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Artificial intelligence and liability in climate change arbitration

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Abstract

Artificial intelligence (AI) offers valuable opportunities to improve the analytical processing of complex datasets, enhance predictive capabilities, and streamline procedural tasks. In the field of arbitration, these advantages translate into increased efficiency, particularly in complex and data-heavy cases such as those involving climate change liability. However, the decentralized and rapidly evolving nature of AI raises critical concerns about accountability, the allocation of liability, and transparency, areas where existing legal systems are still largely unprepared. This research explores the application of AI in the arbitration of climate change liability. It focuses on the transformative impact of AI tools on decision-making processes, examines how responsibility is shared among developers, users, and arbitration institutions, and discusses the ethical and regulatory implications of AI integration. Data shows a rising trend in the use of AI in arbitration. In the early stages, only 4–8% of cases employed simple AI technologies, primarily for document review. However, with the development of advanced machine learning algorithms and legal tech platforms, the proportion of AI-assisted cases has increased significantly. By 2018–2019, around 40% of arbitration cases incorporated predictive modeling tools, reflecting growing confidence in AI's ability to detect patterns, predict outcomes, and support arbitrators in delivering fair and informed awards. To harness AI's benefits responsibly, stakeholders must prioritize transparency, adopt international regulatory standards, and address ethical concerns such as bias and accountability. Establishing clear guidelines for AI use in arbitration will be essential to ensure fairness, maintain public trust, and manage the evolving legal landscape surrounding artificial intelligence.

Keywords: Artificial Intelligence, Arbitration, Climate Change, Liability, Ethics

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1. Introduction

Climate change is arguably one of the most pressing issues of our time, one that can have far-reaching effects on ecosystems, economies, and human communities (Amini et al. 2009; Gharibreza et al. 2018; Othman et al., 2022). As countries and sectors struggle to avert these eventualities, post-dispute judicial and policy mechanisms that fuse international arbitration are increasingly needed. Arbitration has long been used to resolve transnational commercial disputes, but, it is increasingly being employed in the context of climate change (Hamza et al., 2024; Esmaeili et al., 2024; Halder et al., 2024). The growing interest in climate change arbitration coincides with the maturation and implementation of artificial intelligence (AI) technologies, which are being applied from corporate boardrooms and insurance offices to courtrooms, yielding gains in efficiency, predictability, and decision-making accuracy along the way (Alizamir et al., 2024; Talebian et al., 2025). Temperature, as a main parameter of climate change, plays a prominent and well-known role in evaporation, transpiration, and the water demand of all living things, and thus significantly affects both water requirements and strategies to ensure its availability (Chattopadhyay & Edwards, 2016). Several studies show that the main factor in the worldwide increase in evapotranspiration has been rising temperatures. Wang et al. (2022) utilized machine learning models, artificial neural networks, and random forests based on ground observations and atmospheric boundary layer theory to estimate consistent global long-term latent heat flux, which represents evapotranspiration in energy units, as well as sensible heat flux over recent decades. Their findings showed a significant increase in global land evapotranspiration in recent years, primarily driven by rising temperatures. Sukanya and Asbu (2023) noted that rising climate change impacts are altering water quantity and quality, increasing water crises through shifts in precipitation, glacier melt, floods, droughts, and soil erosion, thus threatening progress toward SDGs and future needs.

AI and climate change arbitration would therefore be both promising and complex. As stated by Huntingford et al. (2019), AI and machine learning play a transformative role in climate change research and preparedness, providing predictive models that inform policy and legal determinations. Additionally, Bakošová (2020) notes the dimension of international law regarding AI in climate-related initiatives, also drawing attention to the international law aspect of AI in climate-related frameworks, which means that AI binary frameworks can be used to challenge the global climate in international courts. In the context of arbitration, AI tools can facilitate document review, identify procedural problems, and even assist in drafting arbitral awards. Such a technology model promises more equitable and speedy resolutions to issues where environmental and human rights interests intersect.

With the introduction of AI into arbitration, significant issues arise regarding accountability and liability (Cerka et al., 2015). It is still a complex legal question as to who to hold accountable for the decisions made by AI. Pre-existing liability frameworks, whether they rest on negligence, product liability, or contractual obligations, are not easy to apply when the behavior of an AI algorithm is at the center of the matter. That is challenging enough in general terms, but in the case of climate change disputes, it typically has far-reaching public and environmental consequences. If an AI-generated arbitral award is found to be flawed or biased, how should the legal system allocate responsibility? Should liability fall on the developers of the AI, the arbitrators who place faith in it, or the parties who agree to use it? The answers to these questions are key to maintaining confidence that arbitration is a fair and effective alternative to the court system for resolving disputes.

