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ANALYSIS OF CARBON TRADING REGULATIONS AND THEIR CONTRIBUTION TO ACHIEVING INDONESIA'S NATIONAL EMISSION REDUCTION TARGETS

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ABSTRACT

Background. Climate change has become one of the most pressing global challenges, prompting countries to adopt various policy instruments to reduce greenhouse gas (GHG) emissions. Indonesia, as a party to the United Nations Framework Convention on Climate Change and the Paris Agreement, has committed to reducing emissions through its Nationally Determined Contribution (NDC). One of the key regulatory innovations introduced by the Indonesian government is carbon trading under Presidential Regulation No. 98 of 2021 concerning the Economic Value of Carbon. This study analyzes the effectiveness of Indonesia's carbon trading regulatory framework in supporting national emission reduction targets.
Research Methods. Employing a normative legal research design, this study examines Indonesia's legal framework for carbon trading. It analyzes statutory regulations, international legal instruments, and comparative practices to assess the effectiveness of existing norms in aiding Indonesia's greenhouse gas emission reduction goals. The analysis includes constitutional provisions, national and sector-specific legislation, and relevant international agreements. A comparative approach highlights best practices and identifies regulatory gaps, suggesting potential reforms to enhance Indonesia's carbon trading and support sustainable development objectives.
Findings. The findings indicate that Indonesia has established a comprehensive legal foundation for carbon trading; however, challenges remain regarding institutional coordination, market transparency, carbon credit verification, and legal certainty. While carbon trading has significant potential to contribute to national emission reduction targets, its effectiveness depends on regulatory coherence, robust monitoring systems, and alignment with international carbon market standards.
Conclusion. Strengthening governance mechanisms, improving transparency, and integrating carbon trading into broader climate policy frameworks.

Keywords: Carbon Trading, Climate Change Law, Carbon Market, Environmental Law, Nationally Determined Contribution, Indonesia.

BACKGROUND

Climate change has emerged as a critical legal, economic, and environmental issue in the twenty-first century. Rising global temperatures, increasing frequency of extreme weather events, and biodiversity loss have compelled governments to implement mitigation measures aimed at reducing greenhouse gas emissions. In response to these challenges, the international community adopted the Paris Agreement in 2015, requiring participating states to submit Nationally Determined Contributions (NDCs) outlining their emission reduction commitments [1,2].

Indonesia has committed to reducing greenhouse gas emissions through a combination of domestic and international efforts. The Indonesian government has pledged to reduce emissions significantly while pursuing sustainable economic development. To facilitate this

objective, Presidential Regulation No. 98 of 2021 introduced the concept of Carbon Economic Value, providing a legal framework for carbon pricing mechanisms, including carbon trading, carbon taxes, results-based payments, and other market-based instruments [3].

Carbon trading has gained international recognition as an economic instrument capable of reducing emissions by creating financial incentives for businesses to adopt low-carbon technologies. Globally, emissions trading systems (ETS) have been implemented in multiple jurisdictions, most notably the European Union, where the EU Emissions Trading System has become one of the largest carbon markets worldwide [4].

Despite its potential benefits, carbon trading remains controversial. Critics argue that carbon markets may create opportunities for double counting, market manipulation, inequitable distribution of benefits, and questionable environmental integrity. Consequently, evaluating the effectiveness of Indonesia's carbon trading regulations is essential to determine whether they can meaningfully contribute to national emission reduction targets

Previous studies have predominantly concentrated on the implementation of carbon markets from environmental policy perspectives, economic assessments of carbon pricing mechanisms, comparative analyses of international carbon trading systems, and general discussions regarding the development of Indonesia's carbon market framework [5,6]. Although these studies have provided valuable insights into the operational, economic, and policy dimensions of carbon trading, relatively limited scholarly attention has been devoted to comprehensively examining the legal effectiveness of Indonesia's carbon trading regulations in supporting the achievement of the country's Nationally Determined Contribution (NDC) targets through a normative legal approach. Accordingly, this study seeks to address this research gap by evaluating carbon trading regulations through the perspective of climate governance effectiveness, identifying legal and regulatory barriers that may hinder the implementation of carbon market mechanisms, and assessing the compatibility of Indonesia's carbon trading framework with international carbon market principles established under the Paris Agreement. However, limited research has comprehensively examined the relationship between Indonesia's carbon trading regulations and their legal effectiveness in achieving NDC targets through a normative legal approach. Furthermore, the study proposes legal reforms aimed at strengthening the governance of carbon trading in Indonesia, enhancing regulatory certainty, and ultimately improving the effectiveness of emissions reduction efforts in achieving national climate commitments.

This study contributes by 1)evaluating carbon trading regulations specifically through the lens of climate governance effectiveness, 2)assessing legal barriers affecting carbon market implementation, 3)examining the compatibility of Indonesia's carbon trading framework with international carbon market principles under the Paris Agreement, and 4)proposing legal reforms to strengthen carbon trading governance and improve emissions reduction outcomes.

