

Multistakeholder Collaboration in the Implementation of Green Technology: a Study of Public Policy in East Java

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ABSTRACT

Purpose – This study examines the implementation of green technology policy in East Java Province by analyzing the gap between regulatory commitments and implementation practices, as well as the factors shaping multi-actor collaboration in the adoption of green technology. The study also explores the relevance of a hexahelix-based collaborative governance approach for strengthening policy implementation at the local level.

Methodology – This study employed a qualitative research design using in-depth interviews, participatory observation, and document analysis. Data were collected from relevant actors involved in green technology policy implementation and analyzed through data triangulation to ensure the credibility of the findings.

Findings/Results – The findings indicate that the implementation of green technology policy in East Java is supported by political commitment and growing awareness among communities and businesses. However, implementation remains constrained by limited resources, institutional fragmentation, inadequate policy incentives, and socio-economic resistance, particularly among micro, small, and medium enterprises (MSMEs). These conditions demonstrate that policy implementation is shaped not only by regulatory and administrative factors but also by the quality of relationships and coordination among actors.

Originality/Value – This study extends the conventional policy implementation perspective by incorporating collaborative governance to explain the relational and institutional dimensions of multi-actor implementation. The findings highlight the relevance of a hexahelix-based collaborative governance framework to integrate government, business, academia, communities, media, and other relevant actors in addressing implementation barriers. The study contributes to the development of a more integrated and inclusive approach to green technology policy implementation and provides a framework for strengthening local-level collaboration toward sustainable development.

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1. Introduction

The transformation towards sustainable development today cannot be separated from the urgency of applying green technology as a strategic approach to addressing environmental crises, energy efficiency, and improving quality of life (Hariram et al., 2023). On one hand, technology innovation approaches are considered the key to the transition to a low-carbon economy (He et al., 2022; Mercure et al., 2019). Local governments, as actors in public policy, have the responsibility not only to formulate adaptive regulations but also to build collaborative models with the private sector, academia, and civil society to support the adoption of environmentally friendly technologies in a more systematic and sustainable manner. Globally, the debate on green technology revolves around the dilemma between economic growth and environmental sustainability.

On the other hand, several countries face criticism for still relying on market incentives that have not sufficiently driven structural changes. The issue of just transition also becomes an important discourse, where developing countries often find themselves in an unequal position in accessing technology and financing for green innovation (Monaco, 2023; Siciliano et al., 2021). In the global discourse on green technology and the implementation of public policy, experts have varied views, reflecting the complexity of issues that are not only technical but also social, economic, and political. Advocates of green technology policy generally believe that green technological innovation is a strategic tool in promoting sustainable development, mitigating climate change, and enhancing natural resource efficiency (D'Amato et al., 2021; G. Liu & Liang, 2024). Supporters refer to the argument that strict environmental regulations can indeed drive productivity and competitiveness in industries through sustainable innovation. According to Shah and Soomro (2021) proactively designed and integrated environmental policies can create incentives for industry players to adopt clean technologies, reduce waste, and strengthen corporate reputations. Furthermore, Wu et al. (2025) emphasizes that the success of adopting green technology is greatly influenced by the existence of an adaptive and collaborative policy system, involving cross-sector actors, including government, the private sector, civil society, and academia. With a multi-stakeholder governance approach, green technology is believed to be able to catalyze systemic transformation in environmental management and production.

Existing studies explain green technology primarily through technological innovation, environmental regulation, sustainability transitions, or stakeholder collaboration. However, an unresolved analytical problem remains regarding how implementation barriers particularly resource constraints, institutional fragmentation, weak coordination, limited social acceptance, and financing gaps can be addressed when authority and resources are distributed across multiple autonomous actors. Helix and innovation ecosystem approaches identify relevant actors and innovation relationships, while policy implementation frameworks identify factors affecting implementation, but the mechanisms connecting implementation failures with specific collaborative responses remain insufficiently integrated. This study addresses this gap by combining policy implementation and collaborative governance perspectives to explain how differentiated actor functions and collaborative mechanisms can respond to specific barriers to green technology implementation at the subnational level.

The formulation of this research problem is as follows: 1) How is the dynamics of public policy implementation in promoting the adoption of green technology in East Java Province? 2) What are the driving and hindering factors in the collaborative synergy between local government, the private sector, academia, and the community in the implementation of green technology? 3) How can an ideal collaborative governance model be developed to strengthen the effectiveness of public policies based on green technology in East Java? The selection of East Java Province as a research location has strategic significance considering that this area is one of the centers of national economic growth with a high level of urbanization and industrialization, making the challenges and opportunities for the implementation of green technology more complex and relevant for study. East Java also has a diversity of policy actors ranging from progressive local government, dynamic industrial sectors, to academic communities and civil society actively engaged in environmental issues, making it an ideal social laboratory to examine multistakeholder collaboration practices in public policy based on green technology.