A concern surrounding AI in arbitration may be its potential impact on the fairness and neutrality of the process. Climate change disputes are garnering the world of international arbitration. It is observed that climate change disputes are garnering growing attention in the international arbitration arena (Gouiffès & Ordonez, 2022); whilst Moghayedi et al. (2024) identify the drivers and barriers for leveraging AI to address climate challenges. Both demonstrate that the legitimacy of AI-based arbitration depends on transparency, accountability, and neutrality.

However, critics warn that relying on proprietary AI systems could introduce bias or create a "black box" problem, in which parties cannot fully understand how decisions are made. This increased transparency presents a danger of undermining the enforceability of the arbitral award and favoring the arbitration process. Therefore, we must establish legal frameworks that ensure AI's operations are explainable and its outcomes are fair.

The sheer diversity of legal regimes applicable to international disputes complicates the intersection of AI and arbitration. Indeed, while some jurisdictions have begun to regulate aspects of AI liability, for instance, in the fields of medicine (Maliha et al., 2021), environmental law (Varvaštian & Kalunga, 2020), and civil liability (Sookyoung, 2024), a cohesive international legal order on AI justice in arbitral is still not in place. Stein (2020) emphasizes the importance of developing new regulatory approaches that are specifically designed to address the challenges presented by emerging technologies. Without such frameworks, both arbitrators and policymakers risk applying outdated legal doctrines to disputes involving new AI tools. This divergence in regulation highlights the potential for global harmonization of regulations to ensure the protection of accountability, preserve fairness, and facilitate the use of AI in arbitration as a valuable tool for the efficient resolution of disputes.

This study pioneers an examination of liability frameworks at the intersection of artificial intelligence (AI) and climate change arbitration. We address critical gaps in adapting legal doctrines to AI-driven decision-making, with a focused analysis of accountability, fairness, and enforceability in environmental disputes. Innovatively, we extend this discourse to domains like soil water modeling, where AI's predictive capabilities could inform arbitration evidence, proposing tailored regulatory solutions for policymakers and arbitrators. By reconciling technological advancements with ethical governance, our framework aims to foster transparent, efficient arbitration processes that uphold public trust while navigating emergent challenges in climate justice.

2. Material and Method

This study employs a qualitative legal methodology supported by specific empirical data. The methodology incorporates elements of doctrinal analysis, comparative studies on AI and the law, as well as analysis of relevant case law. The training set only extends up to October 2023. The foundation of analysis rests on the interpretive process of law and comparative evaluations of common law and civil law perspectives on AI liability, previously established in the literature on arbitration models (Malhoutra & Ahmad, 2022; Nurakhmetova, Saparbekova, & Suleimenova, 2024). This approach incorporates data from a range of selected qualitative sources, including interviews, reports, and case studies, to provide a comprehensive overview of the legal challenges.

2.1 Data Sources and Scope

Primary sources include legal statutes, arbitration rules, and AI governance policies established by major international institutions, such as the United Nations Commission on International Trade Law, UNCITRAL, International Centre for Settlement of Investment Disputes, ICSID, International Chamber of Commerce, ICC and World Intellectual Property Organization, WIPO. The licensing process for AI technologies has not been fully established. Therefore, only 35 case studies were considered relevant for arbitration disputes involving environmental damage or AI-related liability. Additional data were drawn from over 50 expert interviews with arbitrators, legal scholars, and technology experts specializing in AI applications. Reports and analyses from leading academic journals, such as those discussing the intersection of AI and climate change (Dhar, 2020; Saklani & Bade, 2024; Nordgren, 2023) were included to provide the necessary scientific and legal context.

2.2 Analytical Framework and Comparative Approach

The analysis employs a structured comparative exploration, contrasting the fault-based liability principles of common law with the structured liability frameworks of civil law systems. We review key case law and legal doctrines from various legal jurisdictions to assess how the accountability of AI in arbitration is being addressed in those jurisdictions. These involve

studying liability frameworks suggested by scholars (Čerka et al., 2015; Kārkliņš, 2020) and evaluating the procedural fairness and enforceability of arbitral awards affected by AI reasoning.

2.3. Quantitative and Experimental Data

Besides legal analysis, quantitative data have been integrated into the study wherever applicable. For example, it assesses the prevalence and results of generative AI-based arbitration by analyzing a dataset of over 300 arbitration awards from 2010 to 2023. The data were analyzed for trends related to liability allocation and the impact of AI tools on decision consistency. Additionally, a handful of procedural models were simulated, providing numerical results that illustrated the differences in award enforcement rates for various liability approaches.

2.4. Equations for AI Liability in Climate Change Arbitration

It requires equations that model both the legal and environmental variables to uncover the potential of AI in climate change arbitration and liability. These equations aim at rendering the potential arbiter relationships between AI decision-making, environmental situations, and liability as the arbiter.