RESEARCH METHOD

This study employs a normative juridical research design**,** a methodological approach widely applied in international legal scholarship to examine the adequacy, coherence, and effectiveness of legal norms governing specific socio-legal issues. The normative approach is particularly appropriate because the present study seeks to analyze the extent to which Indonesia's carbon trading regulatory framework supports the achievement of national emission reduction targets and fulfills broader sustainable development commitments.

The research adopts three complementary analytical approaches: the statutory approach, conceptual approach, and comparative approach. The statutory approach is undertaken by systematically reviewing and analyzing legal instruments governing carbon trading, environmental protection, and climate change mitigation in Indonesia. The primary legal materials examined include:

- Presidential Regulation No. 98 of 2021 concerning the Implementation of Carbon Economic Value for Achieving Nationally Determined Contribution Targets and Controlling Greenhouse Gas Emissions in National Development;

- Law No. 32 of 2009 concerning Environmental Protection and Management;
- Law No. 16 of 2016 concerning the Ratification of the Paris Agreement to the United Nations Framework Convention on Climate Change (UNFCCC);
- Other implementing regulations, ministerial decrees, and relevant policy documents related to carbon market governance.

Through this approach, the study evaluates the consistency, legal hierarchy, and regulatory integration of Indonesia's carbon trading regime, particularly in relation to national climate policy objectives and international commitments.

The conceptual approach is used to explore and interpret the theoretical foundations underpinning carbon trading regulation. This approach enables the study to assess existing legal norms from broader legal and policy perspectives. Several major concepts are employed, including:

- Environmental governance theory, which emphasizes transparency, accountability, participation, and institutional coordination in environmental policymaking;
- Climate justice theory, which focuses on fairness in the distribution of climate-related burdens and benefits among stakeholders;
- Sustainable development theory, which seeks to balance environmental protection, economic growth, and social welfare;
- Market-based environmental regulation theory, which explains the role of economic instruments, including emissions trading systems, in achieving environmental objectives efficiently.

The application of these theoretical perspectives allows for a more critical assessment of whether Indonesia's carbon trading regulations are capable of ensuring both environmental effectiveness and social equity. Recognizing that carbon markets operate within an increasingly globalized regulatory environment, this study also employs a comparative legal approach. Indonesian carbon trading regulations are compared with selected international experiences, particularly:

- The European Union Emissions Trading System (EU ETS), which is widely regarded as the world's most established carbon market mechanism;
- Carbon pricing and emissions trading frameworks implemented in several developed and emerging economies.

Comparative analysis is intended to identify regulatory best practices, institutional arrangements, compliance mechanisms, and governance models that may provide valuable lessons for improving Indonesia's carbon market framework. Comparative legal analysis further assists in evaluating whether Indonesia's regulatory approach aligns with international developments and global climate governance standards.

The study relies exclusively on secondary legal materials. Primary legal materials consist of statutes, regulations, international agreements, and official government documents. Secondary legal materials include peer-reviewed international journal articles, academic books, policy reports, and publications from international organizations.

Scientific literature was collected from reputable academic databases, including Scopus-indexed and Web of Science-indexed journals**,** as well as publications issued by international organizations such as the United Nations Framework Convention on Climate Change (UNFCCC)**,** the World Bank**,** the Organisation for Economic Co-operation and Development (OECD**)**, and other relevant institutions.

All legal materials were analyzed qualitatively using a descriptive-analytical method. The analysis involved identifying legal norms, examining their interrelationships, evaluating their effectiveness in achieving emission reduction targets, and interpreting regulatory gaps that may hinder the implementation of carbon trading in Indonesia. Findings were subsequently interpreted within the broader context of sustainable development and climate governance to formulate recommendations for future regulatory reform.

FINDINGS

Regulatory Framework of Carbon Trading in Indonesia

Indonesia's carbon trading framework represents a significant shift in the country's climate governance strategy, moving beyond traditional command-and-control environmental regulations toward market-based mechanisms that integrate economic incentives with environmental objectives. The adoption of Presidential Regulation No. 98 of 2021 concerning the Economic Value of Carbon marked a major milestone in Indonesia's efforts to fulfill its commitments under the Paris Agreement and achieve its Nationally Determined Contribution (NDC) targets. This regulation recognizes that reducing greenhouse gas emissions requires not only regulatory obligations but also economic instruments capable of influencing the behavior of businesses, investors, and other stakeholders. By assigning economic value to carbon emissions and emission reductions, the government seeks to encourage market actors to actively participate in climate mitigation efforts while maintaining economic competitiveness.

