Unpacking the drivers of artificial intelligence regulation: driving forces and critical controls in artificial intelligence governance

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Article Info

ABSTRACT

The burgeoning field of artificial intelligence (AI) necessitates a nuanced approach to governance that integrates technological advancement, ethical considerations, and regulatory oversight. As various AI governance frameworks emerge, a fragmented landscape hinders effective implementation. This article examines the driving forces behind AI regulation and the essential control mechanisms that underpin these frameworks. We analyze market-driven, state-driven, and rights-driven regulatory approaches, focusing on their underlying motivations. Furthermore, critical regulatory controls such as data governance, risk management, and human oversight are highlighted to demonstrate their roles in establishing effective governance structures. Additionally, the importance of international cooperation and stakeholder collaboration in addressing the challenges posed by rapid technological change is emphasized. By providing insights into the strengths, weaknesses, and potential synergies of different governance models, this study contributes to the development of equitable and effective AI regulatory frameworks that encourage innovation while safeguarding societal interests. Ultimately, the findings aim to inform policymakers, industry leaders, and civil society organizations in their efforts to foster a future where AI is utilized responsibly and equitably for the betterment of humanity.

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1. INTRODUCTION

Governance is a fundamental framework that encompasses rules, processes, structures, and interactions to guide decision-making and align actions with stakeholder interests [1]–[3]. It involves the distribution of power, accountability, and stakeholder participation [4], [5]. In the context of artificial intelligence (AI), AI governance refers to the framework specifically designed to manage the ethical, legal, and societal implications of AI technologies. The rapid evolution of technology necessitates robust AI governance structures to effectively integrate innovation with safety, ethics, and societal well-being [6]. Given the pace of AI advancements, it is crucial that governance frameworks are robust but also flexible and adaptive, allowing for quick responses to emerging challenges and opportunities. This adaptability ensures

that regulations can keep pace with technological changes while effectively addressing ethical and societal implications.

Effective governance is crucial at all levels, from individuals managing personal lives to nations establishing laws and policies. It requires transparency, accountability, and structures tailored to specific issues. AI's transformative power presents both opportunities and risks, including privacy concerns, bias, and misuse [7]. Therefore, a strong governance framework is essential to harness AI's benefits while mitigating these risks and ensuring responsible development and deployment.

To achieve effective AI governance, a comprehensive framework must address risks throughout the AI lifecycle, emphasizing ethical considerations, stakeholder involvement, and data quality. Key principles such as transparency, accountability, and human rights must be upheld [1], [2]. Diverse stakeholders including governments, international organizations, and civil society should collaborate to tackle the challenges posed by rapid technological change. Best practices involve adaptive governance, technical expertise, and harmonized international regulations to balance public trust with innovation.

Critical regulatory controls within AI governance frameworks are vital for establishing safeguards and oversight mechanisms. This study will explore essential controls integral to effective AI governance, including data governance, risk management, and human oversight. Understanding various AI governance approaches based on driving forces reveals differing motivations behind regulatory frameworks. Market-driven approaches prioritize innovation, while state-driven approaches emphasize control and stability, and rights-driven approaches focus on protecting individuals. For instance, the United States emphasizes market-driven innovation [8], while China prioritizes state control [9]. Singapore promotes fairness [10], India emphasizes ethical adoption [11], and the European Union (EU) leads with a rights-driven framework, notably the AI act [12]. Each approach has distinct strengths and weaknesses, reinforcing the need for a balanced governance model that encourages innovation while safeguarding societal interests.

While existing research has examined numerous aspects of AI governance such as global frameworks [13], [14], ethical considerations [15]–[19], regulatory frameworks and best practices [20]–[23], and issues of transparency and accountability [13], [17] alongside human rights [13], [24] several important concepts remain underexplored. Notably, these studies lack a thorough analysis of the AI system lifecycle and do not provide a comprehensive framework that aligns regulatory measures with its distinct phases. They also fail to investigate the roles of stakeholders in shaping AI governance frameworks. Additionally, there is limited discussion on how driving forces, such as technological advancements and societal concerns, impact AI governance approaches. Furthermore, the studies do not adequately address market-driven governance challenges and their mitigations, nor explore rights-based governance challenges and relevant strategies.

In response, this study presents a comprehensive AI governance framework designed to mitigate inherent risks associated with AI by emphasizing regulatory controls throughout the entire system lifecycle. By highlighting the importance of ethical considerations and stakeholder engagement, the framework aims to foster trust in AI technologies. Key elements such as transparency, accountability, and human rights are central to this exploration, advocating for interpretability in AI systems and robust data protection measures. This foundational approach ensures that AI technologies are effective and aligned with societal values, thereby promoting public confidence in their deployment.

Recognizing the significant challenges posed by AI, the study examines the diverse strategies states, companies, and international organizations employ to navigate these complexities. These strategies include adopting regulatory frameworks to keep pace with rapid technological advancements and addressing ethical dilemmas arising from AI applications. The study offers practical solutions, such as investing in technical expertise and enhancing international coordination, which are crucial for developing effective governance structures. By analyzing these varied approaches, the study aims to provide a comprehensive overview of how different entities respond to AI governance's challenges.

Furthermore, this study seeks to identify best practices, challenges, and opportunities for optimizing AI governance models. It aims to answer critical research questions: how can effective AI governance be ensured throughout the AI lifecycle? How do various governance approaches—market-driven, state-driven, and rights-driven—impact the overall effectiveness of AI governance frameworks? The findings will inform policymakers, industry leaders, civil society organizations, and other stakeholders, guiding their efforts to shape a future where AI is used responsibly and equitably for the betterment of humanity. By contributing to a nuanced understanding of AI policy development, the study aims to ensure that governance frameworks are effective and relevant to the evolving landscape of AI.

This research hypothesizes that implementing a comprehensive governance framework prioritizing ethical considerations and stakeholder engagement will significantly enhance trust in AI technologies. Ultimately, the goal is to create a regulatory environment that safeguards public interests. While fostering innovation, enabling the responsible advancement of AI technologies.

