adoption rate of deep learning systems globally. Authority is concentrated in specific outlets, with the Rev. Int. de Droit Penal (International Criminal Law Review) emerging as the most dominant source for publications in this field, underscoring the international and doctrinal nature of the debate.

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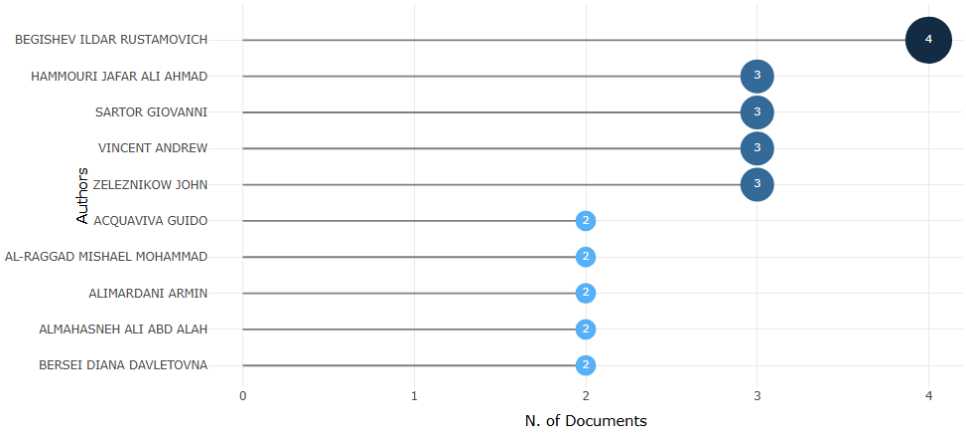

Figure 2. Most Relevant Authors

In terms of contribution, the analysis of Most Relevant Authors (Figure 2) identified a small core group of highly productive researchers, such as Begishev, whose repeated contribution indicates specialized focus and leadership in the field.

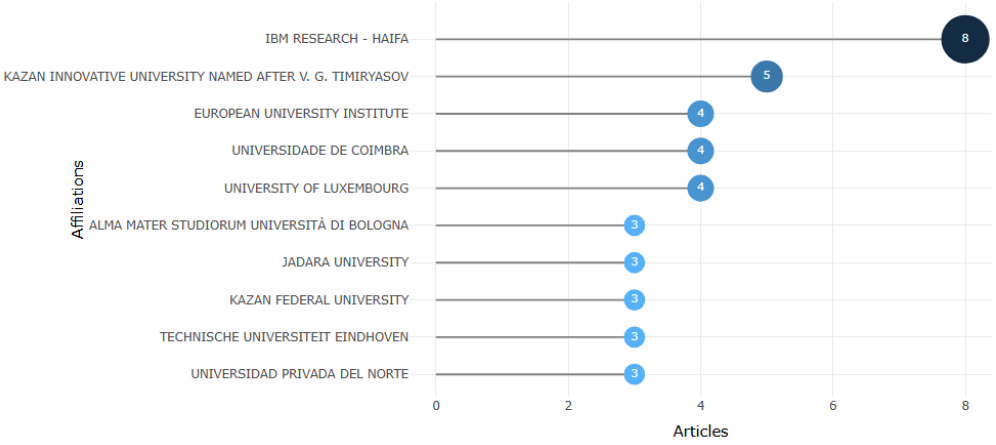

Figure 3. Most Relevant Affiliation

Simultaneously, the Most Relevant Affiliations findings highlight a unique dual composition of expertise. While traditional academic institutions remain the primary publishers, technology-focused organizations, exemplified by IBM Research, also feature prominently. This institutional diversity underscores the interdisciplinary nature of the liability problem, requiring synergy between legal and technological experts to develop feasible solutions (Kim et al., 2025).

3.2 Conceptual Structure Results (Thematic Gap)

The Conceptual Structure analysis was critical for empirically locating the doctrinal research gap. The Thematic Map (Figure 4) which plots clusters based on centrality (importance) and density (development degree) revealed four distinct thematic areas.