2. Literature Review

2.1 Green technology and public policy

Nevertheless, there are also quite sharp criticisms regarding the effectiveness of green technology policies, particularly from public policy critics and economic development observers. The main criticism is directed at the tendency of environmental policies to be overly normative and not taking into account the structural conditions inherent in each country or region, such as fiscal capacity, institutional readiness, and social-political dynamics ([Kiss et al., 2022](#)). [Tereshchenko et al. \(2023\)](#) states that green technology policies implemented without considering the local context often end up with implementation failures or even create additional economic burdens, especially for small and medium-sized industries. The policy is considered to be elitist and more aligned with the interests of global actors or large economic players who have access to resources and advanced technology. Furthermore, criticism also comes from the perspective of equitable development, where green technology policies are seen as not fully accommodating aspects of inclusivity and grassroots participation, which in practice often find themselves in a position of being impacted without being involved in the formulation or evaluation processes of the policy. [Dai et al., \(2023\)](#) warns that without a democratically and accountably designed institutional framework, green technology policies are at risk of widening inequality and strengthening exclusive power structures.

2.2 Policy implementation

In Indonesia, the issue of implementing green technology still faces debates regarding the effectiveness of cross-sector policies and coordination among levels of government. Although there are regulations that govern sustainable development and new renewable energy, their implementation often encounters problems of policy inconsistency, overlapping authorities, and weak political will at the local level. The still sectoral approach weakens the synergy between strategic actors in the development of the green technology ecosystem at the local level ([Marín-González et al., 2022](#)). East Java Province, as one of the centers of national economic growth, faces serious challenges in adopting green technology into its public policies. Although there are several environmental initiatives such as waste management programs and clean energy, their implementation remains partial and is not yet fully integrated into the framework of regional development planning. Collaboration between local

governments, industry, academia, and the community has not achieved optimal synergy, particularly in terms of policy coordination, innovation incentives, and strengthening institutional capacity (Salvador & Sancho, 2021).

Theoretically, policy literature often emphasizes the importance of green technological innovation as an instrument to achieve sustainable development, yet there is still no comprehensive consensus on the most effective governance model to integrate this technology into public policy systems, particularly at the subnational level. Debates arise between normative and regulatory top-down approaches, and participatory and collaborative bottom-up approaches, in promoting the systemic adoption of green technologies (Radtke, 2025). Additionally, classic policy implementation theories such as the Van Meter and Van Horn model still face limitations in explaining the dynamics of actors and collaborative networks in the context of complex environmental policies, which are more suitably analyzed through the perspective of collaborative governance or policy network theory (Ridho et al., 2023).

Empirically, various policies that support the implementation of green technology in the region are often hindered by institutional fragmentation, low coordination among stakeholders, weak bureaucratic capacity, and minimal incentives for the private sector to innovate. Green technology policies tend to be symbolic or programmatic without a mature and contextual implementation strategy, thus failing to significantly impact behavioral transformations or environmentally friendly production systems (Adamowicz, 2022). This problem becomes even more complex when there is no strong collaborative mechanism between local governments, businesses, academia, and the community, which should be key in building a green innovation ecosystem. The absence of integration between empirical evidence and policy formulation also serves as a barrier to evidence-based policy, leading to the implementation of policies that are reactive and not adaptive to long-term sustainability challenges.

3. Methodology

3.1 Research Design and Approach

This research uses a qualitative approach aimed at deeply understanding the dynamics of public policy implementation in promoting the adoption of green technology at the local level through multistakeholder collaboration practices. This approach is chosen because it is capable of capturing complex social and institutional realities, as well as allowing for the exploration of meanings, motivations, and power relations underlying the policy formulation and implementation processes. The qualitative method is deemed appropriate for revealing contextual dynamics that cannot be explained quantitatively, especially in the context of public policies involving multiple actors and negotiation processes among interests (Putra, 2023).

3.2 Data Collection and Analysis

The data collection technique is conducted through three main methods, namely interviews, observations, and documentation (Jain, 2021). In-depth interviews are conducted with stakeholders directly involved in the formulation and implementation of green technology policies, such as local government officials, academics, industry players, and representatives of civil society. Data analysis was conducted using a hybrid coding approach that combined deductive and inductive thematic analysis. Deductive coding was guided by the policy implementation framework of Van Meter and Van Horn and the collaborative governance

perspective, while inductive coding allowed new themes to emerge from participants' experiences that were not fully captured by the theoretical framework. The coding process involved data familiarization, open coding, categorization, theme development, and interpretation through constant comparison across data sources.

3.3 Analytical Framework and Validation

The two frameworks were integrated sequentially in data collection and analysis. Van Meter and Van Horn's variables policy objectives, resources, implementing agency characteristics, implementer disposition, inter-organizational communication, and socio-economic and political conditions were used to identify implementation conditions and barriers. Collaborative governance dimensions were then used to examine how these barriers were addressed through actor participation, shared decision-making, resource exchange, knowledge coordination, trust, and mutual accountability. These dimensions informed the interview guide by directing questions toward both implementation constraints and cross-actor responses. During analysis, the Van Meter and Van Horn variables served as first-order deductive coding categories, while collaborative governance mechanisms formed second-order categories explaining interactions among actors. Inductive codes were retained for empirical themes not captured by either framework. Interpretation subsequently linked identified implementation barriers with the collaborative mechanisms through which government and non-government actors could address them.