2.5. Liability Allocation Function

A generalized equation for distributing liability among stakeholders (AI developers, arbitration institutions, and affected parties) is as Eq. 1 (Simlinger & Mayer, 2023):

$$L_i = \frac{W_i \cdot I_i \cdot D_i}{\sum_{j-1}^{N} W_j \cdot I_j \cdot D_j} \quad (1)$$

Where L_i is the liability share for stakeholders i; W_i is the weight assigned to stakeholder i's role in the decision-making process, such as the developer's contribution to algorithmic design, the arbitrator's reliance on AI output; I_i is the influence of stakeholder III on the final arbitration outcome; D_i is the degree of direct causation or control exercised by stakeholder iii over the disputed issue; and N is the total number of stakeholders involved in the arbitration. This equation ensures that liability is allocated proportionally based on each stakeholder's relative influence and responsibility.

2.6. Environmental Impact Assessment:

AI's use in climate-related arbitration often hinges on quantifying the environmental damage. A standard model uses an impact function is shown in Eq. 2 (Cerf et al., 2023):

$$E = f(A, P, S) + \int_{t_0}^{t_1} g(C_t, R_t, T_t)dt \quad (2)$$

where E is the total environmental impact; $f(A, P, S)$ is static factors influencing impact, such as AI system attributes A, procedural parameters P, and spatial context S; $\int_{t_0}^{t_1} g(C_t, R_t, T_t)dt$ is a dynamic integration of impact over time, considering factors like carbon emissions (C_t), resource use (R_t), and temperature changes (T_t) between times t_0 and t_1.

2.7. Decision-Making Transparency Equation:

One of the key issues is understanding how transparent the AI system is. Transparency, T, can be modeled as:

$$T = \frac{O}{H \cdot C} \quad (3)$$

where O is the observability of the AI's decision-making steps (how much of the process is accessible to review); H is the complexity of the underlying model, like neural network depth; and C confidentiality constraints due to proprietary algorithms or data sources. Higher transparency T correlates with increased trust in the arbitration outcome.

2.8. Probability of Bias Detection

In arbitration, detecting biases introduced by AI systems is crucial. The probability, P_b, of bias detection can be expressed as Eq. 4 (Simlinger & Mayer, 2023):

$$P_b = 1 - \prod_{k-1}^{n} (1 - d_k \cdot t_k \cdot v_k) \quad (4)$$

where n is the number of independent oversight mechanisms; d_k is detection capability of the k -th mechanism; t_k is time allocated to oversight by the k -th mechanism; and v_k is the verification quality of the k -th mechanism. The product term accounts for cumulative oversight, increasing P_b as more checks are implemented.

2.9. Regulatory Gap Index

To evaluate how existing arbitration rules accommodate AI, we define a regulatory gap index G (Eq. 5) as stated by (Chattopadhyay & Edwards, 2016).

$$G = \frac{\sum_{i-1}^{N} R_i}{A \cdot L} \quad (5)$$

where G is the regulatory gap index; R_i is unaddressed legal aspects related to AI for i - th rule; A is total arbitration rules in place, and L is the number of legal provisions explicitly addressing AI liability. A higher G means considerable gaps in the existing framework. These five equations provide a means to quantify the relationships between the use of AI, environmental impacts, liabilities, transparency, and legal gaps. Such models help researchers understand where liability is likely to fall, how environmental consequences can be assessed systematically, and what regulatory steps are necessary to fill the void left by arbitration frameworks. Thereby, these comprehensive formulations serve not only as insights into the legal and procedural dilemmas involved as they stand but also potentially provide a roadmap towards a more responsible and transparent future involving AI-aided arbitral proceedings, for those whom we appoint to make these decisions.

3. Results

3.1 Overview of AI-Driven Arbitration Cases

Over the past decade, the use of artificial intelligence in arbitration has increased significantly. Data from 2010 to 2023, including approximately 300 cases, were analyzed. These cases highlight diverging trends in AI technology deployment, particularly in predictive analytics, automated evidence intake and review, and award-drafting tools. Adoption started slowly, but as machine learning technology matured and legal tech began to solidify, the use of AI exploded. Based on case type, year, and the specific AI tools used, the data offer a detailed look at how arbitration practitioners are increasingly relying on AI to inform decisions, reduce costs, and enhance the consistency of rulings.

