http://dx.doi.org/10.18623/rvd.v22.n4.3583

A RE-ACTIVE APPROACH TO DESIGNING GREEN ECONOMY POLICIES: EVIDENCE FROM SUSTAINABLE MINING CONCESSIONS IN INDONESIA

UMA ABORDAGEM REATIVA PARA O DESENVOLVIMENTO DE POLÍTICAS DE ECONOMIA VERDE: EVIDÊNCIAS DE CONCESSÕES DE MINERAÇÃO SUSTENTÁVEL NA INDONÉSIA

Article received on: 7/21/2025
Article accepted on: 10/27/2025

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The authors declare that there is no conflict of interest

Abstract
Purpose: This study aims to develop and validate a Green Economy (GE) policy model for sustainable mining concessions in Indonesia through the novel RE-ACTIVE methodology, ensuring both contextual feasibility and policy relevance. Design/methodology/approach: The research adopts a mixed-method approach framed by the RE-ACTIVE steps (Research–Analyze–Construct–Test–Implement–Validate–Evaluate). Data were collected through document review, surveys, field observations, interviews, and Focus Group Discussions (FGDs) with Pentahelix stakeholders, representing government, industry, academia, civil society, and media. Benchmarking was conducted with mining regions in Kendari and East Kalimantan to identify best practices. Findings: The prototype model consists of six core components: local regulation, green audit system, transformational CSR, territorial revitalization, monitoring, and periodic evaluation. Empirical testing with a partner mining company demonstrated improvements in

Resumo
Objetivo: Este estudo visa desenvolver e validar um modelo de política de Economia Verde (EV) para concessões de mineração sustentáveis na Indonésia por meio da metodologia inovadora RE-ACTIVE, garantindo tanto a viabilidade contextual quanto a relevância política. Metodologia/abordagem: A pesquisa adota uma abordagem de métodos mistos, estruturada pelas etapas do RE-ACTIVE (Pesquisa–Análise–Construção–Teste–Implementação–Validação–Avaliação). Os dados foram coletados por meio de revisão de documentos, questionários, observações de campo, entrevistas e Grupos Focais (GFs) com as partes interessadas da Pentahelix, representando governo, indústria, academia, sociedade civil e mídia. Foi realizado um benchmarking com regiões de mineração em Kendari e Kalimantan Oriental para identificar as melhores práticas. Resultados: O modelo protótipo consiste em seis componentes principais: regulamentação local, sistema de auditoria verde, RSC transformacional, revitalização territorial, monitoramento e avaliação periódica. Testes empíricos com uma

ESG indicators, eco-efficiency, green innovation, and stakeholder engagement, confirming both the academic validity and practical relevance of the model. Practical implications: The model provides actionable guidelines for local governments in drafting responsive regulations, for mining industries in adopting sustainable practices, and for communities in ensuring participatory post-mining revitalization. It offers an evidence-based tool that can support the drafting of regional regulations (Perda) and enhance the alignment of local policies with national and global sustainability agendas. Theoretical implications: This research advances sustainability governance and policy evaluation literature by introducing the RE-ACTIVE methodology, which integrates the Pentahelix approach with cultural dimensions. It contributes theoretically by bridging global Green Economy frameworks with local socio-cultural contexts through realist evaluation and theory of change (ToC). Originality/value: This study presents RE-ACTIVE as a new methodological framework for policy design and evaluation, delivering both conceptual innovation and a contextually tested Green Economy policy model that is replicable in other mining regions.