To enhance methodological rigor, emerging codes and themes were reviewed iteratively until conceptual consistency was achieved. Differences in interpretation were resolved through repeated examination of interview transcripts and comparison with documentary evidence and field observations. Data triangulation was conducted by systematically comparing interview findings with policy documents, institutional reports, and observational notes to identify convergent, complementary, and divergent evidence. This process strengthened the credibility, dependability, and transferability of the findings by ensuring that the final themes reflected multiple sources of empirical evidence rather than a single perspective.

3.4 Informant Selection and Triangulation

The technique for determining informants is carried out through purposive sampling, which is the intentional selection of informants based on specific criteria deemed to have knowledge, experience, and authority on the issue being researched (Lokot, 2021). This technique is used because not all individuals have relevance or access to the information needed in the research on green technology policies. Some of the research informants will be presented as follows in Table 1:

Table 1. Research informant

No	Informant's Name	Position
1	YBW	Chairman of Commission A of the Surabaya Regional House of Representatives
2	BA	Head of the Environment Agency of Sidoarjo Regency
3	DP	Deputy Director of PT Trufindo Asta Mandiri

4	AT	Chef Aria Centra Hotel
5	FN	Representative of the East Java Provincial Library Service
6	DK	Representative of the East Java Provincial Health Office
7	RS	BPD HIPMI East Java Industry Sector

Source: Author's own work

This study uses data triangulation analysis techniques, which involve comparing and confirming data obtained from various sources (interviews, observations, documentation) as well as from different types of informants. Triangulation is carried out not only to verify the truth of the information but also to reveal the diversity of perspectives that arise in policy practice ([Campbell et al., 2020](#)).

4. Result and Discussion

4.1 Implementation of public policy on green technology in east java

The implementation of public policy is a dynamic process that reflects how policies that have been formulated are executed within specific social, political, and administrative contexts. Within the framework of implementation theory according to [Van Meter and Van Horn \(1975\)](#), there are six main indicators that influence the effectiveness of policy execution, namely: 1) Size and objectives of the policy; 2) Resources; 3) Characteristics of the implementing agency; 4) Disposition or attitudes of the implementers; 5) Inter-organizational communication; and 6) Social, economic, and political conditions surrounding the implementation. These six indicators serve as the foundation for analyzing how green technology policies are implemented in the East Java region.

Based on an interview with YBW, the Chair of Commission A of the Surabaya City DPRD, it is known that the size and objectives of the policies promoting the adoption of green technology are still macro and normative in nature, with the formulation of a vision that has not fully been translated into operational indicators at the regional device level. The informant stated that:

"Environmental policies in big cities like Surabaya often rely on national spirit, but have not yet been specifically translated into measurable cross-sector programs." (The interview was conducted on May 8, 2025)

This indicates that there is a gap between policy design and implementational instruments at the technical level. In terms of resources, the Head of the Environmental Agency of Sidoarjo Regency acknowledges that the implementation of green technology-based programs heavily depends on budget availability and human resource capacity. The informant stated that:

"Many technology or renewable energy-based waste management programs cannot continue due to limited maintenance budgets and the lack of training for technical staff in the field." (Interview conducted on June 28, 2025)

This statement reinforces the finding that the implementation of green technology in the region often encounters financial and institutional challenges that are not yet established. From the perspective of the characteristics of the implementing institution, FN from the East

Java Provincial Library provides an illustration that not all government agencies have an understanding and clarity of roles in supporting green technology policies. The informant stated that:

“Cross-agency support has not been structured, so that environmentally friendly initiatives only emerge from agencies that have a direct affinity with environmental issues.” (Interview conducted on July 4, 2025).

This reflects the weak coordination between agencies and the lack of cross-sector integration in implementing the policy comprehensively. The disposition or attitude of policy implementers is an important indicator in promoting the effectiveness of implementation. In an interview with DK from the East Java Provincial Health Office, it was revealed that there is enthusiasm for reducing carbon emissions in healthcare facilities. However, the realization is still limited due to the absence of SOPs or technical regulations directing the systematic use of environmentally friendly technologies in the health sector. The informant stated that:

"Although there is enthusiasm from the leadership, the lack of technical regulations and training has made green initiatives not a primary policy in healthcare institutions." (Interview conducted on July 5, 2025)

Meanwhile, from the business perspective, DP, Deputy Director of PT Trufindo Asta Mandiri, stated that the collaboration between local governments and the industrial sector in the implementation of green technology is still sporadic. The source mentioned that:

"We are willing to invest in environmentally friendly production systems, but there are no incentive policies or long-term partnership mechanisms that support the sustainability of these innovations." (Interview conducted on July 17, 2025)

This statement indicates that the weakness of communication between organizations and the absence of a collaborative ecosystem are obstacles in building synergy between the public and private sectors. The representative from BPD HIPMI East Java Industrial Sector also added that the economic conditions and bureaucracy in several regions are still the main barriers to the adoption of green technology. The informant emphasized that:

“Many industry players at the MSMEs do not have access to information or regulatory support to adopt environmentally friendly technology, thus green technology is still considered expensive and elitist.” (Interview conducted on July 18, 2025)