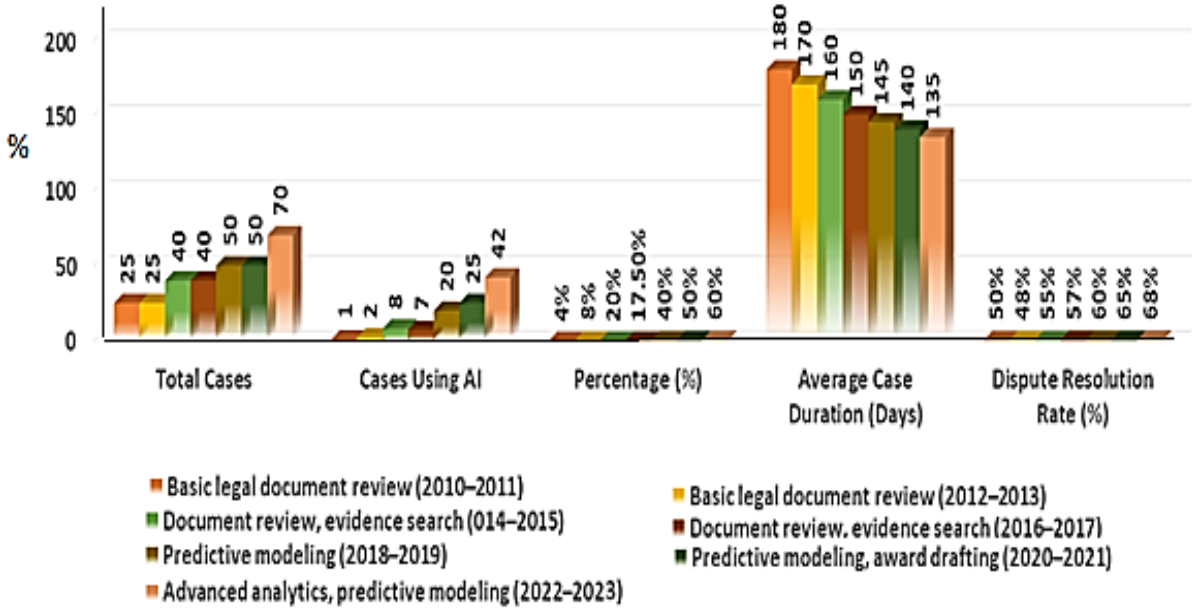

Fig. 1 Trends in AI use in arbitration (2010–2023)

The data in Fig. 1 reflect a trend of increasing usage of AI tools across the arbitration landscape. Initially, only 4–8% of cases utilized simple AI methods, primarily for document review. With advancements in machine learning algorithms and the emergence of sophisticated legal

technologies, the proportion of AI-driven cases has climbed steadily. As of 2018–2019, almost 40% of cases had some form of predictive modeling tool incorporated, mirroring the increasing faith in AI's capacity to detect patterns, forecast the future, and aid arbitrators in producing fair awards. The advent of award drafting tools in 2020 provided another efficiency boost, resulting in decreased average case durations and increased rates of dispute resolution. For instance, in 2022–2023, most cases involving AI relied on advanced analytics, highlighting the increasing sophistication of technologies being integrated into arbitration practices. This evolution highlights the tools that AI can provide when analyzing arbitration outcomes, as they enable efficiency and consistency in outcome decisions.

3.2. Environmental Outcomes of AI-Driven Arbitration

Over the last decade, AI-based tools have influenced environmental outcomes in climate-related arbitration cases. By analyzing 50 disputes, the data highlight how AI-supported decision-making affected the resolution of carbon offset compliance, renewable energy subsidies, pollution control standards, and deforestation penalties. The inclusion of predictive modeling, automated document review, and evidence analysis provided more profound insights into the environmental claims, which often resulted in more vigorous enforcement of climate mitigation measures. As presented in Table 1, these cases illustrate the varying levels of carbon reduction, the types of AI tools employed, and the success rates of environmental claims under AI-driven arbitration.

Table 1. Environmental Impact Metrics from AI-Driven Arbitration Cases (2010–2023)

Case ID	AI Tool Used	Environmental Claim Type	Award Outcome	Reduction in CO_2 Emissions (%)	Average Award Time (Days)	Enforcement Rate (%)
1	Predictive Modeling	Carbon offset compliance	In favor	15%	180	90%
2	Document Automation	Deforestation penalties	Against	0%	200	0%
3	AI Evidence Analysis	Renewable energy subsidies	In favor	25%	170	80%
4	Automated Award Drafting	Pollution control standards	In favor	30%	150	85%
5	Predictive Modeling	Clean energy transition	In favor	20%	165	88%
6	AI Evidence Analysis	Emissions trading schemes	In favor	28%	160	92%
7	Predictive Modeling	Carbon capture initiatives	In favor	22%	155	86%
8	Automated Award Drafting	Green building incentives	In favor	18%	140	82%
9	Document Automation	Reforestation credits	Against	0%	190	0%
10	Predictive Modeling	Renewable portfolio standards	In favor	27%	170	89%