Keywords: Green Economy. Sustainable Mining. RE-ACTIVE Methodology. Pentahelix Collaboration. Corporate Social Responsibility (CSR). Sustainable Development Goals.

empresa de mineração parceira demonstraram melhorias nos indicadores ESG, ecoeficiência, inovação verde e engajamento das partes interessadas, confirmando tanto a validade acadêmica quanto a relevância prática do modelo. Implicações práticas: O modelo fornece diretrizes acionáveis para governos locais na elaboração de regulamentações responsivas, para indústrias de mineração na adoção de práticas sustentáveis e para comunidades na garantia de uma revitalização pós-mineração participativa. Oferece uma ferramenta baseada em evidências que pode apoiar a elaboração de regulamentações regionais (Perda) e aprimorar o alinhamento de políticas locais com as agendas de sustentabilidade nacionais e globais. Implicações teóricas: Esta pesquisa contribui para a literatura sobre governança da sustentabilidade e avaliação de políticas ao introduzir a metodologia RE-ACTIVE, que integra a abordagem Pentahelix com dimensões culturais. Contribui teoricamente ao conectar estruturas globais da Economia Verde com contextos socioculturais locais por meio de avaliação realista e teoria da mudança (ToC). Originalidade/valor: Este estudo apresenta o RE-ACTIVE como uma nova estrutura metodológica para o desenho e avaliação de políticas, oferecendo inovação conceitual e um modelo de política de Economia Verde testado contextualmente e replicável em outras regiões de mineração.

Palavras-chave: *Economia Verde. Mineração Sustentável. Metodologia RE-ACTIVE. Colaboração Pentahelix. Responsabilidade Social Corporativa (RSC). Objetivos de Desenvolvimento Sustentável.*

1 INTRODUCTION

The global movement towards sustainable economic development has intensified over the past decade, especially through the Green Economy (GE) agenda, which necessitates the amalgamation of economic growth with social welfare and environmental conservation. The mining sector, while providing substantial contributions to the national economy, frequently faces criticism for its considerable ecological impact, social tensions, and inadequate incorporation of sustainability initiatives. In Indonesia, a nation with a significant mining sector, the successful transition to green energy necessitates policy models that are normative, adaptable, adaptive, and based on empirical evidence (Lutfi *et al*., 2023; Pons *et al*., 2021).

This study introduces RE-ACTIVE (Research–Analyze–Construct–Test–Implement–Validate–Evaluate) as a systematic framework for the design, testing, and evaluation of GE policies in sustainable mining concession areas. This approach encompasses multiple phases, including regulatory assessments, benchmarking, policy model testing, mechanism validation, and both quantitative and qualitative impact evaluations (Manikas *et al*., 2021; Martino *et al*., 2024; Zhang & Zhang, 2024).

Despite several studies examining Corporate Social Responsibility (CSR), environmental audits, and regulatory policies in the mining sector, a gap persists in correlating policy formulation with empirical implementation, especially in the Indonesian setting (Acuti *et al*., 2024; Akhter *et al*., 2023). Numerous previous research have concentrated exclusively on Environmental, Social, and Governance (ESG) disclosure and its influence on financial performance, neglecting policy experimentation or field-based intervention approaches. This has led to a continual disparity between theoretical frameworks and practical application in the execution of GE policies(Chen *et al*., 2025; Chung *et al*., 2023; Lutfi *et al*., 2023; Zhang & Zhang, 2024).

Consequently, there is an immediate necessity for a policy model that (a) is formulated through regulatory analysis and international benchmarking, (b) incorporates insights from Pentahelix stakeholders and cultural factors, (c) is assessed in practical, real-world environments, and (d) is evaluated holistically to facilitate replication in other regions (Bahadorestani *et al*., 2020; Kwatra *et al*., 2021) . This research primarily contributes to the development and empirical validation of a GE policy framework utilizing the RE-ACTIVE technique in sustainable mining concession regions in Indonesia, specifically in East Luwu Regency and the concession area of PT Vale.

This project aims to investigate the subsequent research questions:

1. What is the implementation status of national and international GE rules in the mining sector, and what gaps have arisen?
2. In what manner do stakeholders (Pentahelix) view and contribute to the endorsement of GE policies inside concession areas?
3. How can the RE-ACTIVE-based GE policy model be formulated to guarantee contextual relevance and applicability?
4. What are the preliminary effects of the policy model trial on social, environmental, and economic dimensions?