Additionally, this article explores the overlaps among the mentioned governance approaches. The intersection of market and rights emphasizes fostering innovation while respecting individual rights, indicating that economic progress can coexist with fundamental freedoms. Similarly, the overlap between state and rights suggests that the state can ensure societal development is aligned with ethical principles and human rights. At the center, where all three approaches converge, lies a balanced framework that promotes innovation, public safety, ethical standards, and equity.

In section 2, we present critical regulatory controls within AI governance frameworks. Section 3 reviews AI governance approaches based on driving forces. Section 4 outlines mitigating conflicts in AI governance: a balanced approach, and section 5 concludes the study.

2. REGULATORY CONTROLS WITHIN AI GOVERNANCE FRAMEWORKS

Effective AI governance necessitates a robust framework that includes critical regulatory controls designed to mitigate the inherent risks associated with AI models and systems [25]. This governance is essential throughout the AI system lifecycle, from initial problem identification to ongoing maintenance. The AI system lifecycle emphasizes the importance of ethical considerations and governance at every stage, as illustrated in Figure 1. Key elements of this framework encompass stakeholder involvement, data quality and privacy, bias mitigation, monitoring and evaluation, risk assessment, updates and improvements, ethical audits, and continuous assessment. Such a comprehensive approach ensures that AI systems are developed and deployed responsibly and ethically, thereby fostering trust in AI technology.

Transparency, accountability, and human rights are foundational principles that guide responsible AI development and deployment [26]. AI systems must be explainable to align with these principles, allowing users and stakeholders to understand the decision-making processes involved. Additionally, rigorous data protection measures must be enforced to safeguard individual privacy and maintain public confidence in AI applications [6]. Meaningful engagement with stakeholders is also critical, as it promotes diverse perspectives and the establishment of effective redress mechanisms [27].

Effective enforcement mechanisms are necessary to ensure compliance with established guidelines and regulations, including penalties for non-compliance [28]. These measures reinforce the importance of adhering to ethical standards within AI governance. By prioritizing these elements, organizations can cultivate a culture of responsibility and trust in AI technologies while effectively addressing potential risks associated with their use. This approach enhances the ethical deployment of AI and aligns with broader societal values and legal requirements, ensuring that AI technologies benefit all stakeholders involved.
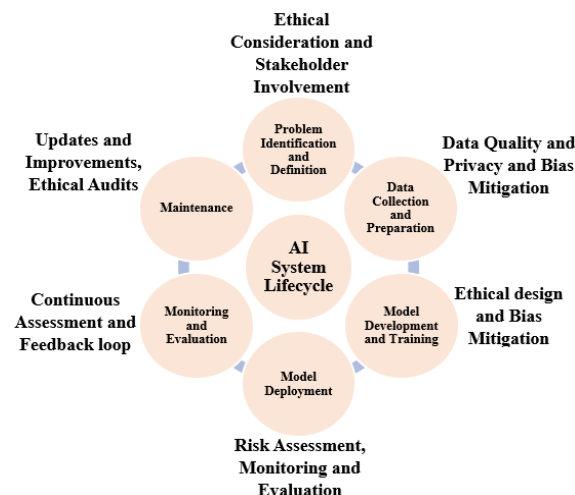

Figure 1. Artificial intelligence governance: a lifelong commitment

As illustrated in Table 1, a comprehensive control matrix can effectively map these regulatory controls to the distinct phases of the AI system lifecycle shown in Figure 1. This table reveals critical regulatory needs for AI development, especially in model development, deployment, and data collection. AI governance emerges from a dynamic interplay among diverse stakeholders. Governments enact regulations (e.g., EU AI Act), while multilateral bodies (organization for economic co-operation and development (OECD), United Nations (UN)) establish guiding principles and standards. Industry self-regulation

complements these efforts, and civil society advocates for human rights and public interests. Moreover, collaborative initiatives foster inclusive dialogue and diverse perspectives. Ultimately, Table 2 details the roles of these key stakeholders in shaping the AI regulatory landscape. AI regulation requires diverse stakeholders: governments, international bodies, industry, and civil society. A collaborative approach ensures responsible AI development.

Table 1. Matrix of regulatory controls in AI governance frameworks

Regulatory control	Design and development	Data collection	Model development	Deployment	Monitoring	Maintenance
Risk assessment	High	Medium	High	Medium	Low	Low
Transparency	Medium	Low	High	High	Medium	Low
Human rights	Medium	High	Medium	High	Low	Medium
Oversight	Low	Medium	High	High	High	Medium
Stakeholder engagement	Medium	Low	Medium	High	High	Medium
Enforcement	Low	Low	Low	Medium	High	Low

Table 2. Stakeholder roles in AI governance framework development

Stakeholder group	Regulatory instruments	Description
National and regional governments	Legislation and regulation	Mandatory requirements (e.g., EU AI act)
Multilateral bodies (OECD, UN)	Principles, guidelines and standards	Templates for governments
Industry (companies, associations)	Voluntary frameworks and best practices	Self-regulation for members
Civil society (non-governmental organizations (NGOs), academia)	Advocacy and public interest	Public representation in controls

The key regulatory challenges in AI governance, as shown in Table 3, including the rapid technological complexity and evolution of opaque AI systems, outpacing policymakers' ability to develop appropriate controls [15], [29]. Moreover, there is a need to balance enabling beneficial AI innovation and implementing sufficient safeguards [30]. Furthermore, translating high-level ethics into concrete requirements while navigating tensions is challenging [16]. In addition, assessing and enforcing compliance is complex [29]. Compounding these challenges is the clash between AI's global reach and national/regional regulations hindering coordination [31]. Additionally, regulators often need more technical expertise and resources to keep pace [32]. Moreover, uncertainty around long-term impacts makes it difficult to anticipate and address potential harms [33]. Finally, maintaining public trust, which requires transparency and dialogue, is essential but challenging [17].