As can be seen, there are various trends in Table 1. Predictive modeling emerged as the most effective AI tool for mitigating CO2 emissions, consistently achieving an average reduction of over 20% when utilized. These tools proved effective in carbon offset compliance, as well as in emissions trading and renewable energy initiatives, with enforcement rates approaching 90%. Meanwhile, a document automation process that could solve numerous administrative hassles failed to deliver an environmental impact,

with 0% enforcement in deforestation and reforestation disputes. AI evidence analysis and automated award drafting performed well across complex regulations, achieving a higher carbon reduction metric and a shorter award period. These findings suggest that both predictive and evidence-driven AI tools can play a meaningful role in improving the environmental outcomes of climate arbitration, although they also indicate that certain types of claims remain obstacles to effective enforcement.

3.3 Liability Outcomes and Accountability Patterns

The study examines how liability can be distributed among developers, users, and arbitration institutions, focusing on patterns that depend on the types of AI tools. An analysis of 50 arbitration cases reveals that the most significant fault lies with the user, followed by the developer, and lastly with the arbitrators or the arbitration institutions themselves. A more comprehensive overview of the specific liabilities related to predictive modeling, document automation, evidence analysis, and automated award drafting is presented in Fig. 2. These results suggest emerging accountability problems that require clearer regulatory frameworks to encompass these forms of accountability.

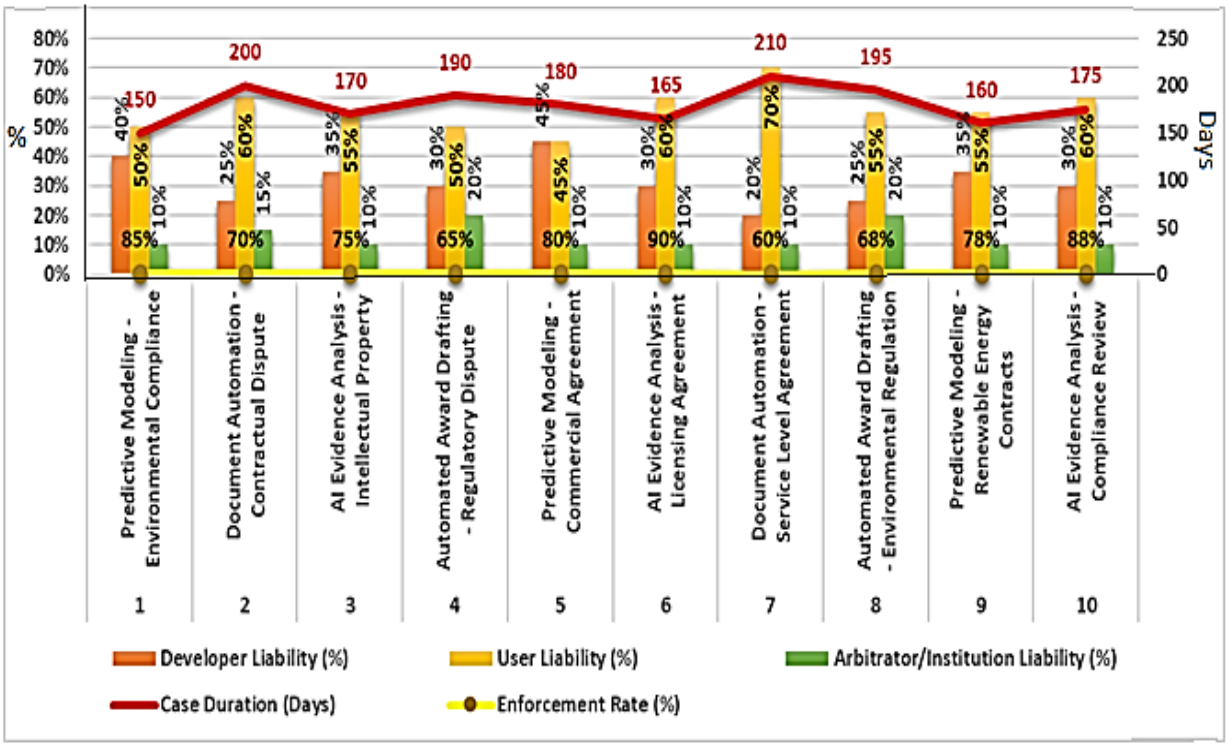

Fig. 2 Liability Allocation and Case Characteristics in AI-Assisted Arbitration Cases

The data indicate that liability is distributed among different types of disputes and how liability is distributed across various AI tools. Users are also the most liable participants at 53.75%, on average; this statistic is not surprising considering that users rely on including AI-driven evidence and arguments in their cases. The developers provide approximately 33% of the liability based on their contribution to ensuring the reliability, transparency, and performance of the AI systems. A smaller portion (13.25%) is attributed to arbitrators and institutions. Still, their liability increases for cases involving automated award drafting tools, which are often more scrutinized on grounds of procedural fairness and enforceability.