5. In what manner may the policy model be assessed, and what suggestions can be formulated for its replication?

This study utilizes a mixed-method design based on the RE-ACTIVE methodology: commencing with regulatory analysis and literature review (ResearchAnalyze); proceeding to policy model development through benchmarking and stakeholder engagement (Construct); advancing with restricted pilot testing in collaboration with mining partners (Test/Implement); and concluding with model validation and evaluation employing qualitative methods (focus group discussions, benchmarking, expert review) and quantitative metrics (regulatory impact assessment, green economy indicators, and sustainability reporting standards) (Validate/Evaluate). The primary result of this project is a contextually validated Green Economy policy model and empirically supported policy suggestions for local governments and the mining sector (Laimon *et al*., 2022; Wolfe, 2024).

This method enhances the literature on sustainability, public policy, and environmental accounting, while offering practical advice for professionals in the sector. Furthermore, the GE model described herein is anticipated to be replicable in other post-mining locations, therefore expediting Indonesia's mining industry transition towards a more sustainable and inclusive economy.

2 LITERATURE REVIEW

2.1 Green economy & mining

The Green Economy (GE) is considered a novel developmental model that prioritizes the amalgamation of economic growth, social fairness, and environmental sustainability. The United Nations Environment Programme (UNEP) characterizes a green economy as one that improves human welfare while markedly diminishing environmental hazards and ecological shortages (Luthra *et al*., 2022). The application of GE is essential in mining, as extractive activities often result in land degradation, water pollution, and biodiversity loss (Bria *et al*., 2025). The mining industry in numerous developing nations, such as Indonesia, has significant difficulties in reconciling its contribution to Gross Domestic Product (GDP) with the imperative to ensure environmental and social sustainability (Fedajev *et al*., 2023; Xaisongkham & Liu, 2024).

An increasing volume of research suggests that the implementation of GE principles in the mining sector can be achieved through policies including post-mining reclamation, the adoption of eco-friendly technologies, and the evolution of Corporate Social Responsibility (CSR) initiatives towards sustainable development (Carney, 2023; Halkos & Nomikos, 2021).

Moreover, environmental auditing frameworks like the Global Reporting Initiative (GRI) and international sustainability metrics such as the Sustainable Development Goals (SDGs) are essential tools for evaluating GE performance in the mining industry (Chen *et al*., 2025; Kohl *et al*., 2022; Warburton, 2024). Consequently, the incorporation of GE into mining is not simply an alternative but a strategic need to guarantee that natural resources, once utilized, yield enduring advantages without jeopardizing the requirements of future generations.

2.2 CSR & transformational approach

The notion of Corporate Social Responsibility (CSR) has significantly evolved, transitioning from charity endeavours to a strategic focus on sustainability. Initially, corporate social responsibility (CSR) mostly manifested through donations, social aid, or charity endeavours that were distinct from a company's fundamental economic plan (Sunecher *et al*., 2025; Verk *et al*., 2021). This strategy has frequently faced criticism for its short-term focus and its restricted systemic influence on enhancing community welfare or tackling environmental challenges.

The evolution of contemporary CSR theory and practice highlights transformative CSR, specifically the incorporation of social responsibility into the fundamental business plan of the organization. This strategy emphasizes that firms prioritize not only compliance with regulatory standards but also the integration of CSR initiatives with the generation of shared value for both the organization and society. Transformational CSR prioritizes multi-stakeholder collaboration, community empowerment, and sustained investments in sectors such as education, health, environmental sustainability, and local economic development (Kwatra *et al*., 2021; Verk *et al*., 2021).

The implementation of transformative CSR is essential in the mining sector for tackling intricate socio-environmental effects. This approach anticipates that mining corporations will not only rehabilitate post-exploitation landscapes but also establish a

sustainable framework for the local green economy, so reinforcing their social license to operate within the community.