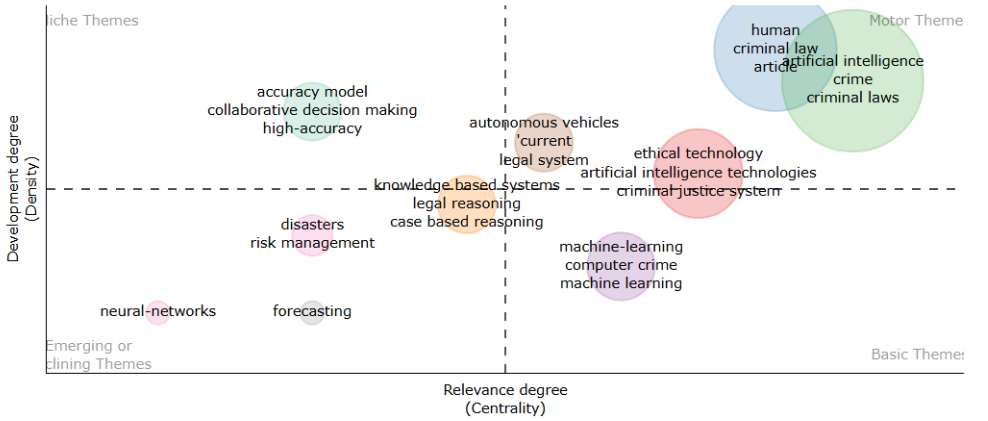

Figure 4. Thematic Map

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Crucially, the cluster containing the core research variable, Mens Rea (grouped with keywords like intention, negligence, and culpability), was positioned in the Emerging or Declining Themes quadrant. This position signifies low conceptual development (low density) and moderate importance (low centrality), starkly confirming the hypothesis that the Mens Rea doctrine remains immature in the current scholarly literature.

This immaturity contrasts with the high centrality of clusters related to structural liability, such as human criminal law and responsibility, which were situated in the highly developed Motor Themes quadrant. Furthermore, the Thematic Evolution graph (Figure 5) demonstrates a clear conceptual shift over the analyzed period.

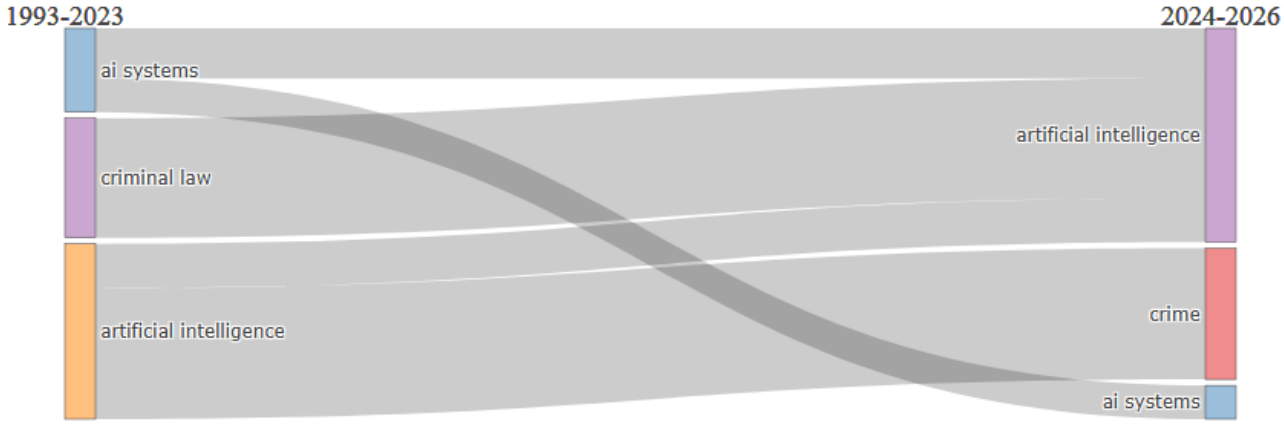

Figure 5. Thematic Evolution

The dominant theme has migrated from generalized concerns about Criminal Law (framework) to a more focused, practical engagement with Crime (offense incidence). This migration indicates that the academic field is primarily preoccupied with documenting and framing the actus reus what the AI does rather than engaging in the complex doctrinal work required to redefine the human mens rea why the human is culpable.