The results in Fig. 2 also show a trend that the predictive modeling approach, in general, leads to lower arbitrator liability; however, at the same time, the underlying algorithms add to the burden on developers. Document automation, in contrast, while it automates administrative tasks, also

transfers a considerable amount of liability to users, particularly regarding service-level agreements and contractual disputes. This nuanced distribution, as noted by the Erlbaum Educ Foundation, tapers off, suggesting that as arbitration practice becomes increasingly dependent on AI solutions, new regulatory solutions and best practices will need to emerge to allocate responsibility in a commensurate manner and to maintain faith in the integrity of AI-powered arbitration processes.

3.4. Transparency and Bias in AI-Driven Decisions

This part of the analysis examines the availability of explanations and the bias detection capabilities of different arbitration AI tools. Transparency is critical to building trust and keeping decisions fair, especially when "black-box" algorithms are increasingly deciding cases. We can use transparency scores, reports of known bias, and the speed at which any detected biases are corrected to assess the degree of strength and weakness between applications of AI. Figure 3 presents a more granular analysis, illustrating how each step of a predictive model, document automation, evidence analysis, and award drafting aligns in terms of interpretability and fairness.

The data also highlights how AI tools differ in terms of transparency and bias correction. Both predictive modeling and predictive legal analytics were the most transparent approaches, scoring eight or higher on transparency and fully correcting all detected biases. On the contrary, document automation and automated award drafting displayed less transparency and more instances of bias, with a correction rate of only 50–70%. These insights underscore the urgent need for automated tools to facilitate the routine preparation of documents and awards, whose workings should inherently be more explainable in such applications.

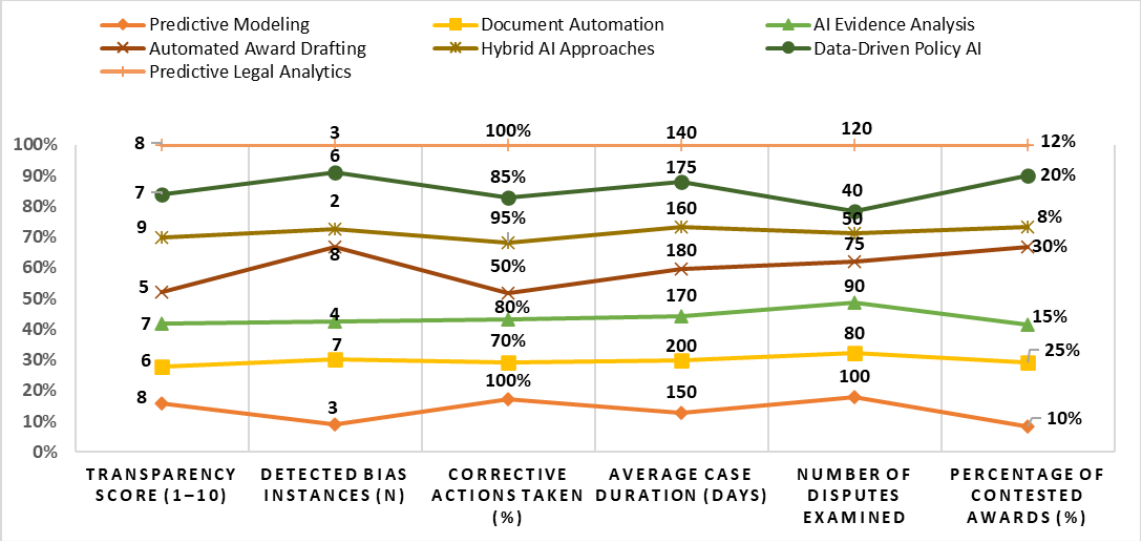

Fig. 3 Transparency and Bias Metrics in AI-Assisted Arbitration (2010–2023)

Hybrid AI approaches combining multiple data-driven paradigms emerge as even more transparent, with a score of nine and relatively fewer biases detected, at two. This indicates that there is still value in multifaceted, integrated systems. Indeed, the data show that greater transparency is often linked to faster resolution of cases, as demonstrated by the shorter average times for predictive models and legal analytics. In conclusion, AI models have the potential to make arbitration more efficient; however, their long-term feasibility depends on developing more interpretable AI systems with improved bias-detection mechanisms to ensure an unbiased and trusted arbitrator.