Table 3. Key challenges and best practices in AI governance

Challenge	Best practices
Rapid technological complexity and evolution of opaque AI systems	Collaborative development of balanced frameworks, iterative and adaptive governance
Balancing AI innovation with sufficient safeguards	Investing in technical expertise among regulators, promoting transparency and accountability
Translating high-level ethics into concrete requirements	Aligning ethical principles with operationalizable requirements
Assessing and enforcing compliance	Continuously evaluate and adjust regulations based on evidence, enabling regulatory sandboxes for testing.
The clash between AI's global reach and national/regional regulations	Coordinating internationally to harmonize regulations
Lack of technical expertise and resources among regulators	Investing in technical expertise among regulators
Uncertainty around long-term impacts	Precautionary yet innovation-enabling approach
Maintaining public trust	Empowering public participation, transparency, and dialogue

The best practices for solving these challenges, as depicted in Table 3, including collaborative development of balanced frameworks. Furthermore, iterative and adaptive governance is essential. Investing in technical expertise among regulators is crucial to address the technical complexity. Additionally, promoting transparency and accountability is paramount. To bridge the gap between ethics and practice, aligning ethical principles with operationalizable requirements is necessary. Moreover, coordinating internationally to harmonize regulations is vital. Continuously evaluating and adjusting rules based on evidence is required to ensure regulatory effectiveness. In addition, enabling regulatory sandboxes for testing is beneficial. Furthermore, empowering public participation is essential for building trust. Finally, adopting a precautionary yet innovation-enabling approach that balances risk mitigation with enabling beneficial AI development is crucial.

A multitude of AI governance frameworks have implemented rigorous regulatory controls, as shown in Table 4. Notable examples include the EU's AI act, the OECD principles on AI, the NIST AI risk management framework, Singapore's model AI governance framework, and the UK's AI strategy. The EU's AI act is a groundbreaking legislative initiative that stands as a paragon of AI governance frameworks. This comprehensive legal framework, proposed by the European Commission, seeks to establish a stratified regulatory landscape for AI systems within the union. Employing a risk-based classification paradigm, the act categorizes AI applications into four discrete tiers: unacceptable, high, limited, and minimal. High-risk applications, subject to stringent oversight, are mandated to undergo rigorous risk assessments and adhere to transparency obligations.

Table 4. AI governance frameworks with robust regulatory controls

Criteria	EU AI act	OECD principles on AI	NIST AI risk management framework	Singapore model AI governance framework	UK AI strategy
Governing body	European commission	OECD	NIST	Singapore government	UK government
Risk classification	Unacceptable, high, limited, minimal	N/A	N/A	N/A	N/A
Key requirements	Risk assessments, transparency obligations	Human-centric approach, fairness, robustness	Risk assessment, mitigation, governance	Fairness, accountability, transparency	Proportional regulation, ethical standards
Focus areas	Bias, privacy, accountability	Inclusive growth, sustainable development	Interoperability, stakeholder engagement	Ethical AI use, collaboration	Innovation, safety, societal values
Legal status	Binding	Non-binding	Non-binding	Non-binding	Non-binding
Enforcement mechanisms	European Commission	Voluntary adoption	Voluntary adoption	Voluntary adoption	Voluntary adoption
Maturity level	Fully developed	Mature	Mature	Mature	Developing
Alignment with international standards	ISO standards, OECD principles	OECD principles	ISO standards, OECD principles	ISO standards, OECD principles	ISO standards, OECD principles
Public participation	High stakeholder involvement	Moderate stakeholder involvement	High stakeholder involvement	High stakeholder involvement	Moderate stakeholder involvement

The OECD principles on AI advocates for a responsible approach to AI development that prioritizes inclusive growth and sustainable development. These principles champion a human-centric perspective, emphasizing fairness, robustness, and safety as paramount considerations in AI system design. The NIST AI Risk Management Framework, promulgated by the U.S. National Institute of Standards and Technology, provides a robust framework for managing AI risks throughout their lifecycle. This framework seeks to inform the development of best practices in AI governance by promoting interoperability standards and fostering stakeholder engagement.

Singapore's model AI governance framework offers a comprehensive guide for organizations seeking to ethically harness AI. This framework outlines fairness, accountability, and transparency principles while encouraging collaboration among industry, academia, and government to foster a responsible AI ecosystem. The UK's AI strategy outlines a regulatory landscape designed to support the development of AI while ensuring its alignment with societal values. By advocating for proportional regulation that balances innovation with safety and by promoting ethical standards, the UK seeks to create an environment conducive to the responsible advancement of AI technologies.

A well-adjusted approach to AI regulation is essential. Governments should prioritize high-risk AI applications and adopt principles-based guidelines. Frameworks like NIST and Singapore's model AI governance framework can provide valuable guidance for fostering innovation while ensuring public safety and promoting ethical standards.

3. AI GOVERNANCE APPROACHES BASED ON DRIVING FORCE

These approaches can be categorized based on their driving force–the primary entity or motivation behind the development and implementation of regulations. Essentially, these classifications answer, "What or who is the main driver behind creating and enforcing AI rules and policies?" Consequently, the frameworks are often distinguished as market-driven, state-driven, or rights-driven [34], depending on

whether the impetus comes from industry, government, or the need to uphold human rights principles. This typology reflects the fundamental differences in how each model envisions the appropriate roles of the private sector, public sector, and civil society in governing the impacts of advanced AI technologies.

To illustrate, the United States prioritizes market-driven approaches (organizational governance frameworks) and relies on innovation and economic growth incentives to drive AI development. This is consistent with Washington's "view" of AI as a tool for economic, geopolitical, and military dominance. Although there is no significant federal legislation, the United States uses voluntary standards and self-regulation. Nevertheless, the White House blueprint for an AI bill of rights is a non-binding guide to the ethical development of AI [35].