This reality affirms the importance of local social and economic contexts in formulating inclusive and adaptive implementation strategies. Lastly, an interview with AT, a chef from Aria Centra Hotel, provides a perspective from the hospitality sector, where awareness of environmental issues is quite high, but environmentally friendly initiatives have not received formal recognition from the local government. The informant stated that:

“Several hotels in Surabaya have started to reduce plastic usage and utilize water treatment systems, but there are no forms of incentives or awards from the government that encourage consistency in innovation.” (The interview was conducted on July 19, 2025)

This indicates that the lack of feedback from the policy system hinders both moral and institutional incentives for non-government actors who have been striving to adopt green practices. This discussion shows that the implementation of green technology policy in East

Java still faces various structural, procedural, and relational obstacles. Despite the enthusiasm and potential from various actors, limitations on six implementation indicators according to Van Meter and Van Horn indicate the need for a reformulation of a more participatory, integrated, and locally responsive implementation strategy. Thus, a collaborative governance model becomes an important agenda in the next stages to ensure that public policies do not merely remain at the rhetorical level but can be operationalized effectively through sustainable intersectoral synergy.

The implementation of public policy on green technology in East Java reflects the complex dynamics between the vision of sustainable development and social, political, and economic realities at the regional level. Public policy literature emphasizes that the effectiveness of policy implementation is greatly influenced by how well policy objectives can be translated into operational technical instruments, institutional capacity, and support from cross-sector actors involved in the process (Van Meter & Van Horn, 1975). In the context of East Java, policies related to green technology often remain at the normative stage, leading to a gap between regulatory design and practical realization on the ground. Theoretically, the success of green technology implementation is closely related to a collaborative governance model. Leal Filho et al. (2025) emphasizes that a multi-stakeholder governance approach can serve as a catalyst for systemic transformation because it is capable of integrating government, the private sector, academia, and civil society into an environmental innovation ecosystem. This aligns with the theory of collaborative governance, which views the implementation of public policy not merely as a top-down hierarchical relationship, but as an arena of interaction among networks of actors that mutually influence each other in achieving collective goals (Wang & Ran, 2023). However, as reminded by Jacob and Ekins (2020) the absence of an inclusive institutional design can actually widen disparities in access to environmentally friendly technology and pose exclusivity risks in policy.

The implementation of policies in East Java shows that budget limitations, low bureaucratic capacity, and weak coordination among implementing agencies remain major obstacles. Information obtained from interviews with local officials and industry players indicates a spirit of adopting green technology, but this spirit has not been supported by incentive mechanisms, technical regulations, or adequate human resource capacity strengthening. This is in line with findings Tereshchenko et al. (2023) that state that green technology policies that do not consider the local context tend to fail in implementation, even creating an additional burden for MSMEs. In addition, socio-economic factors also play a significant role. Many small industries in East Java still view green technology as something expensive and exclusive, leading to resistance due to a lack of access to information, financing, and technology that suits their needs. The literature on equitable development emphasizes the importance of the just transition principle in environmental policy, which ensures that small and grassroots communities also benefit from the green technology transformation without bearing disproportionate burdens. In the context of East Java, this underscores the need for more adaptive and participatory policies so that the transition to environmentally friendly technology does not widen socioeconomic gaps at the local level.

4.2 Driving and hindering factors of collaborative synergy

The driving and hindering factors in collaborative synergy for the implementation of green technology policies in East Java cannot be separated from the surrounding institutional,

political, and socio-economic dynamics. On one hand, there are several driving factors that offer hope for the success of multistakeholder collaboration. The presence of political commitment at the regional level, although still partial, is one of the important elements that signifies the government's awareness to integrate environmental issues into the development agenda. Several initiatives, such as technology-based waste management programs and carbon emission reduction in the health sector, demonstrate the enthusiasm of public actors to support the green agenda (Y. Zhang et al., 2019). This factor aligns with the view Shao et al., (2020) that emphasizes that proactively designed environmental regulations can create structural incentives for both the industrial sector and society to innovate, while also strengthening institutional reputation and competitiveness.

In addition to political commitment, another factor driving synergy is the collective awareness among the business world and civil society regarding the urgency of maintaining environmental sustainability (Hariram et al., 2023). This is reflected in the involvement of the hospitality sector and certain industries in East Java that voluntarily implement environmentally friendly practices, even though they have not received formal incentives from the local government. This awareness reflects the process of internalizing sustainability values that is beginning to develop at the local level, a condition that can encourage competitive innovation when the regulatory and market environments are managed properly. Cross-sector collaboration becomes more effective when public and non-public actors align their interests, resources, and sustainability objectives. Such alignment enables collaborative arrangements to move beyond symbolic participation toward coordinated innovation and implementation of green technologies (Derks et al., 2022; Fusillo et al., 2022). Nevertheless, various structural, institutional, and cultural obstacles still dominate the dynamics of green technology policy implementation in East Java. One of the main barriers is the limited resources, both in terms of funding and the technical capacity of the bureaucracy. Interviews with local officials show that many green technology-based programs have stalled due to inadequate maintenance budgets and a lack of training for technical personnel.