The regulatory framework establishes carbon trading as one component of a broader carbon pricing strategy. Rather than relying solely on sanctions or environmental permits, the government introduces mechanisms that reward entities capable of reducing emissions below established thresholds. This approach reflects a growing international consensus that market-based instruments can complement conventional environmental regulations by providing flexibility and encouraging innovation. Under this framework, companies that successfully reduce emissions may generate carbon credits that can be traded within the carbon market, creating financial incentives for investments in cleaner technologies and sustainable business practices.

One of the central mechanisms introduced under the regulation is the Emissions Trading System (ETS). Through this system, the government sets an emissions cap for specific sectors and allocates emission allowances to regulated entities. Companies that emit less than their allocated limit may sell excess allowances, while those exceeding their limits must purchase additional allowances from other market participants. This mechanism creates a direct economic motivation for industries to reduce emissions because lowering emissions can generate additional revenue, whereas excessive emissions result in additional costs. Theoretically, the ETS allows emission reductions to occur where they are most economically efficient, thereby minimizing the overall cost of achieving national climate objectives.

In addition to emissions trading, the regulation also incorporates carbon offset mechanisms. Carbon offsets enable companies or organizations to compensate for their emissions by investing in projects that reduce or remove greenhouse gases elsewhere. Examples include reforestation programs, mangrove restoration, renewable energy projects, and sustainable land management initiatives. Given Indonesia's extensive forest resources and rich biodiversity, carbon offset projects have considerable potential to generate both environmental and socio-economic benefits. Carbon offsets can create opportunities for local communities, support ecosystem conservation, and contribute to sustainable development while simultaneously helping organizations meet their emission reduction commitments.

The regulation further introduces results-based payment schemes, which provide financial rewards based on verified emission reductions. Unlike traditional funding mechanisms that focus on activities or expenditures, results-based payments emphasize measurable outcomes. This approach aligns with international climate finance principles, where funding is increasingly tied to demonstrated environmental performance. For Indonesia, such schemes can attract international climate finance and strengthen cooperation with global partners seeking to support emission reduction initiatives in developing countries.

Another important component of the framework is the gradual introduction of carbon taxes and carbon levies. These instruments complement carbon trading by imposing a financial cost on carbon-intensive activities. While carbon trading creates incentives through market transactions, carbon taxes establish a direct price on emissions, encouraging businesses to adopt cleaner production methods. The combination of these instruments reflects a hybrid regulatory

approach that balances flexibility with accountability. Such integration is particularly important in sectors where emissions are difficult to regulate solely through market mechanisms.

The establishment of Indonesia's carbon exchange further demonstrates the government's commitment to institutionalizing carbon market activities. The carbon exchange serves as a formal platform where carbon credits can be traded transparently and efficiently. Beyond facilitating transactions, the exchange contributes to market credibility by improving transparency, standardization, and regulatory oversight. A well-functioning carbon exchange can increase investor confidence, attract domestic and international participants, and support the development of a robust carbon market ecosystem. Nevertheless, the long-term success of the exchange depends on the availability of high-quality carbon credits, reliable monitoring systems, and clear legal rules governing market participation.

Despite these regulatory advancements, several governance challenges remain. The implementation of carbon trading involves multiple government institutions, including environmental, financial, energy, and forestry authorities. Effective coordination among these institutions is essential to avoid regulatory fragmentation and overlapping responsibilities. Furthermore, the credibility of carbon markets depends heavily on accurate measurement, reporting, and verification (MRV) systems capable of ensuring that carbon credits represent genuine and additional emission reductions. Without strong institutional oversight, the risk of double counting, greenwashing, and market manipulation may undermine both environmental integrity and public trust in the carbon market.

Overall, Indonesia's carbon trading framework reflects a progressive legal response to climate change challenges. The regulatory architecture demonstrates the government's recognition that climate mitigation requires innovative policy instruments capable of mobilizing private investment and encouraging sustainable economic transformation. However, the effectiveness of the framework will ultimately depend on regulatory consistency, institutional capacity, transparency, and the ability to align domestic carbon market mechanisms with evolving international standards.

Contribution of Carbon Trading to National Emission Reduction Targets

Carbon trading has emerged globally as one of the most widely adopted market-based instruments for reducing greenhouse gas emissions. The underlying principle is relatively straightforward: by placing an economic value on carbon emissions, businesses are encouraged to internalize environmental costs that were previously externalized to society. Rather than treating emissions as a free by product of economic activity, carbon trading transforms emissions into a measurable and tradable commodity. This shift creates incentives for companies to adopt cleaner technologies, improve energy efficiency, and invest in sustainable production processes. Consequently, carbon trading is increasingly viewed not only as an environmental policy instrument but also as a mechanism for supporting broader economic transformation toward low-carbon development.