However, recognizing the limitations, the Biden administration issued an executive order in October 2023 [36], which focuses on mitigating risks such as safety and privacy while promoting responsible innovation and competition. It also calls for bipartisan legislation to provide broader protections for all Americans. For example, Microsoft ("AI ethics and principles") prioritizes accountability, inclusivity, reliability, safety, fairness, transparency, privacy, and security [37]. At the same time, Google's AI principles focus on fairness, interoperability, privacy, safety, and security [38], while IBM educates employees on ethics through everyday AI ethics. Salesforce's AI & equity cloud also advances fairness, transparency, and accountability in its AI products.

The Chinese company Alibaba has also adopted a market-driven approach, utilizing "AI governance principles" for ethical development. Similarly, Siemens' "AI ethics framework" ensures the responsible design, deployment, and use of AI. This highlights the growing focus on ethical AI within technology companies based on a market-driven approach. Table 5 shows that these tech giants share a focus on ethical development, but their methods differ. Some prioritize cultivating a responsible AI culture through employee training, while others integrate ethical considerations directly into their AI product development process. Additionally, some companies, like Alibaba and Siemens, take a more market-driven approach, aligning ethical development with their broader business objectives.

Table 5. Approaches to ethical AI development in tech companies

Company	Framework name	Focus areas	Approach
Microsoft	AI ethics & principles	Accountability, inclusiveness, reliability & safety, fairness, transparency, privacy & security	Cultivate a responsible AI culture.
Google	AI principles	Fairness, interoperability, privacy, safety, security	Achieve specific results (prevent harm, promote social good)
IBM	Everyday AI ethics	Employee education on ethical considerations	Empower employees for responsible AI use
Salesforce	AI ethics & equality cloud	Fairness, transparency, accountability	Integrate ethics into AI product development
Alibaba	AI governance principles	Ethical development	Market-driven approach (alignment with economic goals)
Siemens	AI ethics framework	Responsible design, deployment, use of AI	Market-driven approach (ensure responsible AI use)

The regulation of AI is becoming an international effort, as summarized in Table 6, with countries implementing diverse frameworks; these frameworks are classified as state-driven (national/regional governance) frameworks. In particular, China's approach to AI regulation prioritizes social stability and alignment with Chinese Communist Party (CCP) values. This aligns with China's broader economic model and strengthens the CCP's influence over powerful tech companies.

Over the past two years, China has implemented specific regulations to address information flow, including restrictions on deepfakes and recommendation algorithms. Furthermore, in 2023, draft regulations on generative AI held developers responsible for content that deviates from CCP values. These regulations target risks like transparency in AI systems and traceability of AI-generated content. Additionally, data privacy, security, and content moderation are addressed. This approach allows for some regional flexibility in implementation. Ultimately, the future will reveal how China balances innovation with its focus on control.

In contrast, Singapore's "model AI governance framework" isn't just a mouthful. It's a practical guide by the Infocomm Media Development Authority (IMDA) for responsible AI use in the city-state [39]. Indeed, fairness, transparency, and accountability (FTA) are vital to ensuring unbiased AI with transparent decision-making and accountable actors. Accordingly, the framework takes a risk-based approach with stricter controls for high-risk AI. Furthermore, it promotes phased implementation, urging developers to consider ethics and governance throughout the AI lifecycle. Finally, it aligns with existing regulations for a cohesive approach. As a result, this framework empowers organizations to use trustworthy AI in Singapore.

Table 6. AI governance framework comparison: state-driven frameworks

Country/region	Framework name	Focus areas	Approach	Key features
China	National/regional frameworks	Social stability, CCP power, economic control	State-driven	Specific regulations (deepfakes, recommendation algorithms, generative AI), data privacy, security, content moderation
Singapore	Model AI governance framework (IMDA)	FTA	Practical guide, risk-based	Stricter controls for high-risk AI phased implementation align with existing regulations.
India	National strategy for AI	Responsible AI for everyone, social good	Multi-stakeholder collaboration	Ethical development, anti-discrimination, collaboration (government, businesses, academia), key sectors (healthcare, education)
Canada	Draft legislation & collaboration (AIDA)	Algorithmic fairness, data privacy, responsible government use	Work in progress	Collaboration on AI principles focuses on existing regulations, and public input is needed.
United Kingdom	Principles-based (existing regulators)	Innovation, clear principles	Sector-specific adaptation	Core principles (safety, transparency, fairness, accountability) adapted by regulators, central oversight

Moving to India, their national strategy for AI goes beyond just technology [40]. Instead, it focuses on ensuring responsible AI adoption for everyone, not just the privileged. Consequently, policies and regulations will promote ethical development and prevent discrimination. Moreover, collaboration is critical, with the government working alongside businesses, academia, and research institutions. Specifically, the strategy targets vital sectors like healthcare and education for responsible AI solutions [41]. While the specifics are evolving, a regulatory body might be established to oversee responsible AI development and use. In short, India prioritizes excellent social and ethical AI development alongside technological progress. Canada's proposed AI and data act (AIDA) reflects collaboration with other countries on AI principles [42]. Indeed, while still under development, AIDA focuses on ensuring algorithmic fairness, data privacy, and responsible government use of AI.

The UK takes a unique approach to governing AI, prioritizing innovation with clear principles and focusing on long-term safety risks [30]. Rather than micromanaging regulations, it has core principles that existing regulatory bodies can adapt to their sectors. These principles focus on safety, transparency, fairness, accountability, and the ability to challenge AI decisions. Consequently, financial, data protection and healthcare regulators are drafting specific rules based on these principles in their fields, with a central government body overseeing the overall AI strategy and filling any regulatory gaps. In essence, the UK's approach is a new experiment in balancing innovation and responsible development of AI.

The EU champions a rights-driven approach (multi-stakeholder governance frameworks), prioritizing citizen protection and responsible AI development [43]. Consequently, they've implemented regulations like the general data protection regulation (GDPR), DMA, which stands for digital markets act (regulating tech giants), and digital services act (DSA). Moreover, their most significant contribution is the AI act, addressing sensitive issues like facial recognition and algorithmic bias. This comprehensive act, expected to be enforced by 2026, sets the global standard for AI regulation.