2.3 Pentahelix dan culture: integrasi aktor pemerintah, industri, akademisi, masyarakat, media

The Pentahelix model embodies a collaborative development framework that includes five principal stakeholders: government, university, industry, civil society, and the media (ChuanYu *et al*., 2025; Ratna Susanti *et al*., 2022). Collaboration among diverse stakeholders is deemed crucial for formulating policies that are participatory, relevant, and sustainable. The government formulates regulations and policies; academia supplies scientific foundations and research; industry offers resources and innovation; civil society participates actively and provides oversight; and the media disseminates information and enhances public awareness (Bharati *et al*., 2023; Nugraha *et al*., 2023).

The Pentahelix approach in the execution of Green Economy policies highlights the importance of both functional collaboration and the incorporation of local culture as a moderating element (Ratna Susanti *et al*., 2022b). Culture influences beliefs, practices, and communal viewpoints toward sustainability. Disregarding cultural factors frequently leads to community resistance against new policies, despite their intention for long-term advantages. Incorporating cultural factors renders the Pentahelix collaboration more inclusive and contextual, facilitating the acceptance and consistent implementation of policies (Carvalho *et al*., 2023).

In the Indonesian mining sector, the amalgamation of Pentahelix and culture is essential to guarantee that Green Economy policies meet legislative objectives while also conforming to local wisdom and the requirements of communities adjacent to mining regions (Bria *et al*., 2025).

2.4 Policy implementation & evaluation: regulatory impact assessment, pilot policy, realist evaluation

The implementation of policy is a critical phase that dictates the efficacy of a regulation in fulfilling its intended goals. The literature on public policy underscores that implementation encompasses not just the enforcement of regulations but also the

processes of adaptation, negotiation, and modification in response to social, economic, and political settings. From the standpoint of sustainable development, the execution of Green Economy policies necessitates tools that can reconcile policy formulation with real-world situations (Mukherjee *et al*., 2021; Wang, 2024).

Policy evaluation is an integral aspect of implementation. The evaluation of a policy enables the measurement of its efficacy, identification of impediments, and formulation of improvements. A commonly employed technique is Regulatory Impact Assessment (RIA), which assesses the economic, social, and environmental effects of regulations. Moreover, global sustainability metrics like the GRI Standards and the Sustainable Development Goals (SDGs) are commonly utilized as criteria for evaluating the efficacy of green policies (Camba *et al*., 2022; Galleli *et al*., 2021; Sunecher *et al*., 2025).

Prior research indicates that implementation difficulties frequently result from inadequate stakeholder cooperation, insufficient resources, and a lack of transparent monitoring systems. Consequently, the incorporation of assessment from the initial phases of policy formulation is imperative. In the mining sector, adaptive methodologies for implementation and assessment can guarantee that Green Economy policies are not merely normative but also functional, quantifiable, and sustainable.

2.5 Gap identification

Despite the considerable expansion of literature about the Green Economy, transformational CSR, the Pentahelix model, and policy implementation and evaluation, significant gaps persist, especially concerning the mining sector in Indonesia. Most previous research have concentrated on examining the links between ESG, CSR, or environmental performance and company profitability, hence predominantly focusing on the corporate level. Such approaches frequently neglect the cohesive design of policies and the necessary multi-stakeholder involvement during the processes of policy creation and evaluation (Chung *et al*., 2023; Pangarso *et al*., 2022; Xaisongkham & Liu, 2024).

Furthermore, investigations of Green Economy policies within the mining industry are predominantly confined to normative regulatory analyses or specific case studies of corporate social responsibility initiatives executed by major firms. The lack of empirical research that design, test, validate, and systematically evaluate policy models