Empirical evidence from various jurisdictions suggests that carbon pricing mechanisms can contribute significantly to emission reduction objectives when supported by strong institutional frameworks and effective enforcement. Studies examining carbon markets in Europe, North America, and parts of Asia have found that emissions trading systems can reduce emissions while maintaining economic productivity. However, the effectiveness of these systems depends largely on factors such as market design, regulatory certainty, monitoring mechanisms, and participant compliance. Carbon trading is therefore not a standalone solution to climate change but rather one component of a comprehensive climate governance strategy.

For Indonesia, carbon trading holds particular importance because the country faces the dual challenge of sustaining economic growth while reducing greenhouse gas emissions. Indonesia's economy remains heavily dependent on natural resource-based industries and fossil fuels, making emission reductions both necessary and complex. Carbon trading provides a mechanism through which environmental objectives can be pursued without imposing excessive economic burdens on industries. By allowing businesses flexibility in determining how they achieve emission reductions, carbon markets can facilitate a more cost-effective transition toward sustainability.

One of the most significant contributions of carbon trading is its ability to increase private sector participation in climate action. Historically, climate mitigation efforts have often relied on government programs and public funding. However, achieving ambitious emission reduction targets requires investment levels that exceed public sector capacity alone. Carbon markets help bridge this gap by creating financial incentives that attract private capital. When emission reductions generate economic value through tradable carbon credits, businesses are more likely to invest in renewable energy projects, energy-efficient technologies, and sustainable operational practices. In this way, carbon trading transforms climate action from a regulatory obligation into a potential business opportunity.

Furthermore, carbon trading can play a critical role in mobilizing climate finance. Indonesia possesses substantial natural assets, including tropical forests, peatlands, and mangrove ecosystems that serve as important carbon sinks. Through carbon markets, conservation and restoration activities can generate carbon credits that attract domestic and international investment. This mechanism creates new revenue streams that can support environmental protection while simultaneously contributing to local economic development. For example, carbon finance can fund reforestation projects, biodiversity conservation initiatives, and community-based environmental programs, thereby producing multiple social, economic, and ecological benefits.

Carbon trading also has the potential to accelerate technological innovation. As carbon emissions become associated with financial costs, companies are encouraged to seek innovative solutions that improve efficiency and reduce environmental impacts. This dynamic can stimulate research and development activities, encourage the adoption of renewable energy technologies, and support the emergence of new green industries. Over time, technological innovation driven by carbon pricing can contribute to structural changes within the economy, making low-carbon development pathways increasingly viable and competitive.

From a national policy perspective, carbon trading supports the achievement of Indonesia's Nationally Determined Contribution targets by creating incentives for emission reductions across multiple sectors. Unlike sector-specific regulations that target individual industries, carbon markets can facilitate emission reductions wherever they can be achieved most efficiently. This flexibility allows mitigation efforts to occur across energy, transportation, forestry, agriculture, and industrial sectors, thereby maximizing overall environmental benefits. By integrating climate objectives into economic decision-making processes, carbon trading contributes to a more coordinated and comprehensive approach to emission reduction.

Nevertheless, the contribution of carbon trading to national emission targets should not be overstated. The environmental effectiveness of carbon markets depends on the quality of carbon credits, the stringency of emissions caps, and the integrity of monitoring and verification systems. If carbon credits do not represent genuine emission reductions or if regulatory oversight is weak, the market may generate financial transactions without delivering meaningful environmental outcomes. Therefore, while carbon trading offers substantial opportunities for supporting Indonesia's climate commitments, its success ultimately depends on strong governance, transparent institutions, and continuous regulatory improvement.

In the Indonesian context, carbon trading should be viewed as a complementary instrument rather than a substitute for broader climate policies. Emission reductions will require a combination of regulatory reforms, renewable energy expansion, sustainable land-use management, technological innovation, and public participation. Carbon markets can support these efforts by providing economic incentives and mobilizing investment, but they must operate within a coherent policy framework that prioritizes environmental integrity and long-term sustainability. When integrated effectively into national climate strategies, carbon trading can become an important catalyst for achieving Indonesia's emission reduction goals while promoting sustainable economic development.

DISCUSSIONS

Legal Challenges in Carbon Trading Implementation

Although Indonesia has established a relatively comprehensive legal framework for carbon trading through Presidential Regulation No. 98 of 2021, significant legal and institutional challenges remain in translating regulatory objectives into effective climate action. The effectiveness of carbon trading is not determined solely by the existence of legal instruments but also by the quality of governance, institutional capacity, legal certainty, and public trust. Experiences from several jurisdictions demonstrate that weaknesses in regulatory design and implementation can undermine both market confidence and environmental effectiveness [7,8].