Furthermore, Spain exemplifies this approach by establishing the Spanish agency for AI supervision (AESIA) [44]. This agency focuses on "inclusive, sustainable AI" by creating risk protocols, auditing algorithms, and setting development and deployment rules for AI systems. Following the EU's lead, Brazil and Canada are crafting similar comprehensive, rights-driven frameworks to mitigate AI risks and promote responsible innovation [45], [46]. These regulations are still under development but highlight the growing global trend towards rights-centric AI governance.

Beyond companies and governments, an international movement for responsible AI is gaining momentum. Frameworks like the IEEE's ethical design guide and the partnership on AI's human-rights focus offer direction [47]. In addition, collaborations like the Montreal Declaration and the OECD principles promote responsible development with human rights in mind [48]. Finally, the universal guidelines for AI prioritize human rights and democratic values. This multi-stakeholder approach reflects a global commitment to shaping a responsible AI future.

The above frameworks have strengths and limitations, as depicted in Table 7. Market-driven approaches prioritize innovation and efficiency but often need more oversight, potentially compromising consumer protection and equity. Conversely, state-driven regulation offers consistent protections and coordinated risk management. However, it may stifle innovation through the bureaucracy. Additionally, rights-driven frameworks emphasize human rights and ethical principles, but implementation challenges and potential conflicts with innovation exist. Therefore, balancing these approaches is crucial for developing effective AI governance frameworks that foster innovation while safeguarding societal interests.

Table 7. AI governance approaches based on driving force: a comparative overview

Approach	Advantages	Disadvantages
Market-driven	Innovation, efficiency, rapid adaptation	Lack of oversight, profit prioritization, systemic risk challenges.
State-driven	Consistent protections, clear standards, coordinated risk management, equity, accountability	Bureaucracy, innovation hindrance, potential overreach
Rights-driven	Human rights focus, ethical principles, clear standards, legal recourse, equity	Implementation challenges, innovation conflicts, enforcement difficulties

4.   MITIGATING CONFLICTS IN AI GOVERNANCE: A BALANCED APPROACH

While market-driven approaches offer opportunities for innovation, it also presents challenges. Companies often prioritize profit over broader societal impacts, leading to privacy, fairness, and transparency concerns [33]. Consequently, a combination of self-regulation, industry standards, and public oversight is necessary to mitigate these issues, as presented in Table 8.

Table 8. Market-driven AI governance challenges and mitigations

Challenge	Description	Mitigation
Oversight	Inadequate control over market-driven AI development	Industry self-regulation, third-party audits, transparency measures
Profit prioritization	Prioritization of profit over societal well-being	Ethical frameworks, social impact assessments, public-private partnerships
Systemic risk	Potential for unforeseen negative consequences of AI systems	Robust risk assessment, scenario planning, regulatory sandboxes

Enhancing oversight is crucial to ensuring that market-driven AI development aligns with societal interests [49]. Specifically, industry self-regulation and independent third-party audits can help establish accountability and transparency. Furthermore, requiring companies to disclose AI system functionalities, limitations, and potential impacts can empower consumers and stakeholders.

Balancing profit with public interest is essential for responsible AI development [50]. Therefore, ethical frameworks can guide companies in prioritizing financial success and societal well-being. Additionally, social impact assessments can help identify and address potential negative consequences of AI systems. Moreover, fostering public-private partnerships can facilitate collaboration on addressing societal challenges through AI.

Managing systemic risk requires proactive measures [51]. Specifically, implementing robust risk assessment and management frameworks is essential to identify and mitigate potential harms. Furthermore, scenario planning can help organizations anticipate challenges and develop contingency plans. Finally, regulatory sandboxes can provide controlled environments for testing and iterating AI applications, reducing risks while fostering innovation.

While essential for ensuring public safety and well-being, state-driven AI governance often faces challenges related to bureaucracy, innovation hindrance, and potential overreach [52]. Therefore, to mitigate these risks, governments can adopt agile and flexible regulatory frameworks that minimize bureaucratic hurdles and expedite decision-making processes. Additionally, establishing dedicated AI regulatory bodies with expertise can further streamline regulation and foster innovation, as summarized in Table 9.

Table 9. State-driven AI governance challenges and mitigation strategies

Challenge	Description	Mitigation
Bureaucracy	Excessive administrative burdens hindering AI development	Agile regulatory frameworks, dedicated AI regulatory bodies
Innovation hindrance	The stifling of AI innovation through overly restrictive regulations	Risk-based approach, regulatory sandboxes, public-private partnerships
Overreach	Potential for excessive government control over AI development	Principles-based regulation, transparency, public participation

A risk-based approach is crucial for balancing innovation with regulation in the AI domain. Consequently, governments can create an environment encouraging experimentation and development in lower-risk areas by focusing regulatory efforts on high-risk AI applications. Furthermore, regulatory sandboxes and public-private partnerships can facilitate innovation while ensuring public safety.

Governments can adopt a principles-based approach to AI regulation to prevent regulatory overreach. This involves establishing high-level guidelines that provide flexibility for adapting to technological advancements. Additionally, transparency, public participation, and regular regulatory reviews are essential to build trust and maintain public confidence. Rights-driven AI governance is crucial for protecting individuals and society, but it faces challenges in implementation and potential conflicts with innovation and enforcement. Consequently, various strategies outlined in Table 10 can be employed to overcome these obstacles.

Effective implementation requires clear and actionable guidelines. Moreover, developing practical and adaptable frameworks is crucial. Additionally, prioritizing education and awareness can foster stakeholders' shared understanding of rights-based AI principles. Finally, establishing mechanisms for ongoing evaluation and improvement can enhance implementation effectiveness. Balancing rights protection with innovation requires careful consideration. Creating regulatory sandboxes can encourage experimentation while safeguarding rights to achieve this balance. Furthermore, emphasizing ethical AI development and design can promote innovation that aligns with human values. Finally, fostering collaboration between rights advocates and industry can facilitate the development of solutions that protect rights without stifling innovation.