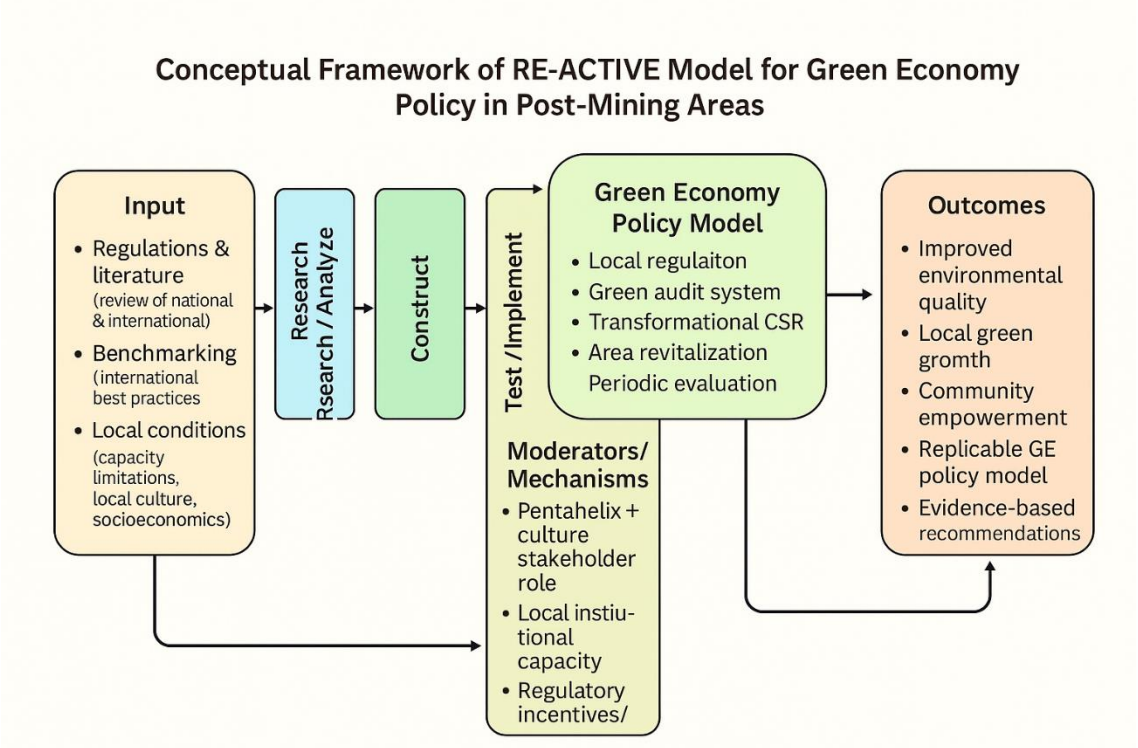
underscores a significant deficiency that requires attention. Conversely, local contexts such as culture, community dynamics, and the capabilities of local governments are rarely regarded with due seriousness in the policy-making process (Koff *et al*., 2023; Xiao *et al*., 2024).

There is an urgent necessity for a methodological framework that effectively connects theory and practice through a systematic, interactive, and evidence-based approach. This necessity underlies the formulation of the RE-ACTIVE technique, an innovation aimed at establishing a Green Economy policy model that is local, relevant, and prepared for execution in post-mining regions of Indonesia.

A conceptual framework has been established to elucidate the interconnections among inputs, the phases of the RE-ACTIVE approach, moderating mechanisms, the Green Economy policy model, and the anticipated consequences.

Figure 1

Conceptual Framework of RE-ACTIVE Model for Green Economy Policy in Post-Mining Areas



Source: Authors' own elaboration (2025)

The conceptual framework presented demonstrates how the RE-ACTIVE technique serves as a conduit between regulations, benchmarking, and local realities in

the development of a Green Economy policy model. Inputs include regulations, literature, worldwide best practices, and local contexts are handled through the phases of Research, Analyze, Construct, Test, and Implement (Carvalho *et al*., 2023; Omer *et al*., 2025). The moderating mechanisms specifically the involvement of Pentahelix stakeholders enhanced by cultural factors, regional institutional capability, and regulatory incentives facilitate the realistic adoption of the paradigm.

The policy approach comprises five fundamental components: local rules, environmental audit systems, transformational corporate social responsibility, territorial regeneration, and periodic review. The final results encompass enhancements in environmental quality, the expansion of the local green economy, community empowerment, and the development of a replicable Green Economy policy model that provides an evidence-based framework for policymaking.