One of the most prominent challenges concerns regulatory fragmentation and institutional coordination. Carbon trading intersects with multiple policy sectors, including environmental protection, forestry, energy governance, financial regulation, taxation, and international trade. Consequently, several government agencies hold overlapping responsibilities in carbon market governance. While the Ministry of Environment and Forestry serves as the primary authority responsible for climate policy implementation, other institutions such as the Ministry of Finance, Ministry of Energy and Mineral Resources, Financial Services Authority, and Indonesia Carbon Exchange also play important regulatory roles. This multiplicity of actors creates risks of overlapping authority, inconsistent interpretation of regulations, and administrative inefficiencies that may discourage market participation and investment [9].

The challenge becomes even more complex when considering Indonesia's decentralized governance structure. Carbon projects are often implemented in forested and rural areas involving provincial and local governments. Without effective coordination mechanisms, conflicts regarding carbon ownership rights, project authorization, and benefit-sharing arrangements may emerge. Such disputes can create legal uncertainty and increase transaction costs for project developers and investors [10].

Another critical challenge concerns the environmental integrity of carbon credits. Carbon markets fundamentally depend on the credibility of carbon credits as representations of real, measurable, and verifiable emission reductions. If carbon credits fail to correspond to actual environmental benefits, the legitimacy of the entire carbon trading system may be questioned. International studies have highlighted concerns regarding the quality of carbon offset projects, particularly with respect to additionality, permanence, leakage, and double counting [11].

Additionality refers to the requirement that emission reductions would not have occurred in the absence of carbon market incentives. If projects would have proceeded regardless of carbon financing, the resulting carbon credits may not represent genuine environmental gains. Permanence poses another challenge, especially for nature-based carbon projects such as forest conservation and reforestation. Carbon sequestration achieved through such projects may be reversed by future deforestation, forest fires, or land-use changes, thereby reducing long-term climate benefits [12].

Leakage represents another important concern. Emission reductions achieved in one location may unintentionally lead to increased emissions elsewhere. For example, restricting deforestation in one region may shift logging activities to another area, resulting in little or no net reduction in overall emissions. In addition, double counting remains one of the most significant risks facing international carbon markets. Double counting occurs when the same emission reduction is claimed by multiple entities or countries, thereby undermining the integrity of climate accounting systems established under the Paris Agreement [13,14].

Monitoring, Reporting, and Verification (MRV) systems also present substantial legal and operational challenges. Effective MRV mechanisms are essential for ensuring that emission reductions are accurately measured and independently verified. Given Indonesia's extensive geographical area, diverse ecosystems, and varying levels of institutional capacity, implementing comprehensive MRV systems requires considerable technical expertise, financial resources, and regulatory oversight [15]. Weak monitoring systems may create opportunities for inaccurate reporting, fraud, and manipulation of carbon credit data, thereby reducing investor confidence and market credibility [16].

Legal certainty constitutes another essential prerequisite for a successful carbon trading regime. Carbon market participants require predictable regulatory environments before

committing long-term investments. However, several aspects of Indonesia's carbon market framework remain under development, including issues related to carbon ownership rights, taxation of carbon transactions, dispute settlement mechanisms, and contractual obligations among market actors. Regulatory uncertainty in these areas may increase investment risks and hinder market growth [17,18].

Beyond environmental and economic concerns, carbon trading also raises important questions regarding environmental justice and social equity. Many carbon offset projects are located in areas inhabited by indigenous peoples and local communities whose livelihoods depend on natural resources. Although carbon markets can generate economic opportunities, benefits are not always distributed equitably among stakeholders. There is a risk that financial gains may be concentrated among large corporations and investors while local communities receive limited compensation despite contributing significantly to conservation efforts [19].

Furthermore, meaningful community participation remains essential for ensuring the legitimacy of carbon projects. International principles such as Free, Prior, and Informed Consent (FPIC) emphasize the importance of involving affected communities in decision-making processes. Failure to incorporate these principles may generate social conflict, reduce community support, and undermine the long-term sustainability of climate mitigation initiatives [7].

Overall, Indonesia's carbon trading framework provides a promising legal foundation for supporting national emission reduction targets. Nevertheless, addressing regulatory fragmentation, strengthening carbon credit integrity, improving MRV systems, enhancing legal certainty, and ensuring environmental justice remain critical priorities. International experience suggests that successful carbon markets require not only economic incentives but also robust legal institutions capable of maintaining transparency, accountability, and public trust [20]. Therefore, continuous legal reform and institutional strengthening will be essential for ensuring that carbon trading contributes meaningfully to Indonesia's climate commitments and sustainable development objectives.

Regulatory Fragmentation and Institutional Coordination

One of the primary legal challenges concerns regulatory fragmentation among government institutions. Carbon trading is inherently cross-sectoral because it involves environmental protection, energy policy, forestry management, financial regulation, taxation, and international trade. Consequently, multiple ministries and government agencies possess overlapping responsibilities in regulating various aspects of the carbon market. While the Ministry of Environment and Forestry plays a central role in climate governance, other institutions such as the Ministry of Energy and Mineral Resources, the Ministry of Finance, the Financial Services Authority, and the Indonesia Stock Exchange also have regulatory interests in carbon market operations [21].