Enforcing rights-based AI regulations can be challenging. Therefore, robust monitoring and enforcement mechanisms are essential. Additionally, international cooperation can help address cross-border issues and ensure consistent enforcement. Furthermore, empowering individuals to assert their rights and providing accessible redress mechanisms can strengthen enforcement efforts.

Figure 2 displays a Venn diagram that represents three approaches through three overlapping circles. The first circle is labelled "market-driven," the second "state-driven," and the third "rights-driven". The market-driven circle includes a description emphasizing innovation, economic growth, and the potential risks of overlooking societal impacts. The state-driven circle highlights social stability and control and the risks of bureaucracy and hindering innovation. In contrast, the rights-driven circle stresses the importance of protecting individual rights while addressing implementation challenges and conflicts with innovation.

Table 10. Rights-based AI governance challenges and mitigation strategies

| Challenge	Description	Mitigation
Implementation	Difficulties in translating principles into practice	Clear guidelines, adaptable frameworks, education and awareness, evaluation mechanisms
Innovation conflict	Balancing rights protection with technological advancement	Regulatory sandboxes, ethical AI development, industry-rights collaboration
Enforcement	Challenges in ensuring compliance with rights-based regulations	Robust monitoring, international cooperation, individual empowerment
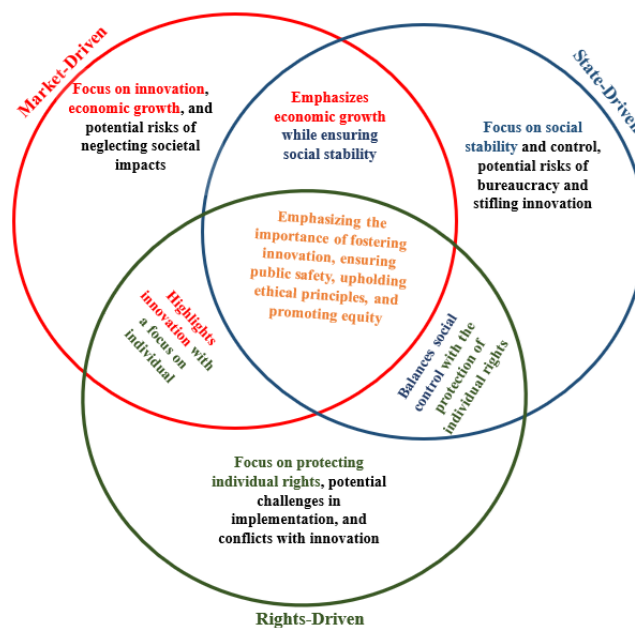
Figure 2. The trifecta of AI governance: market, state, and rights

The overlapping area between market and state highlights the connection between economic growth and social stability. The intersection of market and rights emphasizes the focus on innovation while prioritizing individual rights. The overlap between state and rights depicts the balance between social control and safeguarding individual rights. Finally, the central area where all three circles intersect illustrates a balanced approach that combines elements from each model, underscoring the importance of fostering innovation, ensuring public safety, upholding ethical principles, and promoting equity.

5. CONCLUSION

AI governance presents a complex challenge that necessitates an integrated, multifaceted framework balancing innovation, safety, and equity. This study highlights the necessity of harmonizing market-driven, state-driven, and rights-driven approaches to build robust regulatory ecosystems. Market incentives fuel innovation, state regulations ensure accountability and safety, and rights-based principles uphold ethical standards and inclusivity. Effective AI governance should foster collaboration across public and private sectors, as demonstrated by the EU's AI Act and the OECD's AI principles, which integrate ethical imperatives with innovation. International cooperation is essential to address AI's transboundary impacts, requiring unified standards and capacity-building efforts, particularly for developing nations. Continued research and policy development must address emerging governance challenges—such as those related to generative AI, artificial general intelligence (AGI), and high-impact domains like healthcare and autonomous systems. Moreover, practical tools like comparative assessments and governance metrics are crucial for evaluating policy effectiveness. By advancing inclusive, ethical, and adaptive governance models, policymakers and stakeholders can steer AI development toward outcomes that prioritize human well-being while mitigating systemic risks.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability is not applicable to this paper as no new data were created or analyzed in this study.

REFERENCES

[1] J. W. Stoelhorst and P. Vishwanathan, "Beyond primacy: a stakeholder theory of corporate governance," *Academy of Management Review*, vol. 49, no. 1, pp. 107–134, Jan. 2024, doi: 10.5465/amr.2020.0268.
[2] C. Ortega-Rodríguez, L. Martín-Montes, A. Licerán-Gutiérrez, and A. L. Moreno-Albarracín, "Nonprofit good governance mechanisms: A systematic literature review," *Nonprofit Management and Leadership*, vol. 34, no. 4, pp. 927–957, Jun. 2024, doi: 10.1002/nml.21598.

[3]   H. E. Adama, O. A. Popoola, C. D. Okeke, and A. E. Akinoso, "Theoretical frameworks supporting it and business strategy alignment for sustained competitive advantage," *International Journal of Management & Entrepreneurship Research*, vol. 6, no. 4, pp. 1273–1287, Apr. 2024, doi: 10.51594/ijmer.v6i4.1058.

[4]   O. Welinder, "Interactive accountability in the case of digital governance," in *Handbook of Accounting and Public Governance*, Edward Elgar Publishing, 2024, pp. 116–127, doi: 10.4337/9781800888456.00016.

[5]   A. S. Alamoush, F. Ballini, and A. I. Ölçer, "Management of stakeholders engaged in port energy transition," *Energy Policy*, vol. 188, May 2024, doi: 10.1016/j.enpol.2024.114074.

[6]   J. Zhao, "Promoting more accountable AI in the boardroom through smart regulation," *Computer Law and Security Review*, vol. 52, Apr. 2024, doi: 10.1016/j.clsr.2024.105939.

[7]   F. F. Adedoyin and B. Christiansen, *Generative AI and multifactor productivity in business*. IGI Global, 2024, doi: 10.4018/9798369311981.