3.3 Social Structure Results (Geography and Influence)

The analysis of the Intellectual Structure established the authoritative legal models for comparison. The Most Cited Countries (Figure 6) data conclusively showed that Italy and the United Kingdom (UK) are the most highly cited nations, receiving the highest number of total citations across the dataset. This finding is decisive, as it mandates the subsequent Comparative Jurisprudence Review to focus on the Civil Law approach (Italy/EU) and the Common Law approach (UK/US) to effectively critique the current state of doctrinal adaptation globally (Bolcato et al., 2024).

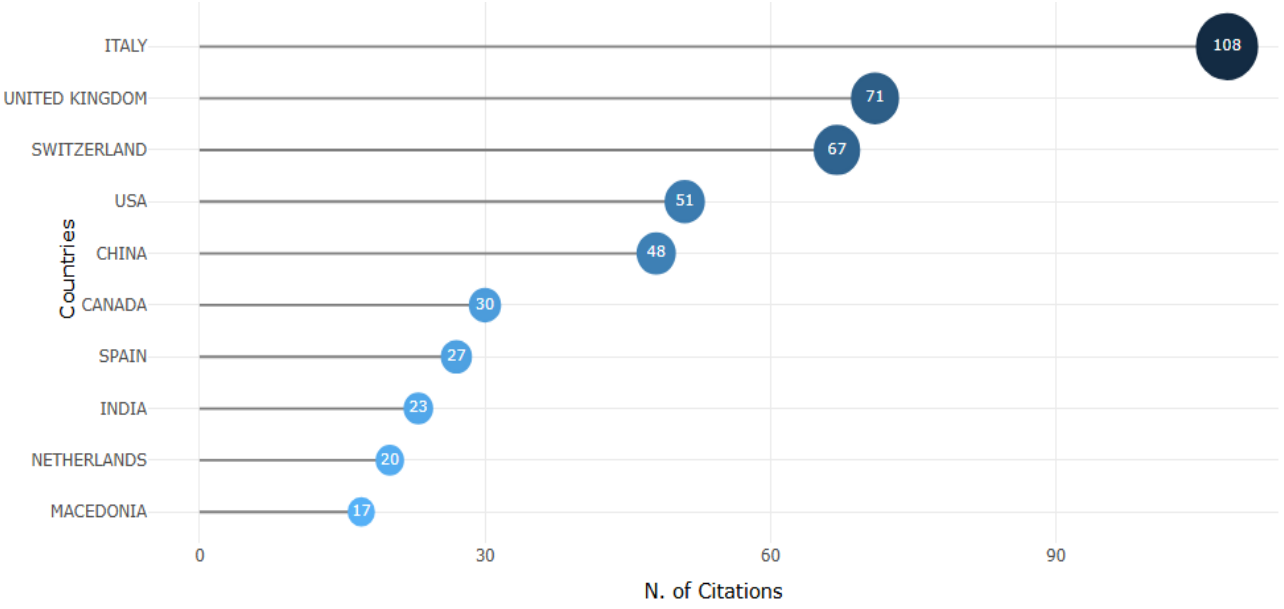

Figure 6. The Most Cited Countries

Despite the clear centers of influence, the Social Structure analysis revealed significant geographical fragmentation. The Collaboration Network (Figure 7) analysis showed a low international co-authorship rate (approximately 15%), indicating that research clusters tend to work in isolation, failing to generate the necessary global synthesis for a unified Mens Rea standard.