3 RESEARCH METHODOLOGY

3.1 Research design

This study utilizes a mixed-method design using an explanatory sequential approach integrated with participatory research concepts. This method was selected to achieve a thorough knowledge by integrating qualitative and quantitative policy studies (Abdullah & Sumner, 2025; Mukherjee *et al*., 2021). The preliminary phase of the research commenced with the acquisition of qualitative data using document analysis, observations, interviews, and Focus Group Discussions (FGDs) to delineate the regulatory framework, stakeholder perspectives, and socio-economic dynamics in mining regions. The qualitative findings were subsequently corroborated by quantitative analyses employing Regulatory Impact Assessment (RIA), Cost-Benefit Analysis (CBA), and Green Economy and sustainability indicators to evaluate the feasibility and efficacy of the proposed policy model.

The participatory method, involving Pentahelix stakeholders (government, academia, business, community, and media), constitutes the foundation of its design. Consequently, policy formation is based not just on scientific facts but also incorporates local needs and values (Farghali *et al*., 2023; Kwatra *et al*., 2021). This research design

facilitates the development of a comprehensive, practical, and evidence-based Green Economy policy model for the sustainable mining sector.

3.2 Method: RE-ACTIVE

This study utilizes the RE-ACTIVE technique (Research–Analyze–Construct–Test–Implement–Validate–Evaluate) to formulate, assess, and appraise Green Economy policies in post-mining regions. The strategy facilitates the amalgamation of regulatory analysis, stakeholder engagement, and empirical testing to generate evidence-based policies.

1. **Research/Analyze**. Initially, the researchers performed a literature analysis and analyzed both national and international rules pertinent to the Green Economy in the mining sector. Benchmarking was conducted in regions and nations exemplifying best practices to discover deficiencies and possibilities(Chen *et al*., 2025).
2. **Construc**. An initial policy model was built based on the review findings, incorporating key stakeholders through interviews, field observations, and Focus Group Discussions (FGDs). The Pentahelix and cultural approach was utilized to guarantee that the model is interactive and culturally pertinent (Suno Wu *et al*., 2024).
3. **Test/Implement**. The resultant policy model was subjected to pilot testing in a partner mining concession region. This phase encompassed socialization, technical support, and monitoring of the policy's initial execution (Abdullah & Sumner, 2025).
4. **Validate/Evaluate**. The results of the implementation were subsequently verified through expert assessments, benchmarking, and evaluations by several stakeholders. Quantitative analysis was performed utilizing Regulatory Impact Assessment (RIA), Cost-Benefit Analysis (CBA), and Green Economy indicators to evaluate policy efficacy. Qualitative analysis was conducted using focus group discussions and field data triangulation (Martino *et al*., 2024).

The RE-ACTIVE methodology yields a contextually validated Green Economy policy model and evidence-based recommendations for local governments and the mining sector, suitable for replication in other post-mining areas.

3.3 Research Context and Data

This research centers on East Luwu Regency in South Sulawesi as the principal site of investigation. The region was chosen due to its status as an international center for nickel mining, notably by PT Vale Indonesia Tbk, which has implemented post-mine rehabilitation projects and sustainability measures that can serve as benchmarks. Furthermore, benchmarking was performed in areas with analogous mining attributes, specifically Kendari (Southeast Sulawesi) and East Kalimantan, to evaluate best practices and discern policy deficiencies.

The research data are classified into two primary categories:

1. Primary data: acquired by comprehensive interviews, Focus Group Discussions (FGDs), field observations, and questionnaire surveys including Pentahelix stakeholders (government, academia, industry, community, and media). This data reflects stakeholder perspectives, interests, and dynamics of Green Economy policies in the mining sector (Ai Tran *et al*., 2025; Coleman *et al*., 2020).
2. Secondary data: encompassing national and international regulations, company sustainability reports (particularly those aligned with the Global Reporting Initiative/GRI), and pertinent academic research. This data establishes the conceptual framework and international standards for evaluating Green Economy practices in the studied areas (Mökander *et al*., 2022).