[8]   K. Bharanitharan and G. Kaur, "Navigating the legal landscape: addressing AI-driven innovations and challenges in Indian Fintech," *Journal of Informatics Education and Research*, vol. 4, no. 3, 2024, doi: 10.52783/jier.v4i3.1361.

[9]   I. A. Filipova, "Legal regulation of artificial intelligence: experience of China," *Journal of Digital Technologies and Law*, vol. 2, no. 1, pp. 46–73, Mar. 2024, doi: 10.21202/jdtl.2024.4.

[10]   P. L. Frana, "Assessing smart nation Singapore as an international model for AI responsibility," *International Journal on Responsibility*, vol. 7, no. 1, Jun. 2024, doi: 10.62365/2576-0955.1109.

[11]   D. K. Jena, "Beyond technology: exploring sociocultural contours of artificial intelligence integration in India," *Educational Administration: Theory and Practice*, vol. 30, no. 5, pp. 1169–1184, 2024.

[12]   G. D'Agostino and R. Fay, "Governing data and AI to protect inner freedoms includes a role for IP," *Centre for International Governance Innovation*, pp. 1-10, 2024.

[13]   H. Roberts, E. Hine, M. Taddeo, and L. Floridi, "Global AI governance: barriers and pathways forward," *SSRN Electronic Journal*, 2023, doi: 10.2139/ssrn.4588040.

[14]   Y. Walter, "Managing the race to the moon: global policy and governance in artificial intelligence regulation—a contemporary overview and an analysis of socioeconomic consequences," *Discover Artificial Intelligence*, vol. 4, no. 1, Feb. 2024, doi: 10.1007/s44163-024-00109-4.

[15]   A. Reuel and T. A. Undheim, "Generative AI needs adaptive governance," *arXiv-Computer Science*, pp. 1-12, 2024.

[16]   S. Knight, A. Shibani, and N. Vincent, "Ethical AI governance: mapping a research ecosystem," *AI and Ethics*, vol. 5, no. 2, pp. 841–862, Apr. 2024, doi: 10.1007/s43681-023-00416-z.

[17]   M. A. Camilleri, "Artificial intelligence governance: ethical considerations and implications for social responsibility," *Expert Systems*, vol. 41, no. 7, Jul. 2024, doi: 10.1111/exsy.13406.

[18]   O. A. Fayayola and O. L. Olorunfemi, "Ethical decision-making in IT governance: a review of models and frameworks," *International Journal of Science and Research Archive*, vol. 11, no. 2, pp. 130–138, Mar. 2023, doi: 10.30574/ijsra.2024.11.2.0373.

[19]   V. Katragadda, "Ethical AI in customer interactions: implementing safeguards and governance frameworks," *Iconic Research and Engineering Journals*, vol. 7, no. 12, pp. 394–397, 2024.

[20]   H. P. Olsen, T. T. Hildebrandt, C. Wiesener, M. S. Larsen, and A. W. A. Flügge, "The right to transparency in public governance: freedom of information and the use of artificial intelligence by public agencies," *Digital Government: Research and Practice*, vol. 5, no. 1, pp. 1–15, Mar. 2024, doi: 10.1145/3632753.

[21]   G. B. Mensah, F. Nyante, A. Addy, and P. O. Frimpong, "Navigating the fragmented landscape: a clarion call for the consolidation of Ghana's AI governance framework," *Africa Journal for Law and Development Research*, no. 1, pp. 16–26, 2024.

[22]   C. Cancela-Outeda, "The EU's AI act: a framework for collaborative governance," *Internet of Things*, vol. 27, Oct. 2024, doi: 10.1016/j.iot.2024.101291.

[23]   Q. Lu, L. Zhu, X. Xu, J. Whittle, D. Zowghi, and A. Jacquet, "Responsible AI pattern catalogue: a collection of best practices for AI governance and engineering," *ACM Computing Surveys*, vol. 56, no. 7, pp. 1–35, 2024, doi: 10.1145/3626234.

[24]   S. M. Ibrahim, M. A. Alshraideh, M. Leiner, I. M. Aldajani, and B. Ouarda, "Artificial intelligence ethics: ethical consideration and regulations from theory to practice," *IAES International Journal of Artificial Intelligence*, vol. 13, no. 3, pp. 3703–3714, 2024, doi: 10.11591/ijai.v13.i3.pp3703-3714.

[25]   K. Palaniappan, E. Y. T. Lin, and S. Vogel, "Global regulatory frameworks for the use of artificial intelligence (AI) in the healthcare services sector," *Healthcare*, vol. 12, no. 5, Feb. 2024, doi: 10.3390/healthcare12050562.

[26]   B. Xia, Q. Lu, L. Zhu, S. U. Lee, Y. Liu, and Z. Xing, "Towards a responsible ai metrics catalogue: a collection of metrics for ai accountability," in *Proceedings-2024 IEEE/ACM 3rd International Conference on AI Engineering-Software Engineering for AI, CAIN 2024*, Apr. 2024, pp. 100–111, doi: 10.1145/3644815.3644959.

[27]   B. C. Cheong, "Transparency and accountability in AI systems: safeguarding wellbeing in the age of algorithmic decision-making," *Frontiers in Human Dynamics*, vol. 6, Jul. 2024, doi: 10.3389/fhumd.2024.1421273.

[28]   V. Jain, A. Balakrishnan, D. Beeram, M. Najana, and P. Chintale, "Leveraging artificial intelligence for enhancing regulatory compliance in the financial sector," *International Journal of Computer Trends and Technology*, vol. 72, no. 5, pp. 124–140, May 2024, doi: 10.14445/22312803/ijctt-v72i5p116.

[29]   H. Padmanaban, "Revolutionizing regulatory reporting through AI/ML: approaches for enhanced compliance and efficiency," *Journal of Artificial Intelligence General science (JAIGS)*, vol. 2, no. 1, pp. 57–69, Feb. 2024, doi: 10.60087/jaigs.v2i1.p69.