This institutional complexity creates the potential for overlapping authority, inconsistent policy implementation, and administrative inefficiencies. For example, differing interpretations regarding carbon credit ownership, carbon asset registration, or reporting requirements may generate legal uncertainty among market participants. Such uncertainty can discourage investment and limit market participation, particularly among private-sector actors seeking stable regulatory conditions. Moreover, fragmented governance structures may hinder effective monitoring and enforcement, reducing the overall effectiveness of the carbon trading system.

The challenge of institutional coordination is particularly relevant in Indonesia because climate mitigation efforts often involve both national and regional authorities. Many carbon offset projects are implemented in rural areas, forests, peatlands, and coastal ecosystems that fall under various layers of governmental jurisdiction. Without clear legal mechanisms for coordination, disputes regarding authority and benefit-sharing may emerge, potentially delaying project implementation and reducing investor confidence.

Carbon Credit Integrity and Environmental Credibility

Another significant challenge relates to the environmental integrity of carbon credits. The success of any carbon market depends on confidence that each carbon credit represents a

genuine, measurable, and additional reduction in greenhouse gas emissions. If carbon credits fail to reflect real environmental benefits, the entire purpose of carbon trading may be undermined.

International experience has demonstrated that carbon offset projects often face several methodological and legal concerns. One of the most frequently discussed issues is additionality. A project is considered additional only if the emission reduction would not have occurred without carbon market incentives. If a project would have been implemented regardless of carbon financing, issuing carbon credits may not result in actual environmental gains. Consequently, ensuring additionality requires rigorous legal standards and transparent assessment procedures [22].

Another concern is permanence. Certain carbon reduction activities, particularly forestry and land-use projects, may generate temporary rather than permanent emission reductions. For example, a forest restoration project may initially sequester significant amounts of carbon, but future deforestation, wildfires, or land conversion could release stored carbon back into the atmosphere. This possibility raises important legal questions regarding long-term responsibility, liability, and monitoring obligations [23].

Leakage also presents a substantial challenge. Leakage occurs when emission reduction activities in one location inadvertently increase emissions elsewhere. For instance, restricting logging activities in one forest area may simply shift deforestation pressures to another region. If leakage is not properly accounted for, reported emission reductions may overestimate actual environmental outcomes.

Furthermore, double counting remains one of the most critical concerns in international carbon markets. Double counting occurs when the same emission reduction is claimed by multiple entities, projects, or countries. Such practices can significantly distort emissions accounting and undermine international climate commitments. Preventing double counting requires comprehensive legal frameworks, transparent registries, and effective verification mechanisms capable of tracking carbon credits throughout their entire lifecycle.

Monitoring, Reporting, and Verification (MRV) Challenges

The effectiveness of carbon trading also depends heavily on the quality of Monitoring, Reporting, and Verification (MRV) systems. MRV serves as the foundation for determining whether claimed emission reductions are accurate, measurable, and verifiable. Without reliable MRV systems, carbon credits may lose credibility among investors, regulators, and international partners [24].

Developing an effective MRV framework presents significant legal and technical challenges for Indonesia. The country's vast geographical area, diverse ecosystems, and varying levels of institutional capacity create difficulties in collecting consistent and accurate emissions data. Monitoring emission reductions across thousands of islands, extensive forest landscapes, and numerous industrial facilities requires substantial financial resources, technological infrastructure, and skilled personnel.

From a legal perspective, MRV systems must be supported by clear regulations defining reporting obligations, verification standards, auditor qualifications, and enforcement mechanisms. Ambiguities in these areas may create opportunities for inaccurate reporting, manipulation of emissions data, or fraudulent carbon credit generation. Investors are unlikely to participate actively in carbon markets if verification procedures are perceived as weak or unreliable.

Additionally, the increasing internationalization of carbon markets means that Indonesian carbon credits must satisfy global standards. International buyers often demand high levels of transparency and accountability before purchasing carbon credits. Therefore, strengthening domestic MRV systems is not only a matter of regulatory compliance but also a strategic necessity for maintaining competitiveness in international carbon markets.

Legal Certainty and Market Confidence

Legal certainty represents another fundamental requirement for a successful carbon trading system. Investors, project developers, and market participants require predictable legal environments in order to make long-term financial commitments. However, carbon markets are relatively new in Indonesia, and several regulatory issues remain under development.

Questions regarding carbon rights ownership, dispute resolution mechanisms, taxation of carbon transactions, and contractual obligations continue to evolve. Unclear legal provisions in these areas may create uncertainty regarding the rights and responsibilities of market participants. Such uncertainty can increase transaction costs, discourage investment, and limit market growth [25].