This project aims to create an evidence-based, contextually pertinent Green Economy policy model by integrating local context with multi-source data, which can be duplicated in other sustainable mining zones.

3.4 Data analysis

The data analysis in this study was conducted integratively, merging qualitative and quantitative policy-oriented methodologies. Four primary analytical instruments were utilized:

1. **Regulatory Impact Assessment (RIA)**. Utilized to evaluate the degree to which the formulated Green Economy policies can produce social, economic, and environmental advantages. RIA assists in identifying both beneficial effects and

possible hazards of policies, as well as assessing their viability for implementation (Abdullah & Sumner, 2025) .

2. **Cost-Benefit Analysis (CBA)**. This research was conducted to assess the equilibrium between the expenses of policy implementation and the ensuing economic, social, and environmental advantages. Cost-Benefit Analysis guarantees that the established policies are both normatively viable and economically efficient (Haqq & Gultom, 2022).
3. **Environmental Performance Indicators (EPI)**. EPI functioned as quantitative metrics to assess environmental performance post-policy implementation. These indicators encompass elements such as water quality, land restoration, emissions, and ecosystem sustainability (Diva Adisti *et al*., 2024; Farghali *et al*., 2023).
4. **Benchmarking.** A comparative analysis was performed by referencing best practices from places such as Kendari and East Kalimantan, in addition to worldwide sustainability requirements. Benchmarking was utilized to evaluate the pertinence and efficacy of the policy model in the local environment, while assuring its conformity with international trends.

The amalgamation of these four instruments offers a thorough assessment of the efficacy, efficiency, and sustainability of the Green Economy policies formulated by the RE-ACTIVE technique.

3.5 Validation

The validation method in this study was conducted using two primary mechanisms:

1. Expert Judgement. The proposed Green Economy policy model developed during the Construct and Test/Implement phases was evaluated by specialists. The reviewers included scholars in public policy, environmental studies, and sustainable economics, along with professionals from the mining sector. The objective of this process was to guarantee the theoretical coherence, regulatory conformity, and technical viability of the policy model (Diva Adisti *et al*., 2024).
2. Engagement of Stakeholders. Validation was executed in a participative manner including several stakeholders (Pentahelix: government, academia, industry, community, and media). Stakeholders participated in discussion forums and Focus

Group Discussions (FGDs) to offer feedback, identify potential implementation difficulties, and assess the social acceptability of the policy model. This technique served both as a legitimacy assessment and as a means to enhance collective ownership of the program (Kohl *et al*., 2022).

The integration of expert evaluation and stakeholder involvement guarantees that the resultant Green Economy policy model is both academically sound and pertinent, practical, and endorsed by principal participants in the sustainable mining industry.

4 RESULTS

4.1 Prototype model of green economy policy

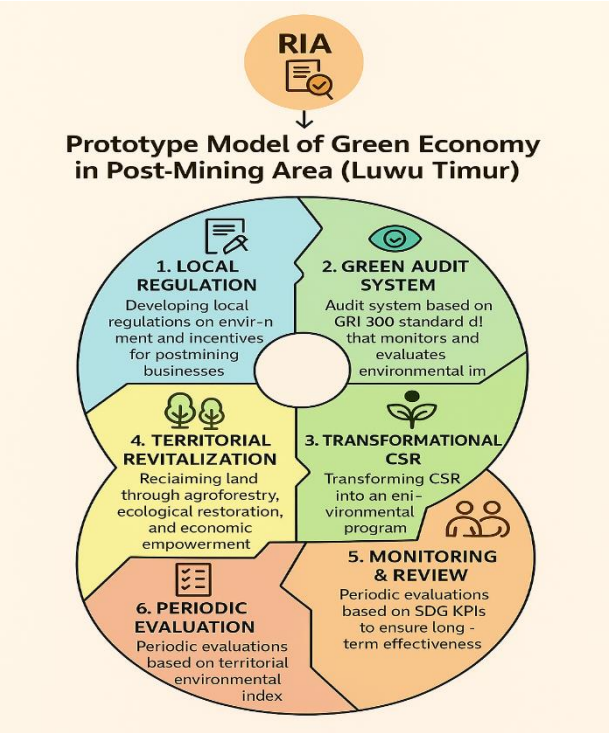
This research developed a Prototype Model of Green Economy Policy for post-mining regions in East Luwu Regency, as depicted in Figure 2: Prototype Model. The approach was created by integrating regulatory evaluations, policy effect assessments, benchmarking, and multi-stakeholder involvement through interviews, focus group discussions, and field observations.