This finding is consistent with the research results Amankwah-Amoah and Syllias (2020) which emphasize that the failure to implement green policies often occurs when local fiscal and institutional capacities are not balanced with the burden of the adopted programs. Furthermore, weak coordination among government organizations becomes a significant barrier to achieving synergy. Information from the East Java Library Service indicates that cross-agency support is not structured, leading to environmental programs being conducted in a sectoral manner without comprehensive integration. This condition is similar to findings from the study Jensen et al., (2020) which show that institutional fragmentation can reduce the effectiveness of environmental policies because each actor tends to maintain their sectoral authority. The absence of adequate formal coordination mechanisms ultimately hinders the creation of a solid collaborative ecosystem (Li et al., 2024; S. Liu et al., 2025).

In addition to institutional factors, socio-economic dimensions also serve as significant obstacles. Most actors in the MSMEs in East Java still consider green technology to be an expensive, elitist investment that is less relevant to their production needs. This leads to a very low adoption rate among MSMEs, which tends to be stagnant. These findings resonate with the just transition discourse proposed by Green & Gambhir (2020) indicating that transition policies towards a low-carbon economy risk widening inequalities if not accompanied by

financing support, technology transfer, and grassroots community participation. In this context, green technology policies in East Java still face serious challenges in ensuring accessibility and inclusivity for smaller actors who are actually the backbone of the regional economy. The debate in the literature also shows a tug-of-war between optimism towards the potential for multistakeholder collaboration and pessimism due to inherent structural barriers. On one hand, literature such as [Fusillo et al., \(2022\)](#) and [Derks et al., \(2022\)](#) believes that collaboration can create collective incentives that accelerate the transition to green technology. However, on the other hand, without institutional improvements and an adaptive local context, collaboration can be symbolic, elitist, or even impose an economic burden on the most vulnerable groups ([Bozic, 2021](#)). This difference in perspective reinforces the argument that the analysis of green technology implementation must be placed within a framework that is not only normative but also empirical, taking into account the unique contextual dynamics in each region.

The driving and inhibiting factors of collaborative synergy in green technology policies in East Java illustrate the duality between opportunities and challenges. Opportunities arise from political commitment, collective awareness, and the potential for integrating sustainability values, while challenges stem from limited resources, institutional fragmentation, and socio-economic resistance among small industries. Both theoretical debates and empirical findings from various studies indicate that the success of collaborative synergy is heavily determined by the ability of public policy to establish institutional designs that are inclusive, responsive, and adaptive to local contexts ([Bryson et al., 2020](#); [Costumato, 2021](#)). Therefore, strategic efforts are needed to strengthen collaborative governance that can address barriers while maximizing driving factors to support the implementation of green technology in East Java. The social consequences of the presence of driving and inhibiting factors in the implementation of green technology policies in East Java are very significant. On one hand, the presence of driving factors such as political commitment, collective awareness, and participation from the private sector and civil society can strengthen social inclusivity and build a culture of sustainability at the local level ([Sénit, 2020](#); [Van Niekerk, 2020](#)). If these factors are consistently developed, the community will find it easier to accept transformative environmentally friendly behaviors, such as waste management, energy efficiency, and sustainable consumption patterns. However, on the other hand, inhibiting factors such as weak institutional coordination and limited resources have the potential to create policy exclusivity. The lower-middle-class society, especially MSMEs are often not substantially involved in the policy formulation process, causing green policies to be perceived as an additional burden. This inequality of participation risks widening the social gap between groups that are able to adopt green technology and those that are left behind due to limited access ([Al-Emran & Griffy-Brown, 2023](#); [Sovacool et al., 2022](#)). Thus, non-inclusive policies have the potential to create social resistance and hinder the formation of collective solidarity in the transition towards sustainability.

From an economic perspective, driving factors such as the existence of innovation opportunities in the industrial sector and potential global competitiveness can pave the way for growth in the green technology-based economy. If not addressed with adaptive policy design, the consequence is the hindrance of green economic diversification as well as the potential loss of international investment opportunities that increasingly require sustainable practices as a global standard ([Lee et al., 2023](#); [Ning et al., 2023](#)). The hospitality sector, large

industries, and multinational companies in East Java have the opportunity to improve energy efficiency and reduce long-term production costs through investments in environmentally friendly production systems. Strict regulations can actually spur innovation and enhance competitiveness. However, inhibiting factors such as fiscal limitations, minimal incentives, and the perception of green technology as expensive among MSMEs can lead to contradictory economic consequences. MSMEs that are unable to adapt risk losing competitiveness and becoming trapped in a cycle of technological backwardness. In the short term, this imbalance can create additional cost burdens that do not match the direct benefits obtained, thus slowing down the pace of green technology adoption at the local level.

The future consequences of this condition place East Java at a strategic crossroads. If the driving factors are strengthened through collaborative governance, capacity building of the bureaucracy, and the provision of inclusive incentives, then East Java can become a model green province that not only supports economic growth but also guarantees social justice in the energy transition. Successful multistakeholder collaboration can stimulate local innovations, expand green jobs, and significantly reduce the regional carbon footprint. On the contrary, if the inhibiting factors remain dominant, then the future of green technology in East Java has the potential to stagnate. Policy fragmentation, social-economic resistance, and limited access will slow down the achievement of sustainable development targets. In the worst-case scenario, green policies would only be symbolic, not implemented substantively, and East Java risks being left behind in the global competition towards a low-carbon economy.