Moreover, because carbon trading involves long-term environmental projects, regulatory stability is particularly important. Frequent policy changes or inconsistent enforcement may undermine confidence among domestic and international investors. Therefore, ensuring legal certainty should be viewed as a central component of carbon market governance rather than merely a technical legal issue.

Environmental Justice and Social Equity Concerns

Beyond economic and environmental considerations, carbon trading also raises important questions regarding environmental justice and social equity. Climate policies are often evaluated not only based on their effectiveness in reducing emissions but also on their impact on affected communities. In Indonesia, many carbon offset projects are located in areas inhabited by indigenous peoples, local communities, and rural populations whose livelihoods depend directly on natural resources [1,8].

Although carbon markets can generate economic opportunities, the distribution of benefits may not always be equitable. There is a risk that large corporations, financial institutions, or external investors may capture a disproportionate share of economic gains, while local communities receive limited benefits despite contributing significantly to conservation efforts. Such outcomes could exacerbate existing social inequalities and undermine public support for climate policies.

Another concern involves participation in decision-making processes. Environmental justice principles emphasize that affected communities should have meaningful opportunities to participate in decisions regarding projects implemented on their lands and territories. However, in practice, local participation may be limited by information asymmetries, unequal bargaining power, or inadequate consultation mechanisms [6,10].

The principle of Free, Prior, and Informed Consent (FPIC), widely recognized in international environmental and human rights law, is particularly relevant in this context. Ensuring that communities understand the implications of carbon projects and voluntarily agree to participate is essential for maintaining social legitimacy and preventing future conflicts. Consequently, legal safeguards protecting community rights should be integrated into carbon trading regulations to ensure that climate mitigation efforts contribute not only to environmental sustainability but also to social justice.

International Legal Harmonization

In the contemporary era of global climate governance, carbon markets no longer operate solely within national boundaries. Greenhouse gas emissions constitute a transboundary environmental problem, meaning that climate mitigation efforts in one country can have significant implications for other countries. Consequently, the effectiveness of national carbon trading systems increasingly depends on their compatibility with international legal frameworks and global carbon market standards. For Indonesia, international legal harmonization is not merely a regulatory preference but a strategic necessity for ensuring the credibility, marketability, and environmental integrity of its carbon trading system [10,13].

The legal foundation for international carbon market cooperation is primarily established through Article 6 of the Paris Agreement. This provision recognizes that countries may voluntarily cooperate in achieving their Nationally Determined Contributions (NDCs) through market and non-market mechanisms. Article 6 creates opportunities for countries to transfer internationally recognized carbon credits while maintaining accountability for their respective

emission reduction commitments. The provision seeks to encourage greater global ambition by enabling emission reductions to occur where they can be achieved most efficiently while preventing the risk of double counting.

For Indonesia, alignment with Article 6 is particularly important because the country possesses substantial carbon reduction potential through forestry conservation, peatland restoration, mangrove protection, renewable energy development, and sustainable land-use management. These resources position Indonesia as a potentially significant supplier of carbon credits in international markets. However, international buyers and investors increasingly demand assurance that carbon credits comply with internationally recognized standards and contribute to genuine emission reductions. Therefore, harmonization with global frameworks is essential for ensuring that Indonesian carbon credits remain competitive and credible in international transactions.

One of the most critical objectives of international harmonization is preventing double counting. Under international climate agreements, countries are required to account accurately for their emissions reductions. If the same carbon credit is counted simultaneously toward Indonesia's NDC and another country's climate commitment, the environmental integrity of the transaction is compromised. Such situations can undermine trust in carbon markets and weaken the effectiveness of global climate governance. Consequently, Indonesia must establish robust accounting systems that align with international reporting requirements and ensure transparency in carbon credit transfers [14,18].

International harmonization is also necessary for facilitating cross-border carbon transactions. Carbon markets rely heavily on investor confidence, and investors generally prefer jurisdictions with clear, predictable, and internationally compatible regulatory frameworks. If Indonesia's regulatory standards differ significantly from international norms, potential buyers may be reluctant to purchase Indonesian carbon credits due to concerns regarding legal uncertainty or environmental credibility. Harmonized regulations can reduce transaction costs, simplify compliance procedures, and increase market accessibility for domestic project developers [20-22].

Transparency and accountability represent additional dimensions of international harmonization. Global carbon markets increasingly emphasize rigorous standards for project validation, emissions monitoring, verification, and reporting. International stakeholders expect carbon credits to be supported by reliable scientific methodologies and independent verification processes. Therefore, Indonesia's regulatory framework must ensure that carbon credits generated domestically meet the transparency requirements expected by international markets. Such alignment can strengthen market confidence and enhance the country's reputation as a reliable participant in global climate initiatives.