[30]   K. Huang, A. Joshi, S. Dun, and N. Hamilton, "AI regulations," in *Generative AI Security*, Switzerland: Springer Nature, 2024, pp. 61–98, doi: 10.1007/978-3-031-54252-7_3.

[31]   Y. Cui, "AI laws and policies," in *Blue Book on AI and Rule of Law in the World*, Singapore: Springer, 2024, pp. 51–152, doi: 10.1007/978-981-99-9085-6_2.

[32]   G. Papyshev and M. Yarime, "The limitation of ethics-based approaches to regulating artificial intelligence: regulatory gifting in the context of Russia," *AI and Society*, vol. 39, no. 3, pp. 1381–1396, Jun. 2024, doi: 10.1007/s00146-022-01611-y.

[33]   T. O. Oladoyinbo, S. O. Olabanji, O. O. Olaniyi, O. O. Adebiyi, O. J. Okunleye, and A. I. Alao, "Exploring the challenges of artificial intelligence in data integrity and its influence on social dynamics," *Asian Journal of Advanced Research and Reports*, vol. 18, no. 2, pp. 1–23, 2024, doi: 10.9734/ajarr/2024/v18i2601.

[34]   P. G. Kirchschlaeger, "An international data-based systems agency IDA: striving for a peaceful, sustainable, and human rights-based future," *Philosophies*, vol. 9, no. 3, May 2024, doi: 10.3390/philosophies9030073.

[35]   M. Amarikwa, "Rules for robots: constitutional challenges with the AI bill of right's principles regulating automated systems," *University of Pennsylvania Journal of Constitutional Law*, vol. 26, no. 4, pp. 1176–1211, 2024, doi: 10.58112/jcl.26-4.6.

[36]   D. Blumenthal, "The U.S. president's executive order on artificial intelligence," *Nejm Ai*, vol. 1, no. 2, Jan. 2024, doi: 10.1056/aipc2300296.

[37] A. Pant, R. Hoda, S. V. Spiegler, C. Tantithamthavorn, and B. Turhan, "Ethics in the age of AI: an analysis of AI practitioners' awareness and challenges," *ACM Transactions on Software Engineering and Methodology*, vol. 33, no. 3, 2024, doi: 10.1145/3635715.

[38] S. Khattab, "Frameworks for ensuring fairness and accountability in AI systems," *Journal of Innovative Technologies*, vol. 6, no. 1, pp. 1–14, 2023.

[39] S. S. Lim and G. Chng, "Verifying AI: will Singapore's experiment with AI governance set the benchmark?," *Communication Research and Practice*, vol. 10, no. 3, pp. 297–306, Jul. 2024, doi: 10.1080/22041451.2024.2346416.

[40] A. Panigrahi, S. C. Ahirrao, and A. Patel, "Impact of artificial intelligence on Indian economy," *Journal of Management Research and Analysis*, vol. 11, no. 1, pp. 33–40, Mar. 2024, doi: 10.18231/j.jmra.2024.007.

[41] A. Q. Bataineh, A. S. Mushtaha, I. A. Abu-Alsondos, S. H. Aldulaimi, and M. Abdeldayem, "Ethical & legal concerns of artificial intelligence in the healthcare sector," in *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems, ICETSIS 2024*, Jan. 2024, pp. 491–495, doi: 10.1109/ICETSIS61505.2024.10459438.

[42] N. Tafazoli, "Crossing the digital rubicon: recalibrating private power for public purpose by centering rights, risks, and harms in the artificial intelligence and data act," *University of Toronto Faculty of Law Review*, vol. 82, no. 1, pp. 52–100, 2024.

[43] T. Davis and S. Haapasaari, "Access to effective remedy and grievance mechanisms: a brief review of the situation for exploited migrant workers in Finland and Norway," *Journal of Modern Slavery: a Multidisciplinary Exploration of Human Trafficking Solutions*, vol. 9, no. 1, pp. 44–69, 2024.

[44] R. Nabil, "Artificial intelligence regulatory sandboxes," *Artificial Intelligence Regulatory Sandboxes*, vol. 19, no. 2, pp. 295–348, 2024.

[45] A. C. C. Andrade and M. C. S. Vasquez, "The compatibility between SDGs and the EU regulatory framework of AI," *Journal of Ethics and Legal Technologies*, vol. 6, no. 1, pp. 11–144, 2024.

[46] S. Nahar, "Modeling the effects of artificial intelligence (AI)-based innovation on sustainable development goals (SDGs): Applying a system dynamics perspective in a cross-country setting," *Technological Forecasting and Social Change*, vol. 201, Apr. 2024, doi: 10.1016/j.techfore.2023.123203.

[47] A. Jedličková, "Ethical approaches in designing autonomous and intelligent systems: a comprehensive survey towards responsible development," *AI and Society*, vol. 40, no. 4, pp. 2703–2716, Apr. 2024, doi: 10.1007/s00146-024-02040-9.

[48] B. Attard-Frost, A. Brandusescu, and K. Lyons, "The governance of artificial intelligence in Canada: findings and opportunities from a review of 84 AI governance initiatives," *SSRN Electronic Journal*, 2023, doi: 10.2139/ssrn.4414212.

[49] P. Francés-Gómez, "Ethical principles and governance for AI," in *International Library of Ethics, Law and Technology*, vol. 41, 2023, pp. 191–217, doi: 10.1007/978-3-031-48135-2_10.

[50] K. Patel, "Ethical reflections on data-centric AI: balancing benefits and risks," *International Journal of Artificial Intelligence Research and Development (IJAIRD)*, vol. 2, no. 1, pp. 1–17, 2024.

[51] Y. Bengio *et al.*, "Managing extreme AI risks amid rapid progress: preparation requires technical research and development, as well as adaptive, proactive governance," *Science*, vol. 384, no. 6698, pp. 842–845, May 2024, doi: 10.1126/science.adn0117.

[52] M. Busuioc, "AI algorithmic oversight: new frontiers in regulation," in *Handbook of Regulatory Authorities*, Edward Elgar Publishing, 2022, pp. 470–486, doi: 10.4337/9781839108990.00043.

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