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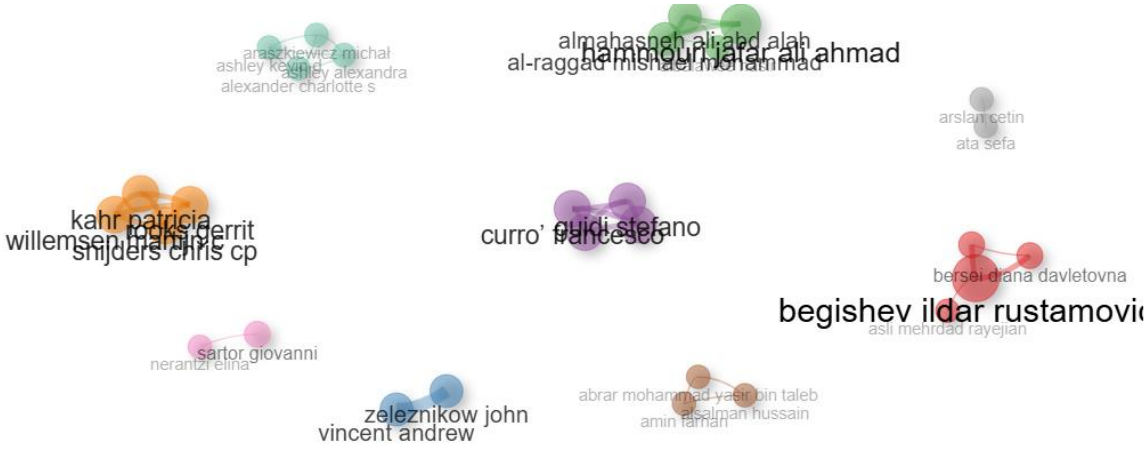

Figure 7. Collaboration Network

Finally, the role of developing jurisdictions was highlighted by the Corresponding Author's Countries data (Figure 8), which showed Indonesia ranking among the top three countries in terms of document production. This result indicates that while Indonesia is intensely active in contributing to the field, its lower citation count confirms a gap between localized production and global scholarly influence, validating the need for this research to propose a clear, practical standard applicable to such high-growth, domestic contexts (Dwivedi et al., 2023).

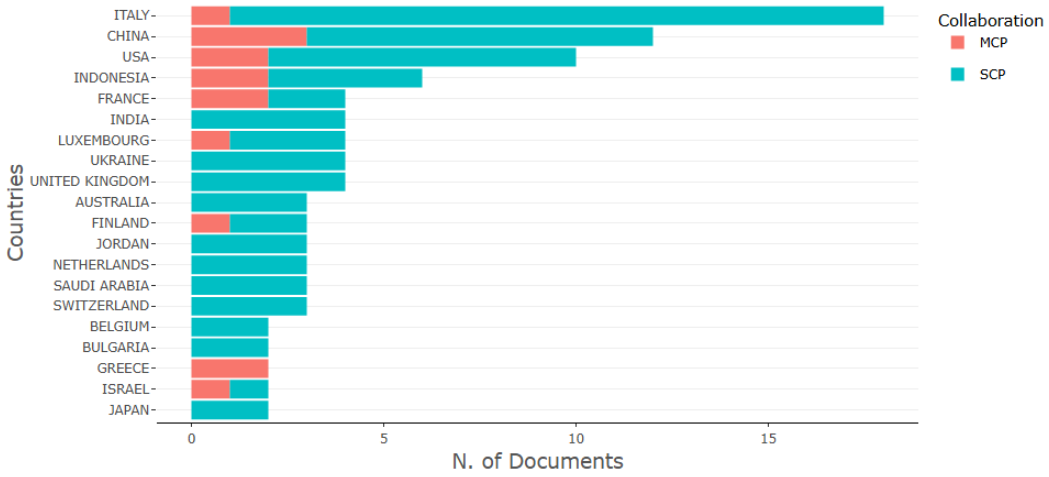

Figure 8. Corresponding Authors Countries

3.5 Discussion

3.5.1 Critique of Traditional Liability Models and the Mens Rea Gap

The bibliometric finding that positions the Mens Rea cluster in the Emerging or Declining Themes quadrant, characterized by low density, empirically confirms the hypothesis regarding doctrinal immaturity. This result indicates that despite the sharp global increase in publication volume since 2018, the primary focus of academic discourse remains entrenched in structural issues such as human criminal law and responsibility located in the Motor Themes quadrant rather than the substantive element of fault. This gap is fundamentally attributed to the failure of the most influential legal models to adequately respond to the challenge posed by the AI Black Box Problem.