4.3 Collaborative governance model for green technology

The model of collaborative governance of green technology fundamentally needs to bridge the interests of various different yet interconnected actors within the framework of sustainable development. So far, the triple helix concept, which emphasizes the interaction between government, industry, and academia, has often been used as a basis for developing innovation policies (Carayannis et al., 2022; Zadeگان et al., 2025). However, the development of public governance discourse indicates that this approach does not fully capture the complexity of actors in the green policy ecosystem. Therefore, the hexahelix concept becomes more relevant as it not only involves the three main actors but also expands the roles of civil society, media, and financial institutions or supporting communities as integral parts of strengthening the implementation of green technology.

Collaboration among a larger number of actors does not automatically produce effective or inclusive policies. It may create coordination costs, overlapping authority, elite domination, unequal access to information, financial dependence, symbolic participation, and unclear accountability. For this reason, the hexahelix model requires clearly defined roles, transparent decision-making procedures, mechanisms for managing conflicts of interest, accessible financing schemes, performance indicators, and joint monitoring arrangements. The analytical differences between the existing helix models and the proposed framework are presented in Table 2:

Table 2. Comparasion of existing helix models and the proposed hexahelix model

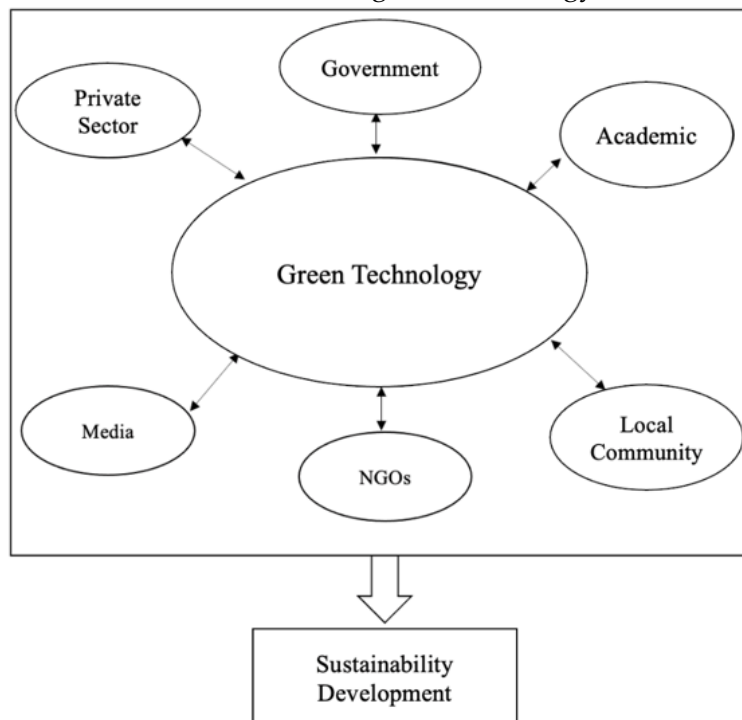
Model	Main Actors or Dimensions	Primary Analytical Focus	Main Contribution	Expected Governance Outcome	Main Limitation or Governance Risk
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Triple Helix	Government, industry, and academia	Knowledge production, technological innovation, and commercialization	Explains how regulation, research, and business interact to produce innovation	Increased innovation capacity, technology transfer, and industrial competitiveness	Tends to underrepresent community interests, social legitimacy, public communication, and financing inequality
Quadruple Helix	Government, industry, academia, and civil society or users	Socially responsive and user-oriented innovation	Introduces public participation, user knowledge, and societal acceptance into the innovation system	Greater responsiveness, social relevance, and acceptance of innovation	Participation may remain consultative or symbolic; power asymmetries between institutional actors and communities may persist
Quintuple Helix	Government, industry, academia, civil society, and the natural environment	Innovation aligned with ecological sustainability	Integrates environmental sustainability into knowledge and innovation systems	Ecologically oriented innovation and stronger alignment with sustainable development	The environment is a systemic dimension rather than an accountable organizational actor; financing and communication mechanisms remain insufficiently specified
Proposed Hexahelix	Government, industry, academia, civil society, media, and financial institutions	Collaborative implementation of green technology through regulation, innovation, legitimacy, communication, and financing	Connects innovation governance with public accountability, social inclusion, agenda setting, and resource mobilization	More integrated, inclusive, financeable, and publicly accountable green technology implementation	Higher coordination costs, fragmented accountability, media distortion, financial exclusion, conflict of interest, and potential domination by powerful actors

Source: Data processed by Author (2026)