The experience of the European Union Emissions Trading System (EU ETS) provides valuable lessons in this regard. As the world's largest and most mature carbon market, the EU ETS demonstrates the importance of robust regulatory institutions, centralized registries, standardized reporting systems, and strict compliance mechanisms. The European experience suggests that legal certainty and institutional transparency are fundamental prerequisites for maintaining market stability and environmental effectiveness. While Indonesia's socio-economic context differs significantly from that of the European Union, many of the underlying governance principles remain highly relevant.

Another important aspect of international legal harmonization involves balancing global standards with national interests. Although adopting international best practices can enhance market credibility, regulatory frameworks must also accommodate domestic development priorities and local conditions. Indonesia faces unique challenges related to economic development, energy transition, poverty reduction, and natural resource management. Consequently, harmonization should not be understood as simply replicating foreign regulatory models but rather adapting international principles to national circumstances while maintaining compliance with global climate commitments.

Ultimately, international legal harmonization represents a critical component of Indonesia's long-term climate strategy. By aligning domestic carbon trading regulations with

evolving international standards, Indonesia can strengthen environmental integrity, attract climate finance, facilitate international cooperation, and enhance its contribution to global emission reduction efforts. Such harmonization will not only support the achievement of national climate targets but also reinforce Indonesia's position as an active and responsible participant in international climate governance.

This study has several limitations that should be acknowledged when interpreting the findings. First, this research adopts a normative legal research approach that primarily focuses on the analysis of statutory regulations, legal principles, policy documents, and international legal instruments governing carbon trading in Indonesia. Consequently, the study does not empirically assess the actual implementation of carbon trading mechanisms in practice or quantitatively measure their direct contribution to greenhouse gas (GHG) emission reductions. The conclusions regarding regulatory effectiveness are therefore based on legal and doctrinal analysis rather than empirical observations derived from field studies or market performance data.

Second, the study relies predominantly on secondary legal materials**,** including legislation, government reports, international agreements, and academic literature. Although these sources provide a comprehensive understanding of the existing legal framework, they may not fully capture the dynamic realities faced by stakeholders involved in carbon market implementation, such as government agencies, private sector actors, project developers, and local communities. The absence of primary data obtained through interviews, surveys, or stakeholder consultations may limit the ability of this study to reflect practical challenges and institutional experiences encountered during policy implementation.

Third, Indonesia's carbon trading system remains at a relatively early stage of development. As a result, the availability of long-term implementation data, market performance indicators, and verified emission reduction outcomes remains limited. The evolving nature of carbon market regulations and institutional arrangements means that future legal and policy developments may significantly influence the effectiveness of the current framework. Consequently, some findings presented in this study should be interpreted within the context of an emerging and continuously evolving regulatory environment.

Fourth, although this research incorporates a comparative legal approach by examining selected international carbon market frameworks, the comparison is limited to several jurisdictions and may not comprehensively represent the diversity of global carbon trading experiences. Differences in legal traditions, economic structures, institutional capacities, and climate policy priorities among countries may affect the applicability of international best practices within the Indonesian context. Therefore, caution should be exercised when generalizing comparative findings or directly adopting foreign regulatory models.

Fifth, this study primarily evaluates carbon trading from a legal and governance perspective and does not comprehensively examine broader economic, social, or environmental dimensions, such as market competitiveness, distributional impacts, social justice concerns, indigenous community rights, or the cost-effectiveness of carbon pricing mechanisms. These dimensions are essential for understanding the overall sustainability and inclusiveness of carbon market policies and warrant further interdisciplinary investigation.

Finally, the study does not specifically analyze the potential implications of emerging international developments, including the operationalization of Article 6 of the Paris Agreement, cross-border carbon market linkages, and evolving global standards for carbon credit certification. Given the rapidly changing landscape of international climate governance, future regulatory developments may substantially influence Indonesia's domestic carbon trading system and its contribution to achieving national emission reduction targets.

Despite these limitations, this study provides a valuable legal assessment of Indonesia's carbon trading regulatory framework and offers important insights into the opportunities and challenges associated with utilizing market-based mechanisms to support national climate commitments. Future research is encouraged to employ empirical and interdisciplinary approaches to complement normative legal analyses and to generate a more comprehensive

understanding of the effectiveness of carbon trading in achieving sustainable climate governance.

CONCLUSION

Indonesia has established a significant legal foundation for carbon trading through Presidential Regulation No. 98 of 2021 and related climate policies. The regulatory framework reflects Indonesia's commitment to achieving its Nationally Determined Contribution targets and supporting sustainable development objectives. While carbon trading offers substantial opportunities to mobilize climate finance, encourage private-sector participation, and reduce greenhouse gas emissions, its effectiveness depends heavily on regulatory quality, institutional capacity, and market integrity.

The study concludes that carbon trading can become a valuable instrument for achieving national emission reduction targets if supported by robust governance, transparent verification systems, and alignment with international carbon market standards. Future legal reforms should focus on strengthening environmental integrity, enhancing accountability, and ensuring equitable distribution of benefits among stakeholders.

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