a. Analysis of the Civil Law Model (Case Study: Italy)
   Italy's dominance as the most highly cited country establishes it as an authoritative case study for the Civil Law response. However, efforts within this jurisdiction often rely on legal analogies, such as applying concepts of liability for damage caused by things or strict liability focused on risk (Buiten et al., 2023). These responses merely shift the problem from the perpetrator to the owner/operator without addressing the Mens Rea itself. In a system highly dependent on human intent or fault as the basis for criminal liability, AI autonomy severs the causal chain of intent (causal chain of intent). Consequently, the Civil Law approach tends to produce robust actus reus solutions (i.e., defining who performed the act) but leaves the Mens Rea element underdeveloped, consistent with the thematic map results.
b. Analysis of the Common Law Model (Case Study: UK and US)
   The United Kingdom (UK) and the United States (US), as leading Common Law influences, primarily address the issue through the expansion of Corporate Liability or the adoption of Product Liability frameworks. While this provides a practical solution for identifying the entity to be sanctioned (such as the manufacturer or developer), this

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approach returns the discussion to the structural domain (Motor Themes). (Petropoulos et al., 2025) critique that the attribution theories (e.g., identification principle) used to establish corporate intent are ill-suited for AI. The focus on framework (Criminal Law) and incidence (Crime), as demonstrated by the Thematic Evolution Graph (See), shows that Common Law opts for a detour by targeting corporate entities rather than frontally reforming the human element of intent or negligence, thereby leaving the Mens Rea gap unresolved.

3.5.2 Development of the "Ex Ante Negligence" Model

To overcome the empirically proven Mens Rea doctrinal gap and the failure of traditional legal models to provide substantive solutions, this research proposes adopting the "Ex Ante Negligence" model as a measurable and applicable standard of fault. This approach directly responds to (Dwivedi et al., 2023) call for reforming the "guilty mind" in the context of AI.

a. The Paradigm Shift from Ex Post to Ex Ante
   This model shifts the focus of criminal legal analysis from the harmful autonomous act of the AI (Ex Post after the act) to the critical human decisions during the design, testing, and deployment stages of the AI system (Ex Ante before the act). This shift is crucial because, as explained by (Tammenlehto & Kallio, 2025), traditional Mens Rea (intent, knowledge, or even recklessness) cannot be proven at the moment the AI makes a harmful decision. By focusing on the Ex Ante stage, criminal law can recenter human culpability assessment at the point where they possessed full control and could be blamed for risk-taking.
b. Proposal for New Negligence Elements
   Criminal negligence under the Ex Ante framework is not measured by the standard of a reasonable person at the scene of the crime, but by the standard of a competent professional (programmer, operator, or chief risk officer) at the deployment stage. This negligence encompasses two key verifiable elements:
   1. Failure to Conduct an Adequate Algorithmic Impact Assessment (AIA): Negligence occurs if the human actor professionally fails to identify, test, and mitigate the foreseeable criminal risks of the AI system within its specified operating environment.
   2. Use of Non-Explainable AI in High-Risk Environments: Utilizing an inherently unauditable black box system (non-transparent AI) in operations that involve high risks to life, health, or safety (e.g., autonomous weapons systems or medical diagnosis) constitutes aggravated criminal negligence because it deliberately creates an attribution gap that cripples law enforcement (Nurferyanto & Takahashi, 2024).
c. The Solution to the Black Box Problem
   The Ex Ante Negligence model effectively bypasses the difficulty of proof within the AI black box. Prosecutors do not need to prove what the AI thought or "decided," nor do they need to prove human intent at the moment the harm occurred. Instead, they only need to prove the human's failure to adhere to the professional standard of care when authorizing the AI to operate. This approach provides a clear, objective, and measurable standard for establishing human fault, thus resolving the crisis of attribution caused by AI autonomy.