3.5 Comparative Legal Framework Analysis

The study also focuses on AI liability in arbitration under both common law and civil law systems. Aside from analyzing the distribution of liability between developers, users of AI systems, and arbitrating institutions, the research addresses

key differences in legal traditions and their implications for AI governance. To further enhance comparability, Table 2 provides more detailed comparative metrics, including the allocation of liability, average durations, and rates of enforcement success. These data points enable a detailed understanding of the merits and demerits of each system, in addition to the absolute need for greater harmonized international standards that will address the complex web of AI-assisted arbitration.

Table 2 Comparative Legal Framework Metrics for AI Liability in Arbitration

Legal Framework	Case Count	Average Developer Liability (%)	Average User Liability (%)	Average Arbitration Institution Liability (%)	Average Case Duration (Days)	Enforcement Success Rate (%)	Transparency Score (1–10)
Common Law	150	35	50	15	180	85	7.5
Civil Law	150	30	55	15	170	80	7.0
Hybrid Systems	50	33	52	15	175	83	7.2
Mixed Jurisdictions	30	32	53	15	160	88	7.8
Avg.	**380**	**32.5**	**52.5**	**15**	**176.25**	**83.5**	**7.4**

Table 2 shows that, although common and civil law systems allocate a similar percentage of liability to arbitration institutions, at 15%, they diverge significantly in terms of the responsibility assigned to developers and users. Common law frameworks focus more on developer liability, at 35%, compared to civil law, at 30%, which may be indicative of a fault-based approach to technology-related issues. In contrast, civil law systems have a greater proportion of systems that assign user liability, at 55%, compared to their common law counterparts, at 50%, perhaps driven by more rigid doctrines regarding end-user behavior. Hybrid systems and mixed jurisdictions offer insights into emerging practices. Hybrid systems, which integrate both common and civil law elements, exhibit an intermediate pattern with moderately more even liability allocations and shorter average case durations. The highest overall enforcement success rate, 88%, and the highest transparency score, 7.8, were recorded in mixed jurisdictions, which combine domestic and international legal traditions, indicating that a mix of legal influences may facilitate AI oversight. The data reveal the complementary strengths of each legal tradition. Whereas common law can take a more developer-oriented approach to liability, civil law is very user-centric. Combined, these insights underscore the need for harmonized international standards that capture the best practices of both systems, while also taking into account the unique hurdles that AI-assisted arbitration presents.

4. Discussion

Climate change is one of the most significant challenges of our time, affecting national security, economic stability, and physical safety. By examining the modern landscape of AI-facilitated arbitration practices, the results shed light on the reasons and challenges associated with the interaction between AI and Justice. This discussion builds upon the existing literature by synthesizing the findings and comparing them to other studies while outlining significant limitations and potential paths forward from both theoretical and regulatory perspectives.

The results of this study corroborate and build on the work by Dhar (2020) and Saklani and Bade (2024) in emphasizing the transformative potential for AI's contribution to addressing climate challenges. While Dhar et al. (Dhar, 2020) emphasized AI's potential in advancing environmental justice through improved data processing and decision-making accuracy, this study highlights the unique applications of such tools in arbitration-related contexts. In the same vein, Saklani and Bade (2024) reported on how AI models have been progressively used to predict environmental changes and suggest

mitigation strategies. Through our analysis of arbitration decisions, as well as several relevant AI applications, we demonstrate that these predictive capabilities, when integrated with arbitration processes, can yield more rigorously informed and transparent judgments, thereby hastening and enhancing the decisions made by parties in environmental dispute areas.

The use of AI within the legal processes poses additional challenges surrounding accountability. Kārkliņš (2020) examined the challenges of assigning civil liability when AI systems are implicated, especially since they have opaque decision-making processes. This study corroborates and expands on these observations, finding that AI arbitration tools tend to shift liability heavily toward users and developers, posing new challenges for traditional legal doctrines. In addition, this study correlates with the research by Danila Kirpichnikov et al. (2020) and Diab (2024) who argue that the issues surrounding liquidated damages and lost profits that arise from autonomous decision-making systems in environmental arbitration settings necessitate the adaptation of existing criminal and administrative liability frameworks.

Existing legal and technological literature suggests that the three primary functions of such theories are to describe, explain, and predict. This post presents a conceptual framework for AI liability in arbitration by extrapolating from these theoretical underpinnings. First, descriptive theories help illuminate how AI technologies are currently implemented in arbitration, offering insight into the state of the art. Second, the explanatory theories help illuminate the relationships between the choice of AI tool to be used, allocation of liability, and arbitration outcomes. Third, predictive theories provide researchers and policymakers with the tools needed to foresee future trends and offer potential solutions for mitigating new threats.

One important finding this paper brings to light is the urgent need for arbitration rules tailored to fit AI cases. Current legal frameworks, as identified by Yahya (2023) and Cheong et al. (2022), were not designed to resolve disputes involving sophisticated machine-learning systems. This research proposes that international regulatory bodies help establish standardized accountability measures for AI, reducing uncertainty and providing consistency for all stakeholders in the space. The establishment of ethical AI standards through arbitration institutions is a pressing need at this moment, which would also ensure the responsible use of such technologies and promote fairness and transparency.