The novelty of the proposed model lies not merely in expanding the number of actors, but in integrating their distinct functions into a corrective governance mechanism for green technology policy implementation. Unlike conventional helix models, which primarily emphasize knowledge production and innovation among government, industry, academia, and society, the proposed model explicitly incorporates media as an agenda-setting and public communication actor and financial institutions as providers of resource mobilization and risk-sharing. Compared with the innovation ecosystem approach, which focuses on interdependence among actors in generating innovation, this model places greater emphasis on policy implementation and public accountability. Unlike policy network models that primarily explain patterns of interdependence and resource exchange, the proposed framework specifies how these relationships address concrete implementation failures. It also extends collaborative governance by assigning differentiated institutional functions to six actors. Therefore, the model connects policy implementation barriers with specific collaborative mechanisms, including co-financing, joint decision-making, knowledge transfer, participatory co-design, integrated monitoring, and inclusive financing. If these six actors collaborate within an inclusive governance framework, the implementation of green technology in East Java can move from a normative level to substantive and measurable practices. This model emphasizes that collaboration is not merely administrative coordination but must be realized in the form of mutually reinforcing interaction networks. For example, academic research on renewable energy innovation will only be meaningful if there are industries that adopt it, communities that accept it, media that disseminate it, governments that facilitate its regulations, and financial institutions that fund it. This synergy is the core of collaborative governance based on the hexahelix. Next, the hexahelix model will be reviewed in conjunction with the concept of green technology as follows:

Figure 1. Combination of hexahelix and green technology



Source: Data processed by the author (2025)

Figure 1 shows that green technology becomes the focal point connecting six strategic actors. Academics are positioned at the top as sources of knowledge and innovation. The media and industry play roles on the left and right sides, representing the functions of communication and technology implementation. The government and civil society are placed below to emphasize the balance between regulation and social acceptance. Financial institutions are positioned at the base as the foundation supporting the entire process with sustainable financing support. This position is dynamic, where each actor does not work linearly, but instead forms a network that enables mutual exchange of resources, information, and legitimacy.

The adjustment of the hexahelix model in the context of green technology in East Java has important implications. First, the model emphasizes the importance of democratic and participatory governance, so that green policies are not elitist and can be accessed by all groups, including MSMEs and grassroots communities. Second, the presence of media and financial institutions strengthens the sustainability dimension because public awareness will continue to be built through constructive narratives, while the financial aspect is secured through inclusive financing mechanisms. Third, this model positions green technology not as an economic burden, but as a joint innovation arena that can drive green economic growth and create new job opportunities in the future.

Media and financial institutions should be treated as independent governance actors because they possess distinct resources, authority, and mechanisms of influence that cannot be fully represented by government, industry, academia, or civil society. Media influences implementation through agenda-setting, information dissemination, public awareness, and accountability mechanisms, thereby shaping public legitimacy and social acceptance of green technology policies. Financial institutions operate through resource mobilization, credit allocation, investment decisions, and financial risk-sharing, which directly determine whether green technologies are economically accessible and scalable, particularly for MSMEs. Their influence is therefore not merely supportive. Media reduces information and legitimacy gaps between policy actors and the public, while financial institutions address resource and investment constraints that limit technological adoption. Treating both as autonomous actors enables the proposed hexahelix model to explain how communication, legitimacy, financing, and risk allocation translate collaborative interaction into concrete policy implementation outcomes.

The findings therefore support the development of a hexahelix collaborative governance model, not simply because more actors need to be involved, but because each implementation failure requires a specific combination of resources and institutional functions. The analytical themes provide an empirical basis for linking implementation barriers with corrective collaborative mechanisms, thereby strengthening the explanatory depth of the study. The study therefore extends policy implementation analysis by linking implementation variables with corrective governance mechanisms. Resource constraints are linked to resource pooling and co-financing; communication problems are linked to joint decision-making and integrated monitoring; technical capacity deficits are linked to knowledge transfer and policy experimentation; weak social acceptance is linked to participatory co-design; and low technological adoption is linked to coordinated incentives and inclusive financing. This theoretical integration allows the hexahelix model to explain not only the actors involved in

green technology policy, but also the causal mechanisms through which their collaboration may improve implementation outcomes.

Discussion

The results of this study show that the implementation of green technology policies in East Java is still facing structural, institutional, and socio-economic constraints, despite growing political commitment and collective awareness at the local level. This theoretical integration enables the analysis to identify both the conditions affecting policy implementation and the collaborative mechanisms through which implementation constraints can be addressed (Calliari et al., 2019; Pfisterer & Van Tulder, 2020). These findings indicate that the green technology agenda in the region has not fully transformed from normative discourse into measurable practices, particularly due to weak coordination between institutions, budget constraints, and a lack of incentive mechanisms for MSMEs. On one hand, this condition affirms the policy implementation theory of Van Meter and Van Horn (1975) the framework effectively identifies key implementation dimensions, including policy objectives, resources, implementing agencies, implementer disposition, inter-organizational communication, and external conditions. However, it provides limited explanation of how autonomous actors negotiate shared goals, mobilize resources, coordinate knowledge, manage conflicts, and establish mutual accountability when implementation extends beyond formal government structures. Therefore, this study supplements the implementation framework with collaborative governance theory to explain these relational and institutional mechanisms.