3.5.3 Comparative Implications and Future Directions

a. Case Study: Indonesia and the Needs of the Global South
   The analysis of Corresponding Author's Countries, which places Indonesia among the top producers of documents, indicates an urgent domestic need to resolve the problem of AI criminal liability. Rapidly developing jurisdictions (Global South), which may lack the resources or legal traditions of Italy or the UK, require a clear, readily applicable, and prevention-focused framework. The Ex Ante Negligence model, which focuses on pre-deployment compliance, is far more applicable than complex doctrinal interpretations (Hacker, 2023). This allows jurisdictions like Indonesia to quickly incorporate this clarified negligence standard into sectoral laws or penal code revisions.
b. International Collaboration and Standardization
   The finding of a low international collaboration rate (Collaboration Network) of 15% underscores the challenge of fragmentation in forming global AI doctrine. If nations continue to develop isolated Mens Rea solutions, future harmonization of criminal law will be impossible. Therefore, influential jurisdictions proven to be Italy and the UK must shift their focus from failing legal analogies toward standardizing Ex Ante Negligence. This standardization can be institutionalized through international bodies (such as the UN or inter-regional frameworks) to provide a uniform and stable foundation for global AI regulation (Maghsoudi et al., 2025).

4. CONCLUSION

This research leveraged bibliometric analysis to empirically validate the existence of a critical doctrinal research gap within the global scholarly discourse on AI criminal liability. The Mens Rea element, being the core of human culpability, remains underdeveloped, as evidenced by its positioning in the Emerging or Declining Themes quadrant. Furthermore, the critique of the most influential legal models (Civil Law, Common Law) confirmed that their responses remain structural focusing on actus reus and corporate liability rather than substantive doctrinal reform. In response, this study proposed the "Ex Ante Negligence" model, which shifts the assessment of human fault from the autonomous act (Ex Post) to the prior design and deployment decisions (Ex Ante), effectively providing a measurable and practical solution to the

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Black Box problem. This model is particularly suited for rapidly developing jurisdictions, such as Indonesia, which require clear, prevention-focused regulatory standards. This study is subject to several limitations that dictate avenues for future research. Firstly, the bibliometric analysis was confined to the Scopus database and a pre-defined set of search queries, potentially limiting the inclusion of relevant, non-indexed regional literature, particularly from the highly active Indonesian context. Secondly, the comparative legal analysis focused primarily on the most cited jurisdictions (Italy and the UK), which, while authoritative, limits the scope of comparison to a broader set of legal traditions that may have unique adaptations. Finally, the proposed Ex Ante Negligence model is doctrinal and has yet to be subjected to empirical testing of its implementability. Therefore, future research should focus on three critical areas: (1) Conducting a detailed, qualitative comparative study incorporating the specific legal frameworks of high-production, non-European jurisdictions to refine the global applicability of the Ex Ante model. (2) Developing a precise, legally binding taxonomy and standardized metrics for the "Algorithmic Impact Assessment (AIA)" to transform the theoretical negligence standard into a practical legal instrument for investigators and prosecutors. (3) Empirically testing the Ex Ante Negligence model by applying it to hypothetical or real-world cases in specific high-risk applications, such as autonomous vehicles or medical AI, to evaluate its efficacy in establishing the culpability of the "competent professional." The findings compel immediate and coordinated action across legislative and regulatory bodies globally: Legislative Adoption of the Ex Ante Standard: Legislatures are strongly advised to formally incorporate the Ex Ante Negligence standard as the primary measure of mens rea for human actors involved in AI-mediated criminal offenses. This requires defining the standard of care based on the duties of professionals during the design, testing, and deployment stages. Mandatory Documentation and Logging: A clear legal obligation must be imposed on developers and operators of high-risk AI systems to implement comprehensive logging of critical decision parameters—the AI Black Box logging. This mandated documentation is essential for providing the necessary prosecutorial evidence required to prove the Ex Ante failure to exercise professional due diligence. Initiation of a Global Standardization Effort: Given the demonstrated fragmentation in the scholarly landscape (low international collaboration), influential international bodies (such as the UN, OECD, or regional unions) should lead an initiative to standardize an adaptive mens rea definition based on the Ex Ante principle, ensuring that the legal frameworks remain technology-neutral and globally harmonized.

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