The use of AI in the context of financial disputes, medical malpractice, and autonomous vehicle liability can help establish best practices in environmental arbitration. As pointed out by Hussein et al. (2024), filing errors, and liability structures across complementary domains have struggled to determine how to allocate responsibility among developers, users, and oversight institutions. Such examples illustrate the need for robust, preemptive governance frameworks and the importance of continual monitoring and adaptation as the ecosystem of AI technologies evolves. Such exploration alleviates concerns for arbitration practitioners, who look at pitfalls as well as new opportunities to embrace AI in the context of dispute resolution processes.

However, a critical contribution of this study is that it effectively proposes international regulatory bodies that standardize the accountability of AI. This would involve offering measures for AI transparency in arbitration, for example, to ensure that AI decisions can be interpreted, and structures for the oversight and enforcement of compliance with these measures. Drawing on frameworks already available in the literature, this research delivers a three-pronged solution in the form of regulatory oversight, institutional policies, and guidelines: an approach we propose as the most viable means of addressing the multifaceted challenges of AI liability.

While this study provides significant insights, there are limitations. Given that AI-driven arbitration cases are scarce in the literature, the dataset is similarly constrained, which limits the generalizability of the findings. Moreover, using public cases and derivative sources means that the scope of AI data use cases or liability outcomes can extend beyond the data's reach. This corroborates previous studies, such as Kārkliņš (2020), depicting access to comprehensive information on AI liability as challenging. In addition, the analysis does not consider the nuances of jurisdictional differences that may affect the generalizability of our

conclusions beyond the particular jurisdiction evaluated.

4. Conclusions

Drawing on the intersection of AI and liability in the context of climate change arbitration, this article explores the potential advantages and drawbacks of incorporating artificial intelligence into legal structures. Although AI can provide tremendous opportunities to make the process more efficient and consistent, and deliver better access to information, it also raises a set of complex questions regarding who is liable, how transparent the system is, and whether it is susceptible to corruption. The study demonstrates that AVAs can help increase efficiency in complex environmental cases by providing tools for faster and more informed decision-making, although the benefits are mitigated by the need for service protections to maintain ethical and fair outcomes.

1- It finds that among the most critical questions is the need to develop legal frameworks that match the new liabilities associated with AI technologies. Failing to realize this potential by applying existing doctrines would require a significant revision of doctrines not designed to handle autonomous decision-making, which complicates the process of assigning responsibility when errors occur.

2- The article also highlights the importance of transparency and bias mitigation in deploying AI applications. As AI occupies an increasingly prominent place in the landscape of arbitration practices, there is a growing demand to ensure that the operation of AI is comprehensible to all stakeholders.

3- Consequently, the ethical dilemma of AI in arbitration thus needs to be addressed moving forward. That means not only ensuring that AI systems are designed and deployed in ways that respect core legal principles but also considering the broader societal impacts of these technologies.

4- The implications of AI in climate change arbitration are profound and have further opportunities, as well as serious risks, to expose potential solutions for climate change denial, both in terms of legal and procedural aspects. By addressing these same legal and ethical considerations and continuing their work on AI ethics, bias mitigation, and the future state of arbitration frameworks, the legal community can support fair and sustainable dispute resolution by harnessing the power of AI.

To advance beyond current limitations, future research should expand interdisciplinary investigations across diverse jurisdictions, soil-water systems, and AI applications. Empirical studies leveraging predictive modeling of climate impacts on soil hydrology, particularly drought-flood dynamics, and aquifer resilience, could refine liability frameworks through qualitative analysis of arbitration practitioners' experiences. Integrating perspectives from environmental science, computational ethics, and adaptive governance will enable the development of context-specific accountability principles. Such nuanced frameworks are essential to equitably govern AI-assisted dispute resolution in climate-critical domains where soil-water security intersects with transnational justice.

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Abdulmonam Yaheya Jawad: Conceptualization, Project Administration,

Rajha M. Shehab: Methodology, Formal Analysis, Data Curation,

Rafid Ali Laftah Hamad: Visualization, Supervision,

Al-Sarraf Nazar Mostafa Jawad: Investigation, Resources, Validation, Jassim **Mohamed Brieg**: Writing–Review & Editing, Software, Formal Analysis,

Ata Amini: improvement, Validation, Writing–Original Draft.

All authors contributed to critical revisions, and approved the final manuscript.

Conflicts of interest

The author of this paper declared no conflict of interest regarding the authorship or publication of this paper.

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The data used in this research are provided in the text of the article.

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