These findings position collaborative governance as an institutional response to implementation failure rather than merely a participatory ideal. While the Van Meter and Van Horn framework identifies key implementation variables, collaborative governance explains how weaknesses in resources, communication, capacity, and legitimacy can be corrected through shared goals, resource exchange, knowledge coordination, and mutual accountability. In East Java, this requires decision-making forums, integrated monitoring, joint financing, and collaboration among government, industry, academia, civil society, media, and financial institutions. The hexahelix model therefore provides a causal explanation of how collaboration can improve policy implementation. Resource constraints can be addressed through co-financing, communication problems through joint decision-making, capacity gaps through knowledge transfer, and low adoption through coordinated incentives and inclusive financing. However, collaboration may reproduce inequality when power and resources are unevenly distributed. Its effectiveness therefore depends on transparent participation rules, balanced representation, conflict-of-interest management, measurable performance indicators, and independent evaluation.

Proactive environmental policies can create incentives for innovation and enhance the industry's reputation (Mulaessa & Lin, 2021; Quintana-García et al., 2022). However, research findings in East Java indicate that structural incentives are still minimal, so despite the willingness of the industrial sector to invest in green technology, the lack of technical regulations and long-term support hinders the sustainability of implementation. This difference shows that the success of adopting green technology is highly contextual and cannot be separated from the institutional design that applies in a particular region (Skafi et al., 2020). Furthermore, the results of this study resonate with the findings of Topping et al. (2020) which emphasize the failure of green policies when local contexts are not taken into account. As

found in East Java, many MSMEs still perceive green technology as something elitist and expensive, limiting its adoption to larger actors with more established access to technology and resources. This comparison reinforces the argument that public policies not accompanied by the principle of just transition have the potential to exacerbate socio-economic inequality, as a small group becomes the most burdened by the costs of the green transition.

Another interesting finding is the role of the non-governmental sector, particularly civil society and the service industry such as hospitality, which shows a high level of awareness regarding environmental issues without any formal incentives from the local government. This phenomenon contrasts with the research results [Zhang et al. \(2020\)](#) that emphasize that the adoption of green technology is greatly influenced by the existence of adaptive and collaborative policy systems. The case in East Java instead demonstrates that grassroots and private initiatives can emerge sporadically even without full support from the regulatory system. However, this also highlights limitations, as without institutional support, such practices struggle to develop into sustainable systemic transformation.

From the perspective of collaborative governance, this study found that institutional fragmentation remains a major obstacle, consistent with findings [Pavlović \(2020\)](#) that highlight the risks of policy exclusivity when institutional designs are not democratic and accountable. However, unlike that research, the findings in East Java also indicate a significant potential from the integration of the hexahelix model that involves the roles of media and financial institutions. These two actors have often been overlooked in previous literature, but the results of this study show that both can play a significant role in strengthening public awareness and access to financing for MSMEs to adopt environmentally friendly technologies.

This discussion emphasizes that the success of green technology implementation is largely determined by the balance between driving and inhibiting contextual factors. Research in East Java enriches public policy literature by showing that despite political commitment and public awareness, weak institutional coordination and minimal incentives remain the main barriers. Comparisons with other studies show that the adoption of green technology cannot be understood solely from a normative perspective on regulation or incentives, but must be analyzed more holistically through the lens of collaborative governance that places various actors in dynamic and mutually reinforcing relationships.

5. Conclusion and Suggestion

This research shows that the implementation of green technology policies in East Java still faces gaps between regulatory design and implementation practices. The analysis results based on the Van Meter and Van Horn implementation model indicate that policy goals have not been fully translated into operational indicators, budgetary resources and bureaucratic capacity remain limited, and inter-organizational coordination operates in a sectoral manner. Driving factors such as political commitment, collective awareness of society and the business world, as well as grassroots initiatives demonstrate the potential for a green transition in the region. However, inhibiting factors such as institutional fragmentation, minimal incentives for the private sector, and the perception of the high cost of green technology among MSMEs indicate that green policies are at risk of being exclusive and have not been socially and economically inclusive. The hexahelix model developed in this study offers a more comprehensive collaborative governance framework involving six main actors, namely the government, industry, academia, society, media, and financial institutions. This model is

expected to strengthen inter-sectoral synergy and serve as an implementable strategy to promote sustainable development. By placing green technology at the center of interaction, this research emphasizes the importance of participatory, adaptive, and responsive governance to local dynamics. However, this study has limitations in terms of the scope of the study area, focusing on East Java, so its results cannot yet be generalized to the national context.

6. Limitations and Future Research

Additionally, this research relies on a qualitative approach with a limited number of informants, leaving room to expand the empirical database through quantitative or comparative approaches across regions. For future researchers, it is important to conduct comparative studies between provinces to see the variations in the implementation of green technology policies in various socio-political contexts. For academics, the development of a theoretical framework for collaborative governance needs to be expanded by integrating the perspectives of a just transition and green financing innovation. For the government, a reformulation of more inclusive policies is needed by strengthening incentives for the private sector, providing access to financing for MSMEs, and ensuring more substantial civil society participation in both policy formulation and evaluation. With these steps, green technology-based public policy in East Java can evolve from normative discourse to concrete, inclusive, and sustainable implementation.

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