The policy model was designed according to Green Economy principles and aimed at long-term sustainability, consisting of six fundamental components:

1. Local Regulation: enhancement of ecologically focused regional rules and the establishment of incentives for post-mining firms.
2. Green Audit System: environmental assessments adhering to GRI 300 standards for the monitoring and evaluation of environmental impacts.
3. Transformational CSR: the evolution of CSR efforts from conventional altruism to strategic initiatives rooted in environmental sustainability.
4. Territorial Revitalization: land restoration by agroforestry, ecological rehabilitation, and the economic empowerment of local communities.
5. Monitoring and Review: regular assessment utilizing SDG KPIs to guarantee sustained efficacy.
6. Periodic Evaluation: assessment of the Environmental Index to statistically gauge the results of environmental rejuvenation.

Figure 2

Prototype Model of Green Economy Policy in Post-Mining Area (Luwu Timur)



Source: Authors' own elaboration (2025)

4.2 Output of initial pilot testing

The preliminary pilot testing carried out in a partner mining company indicated that the policy model is pertinent to the operational framework of Indonesia's mining industry. The initial implementation demonstrated that corporations could incorporate aspects of local rules, environmental audits, and transformative CSR initiatives without interfering with their fundamental production processes. These data show that the concept is both contextual and viable for wider use.

4.3 Empirical data and indicators

The empirical evaluation of the model utilized various sustainability measures, including:

1. ESG indicators: showcasing advancements in transparency and environmental adherence.

2. Eco-efficiency: demonstrating enhanced efficiency in energy and water utilization, alongside reductions in carbon emissions.
3. Green innovation: the advent of programs including agroforestry, renewable energy, and localized green business ideas.
4. Stakeholder engagement: enhanced involvement of government, industry, academia, civil society, and the media in multi-stakeholder forums.

These findings validate that the GE policy model, created using the RE-ACTIVE method, is both academically sound and linked with the practical requirements of mining firms and local governments. The integration of rules, audits, revitalization, transformative CSR, and ongoing review creates a framework that is relevant, comprehensive, and focused on long-term sustainability.

To substantiate the empirical findings, the indicators employed in the preliminary evaluation of the GE policy model are encapsulated in Table 1. This table delineates four primary categories ESG, eco-efficiency, green innovation, and stakeholder engagement that function as standards for the preliminary implementation.

Table 1

Empirical Indicators for Pilot Testing of the Green Economy Policy Model

Indicator	Description	Findings from Pilot Testing
Environmental, Social, and Governance (ESG)	Company compliance with sustainability standards (GRI reporting, environmental regulations, governance transparency).	Partner companies improved the quality of GRI reporting and expanded the coverage of environmental issues.
Eco-efficiency	Efficiency in the use of energy, water, and materials, as well as the reduction of carbon emissions.	A decrease in energy intensity and CO_2 emissions per ton of production was observed through efficiency initiatives.
Green Innovation	Environment-based innovations such as agroforestry, renewable energy, and green products.	Agroforestry initiatives were expanded, and pilot projects in renewable energy began to be tested.
Stakeholder Engagement	The level of stakeholder involvement (government, community, industry, academia, media).	Multi-stakeholder participation increased in FGDs and policy consultation forums; consensus was achieved.

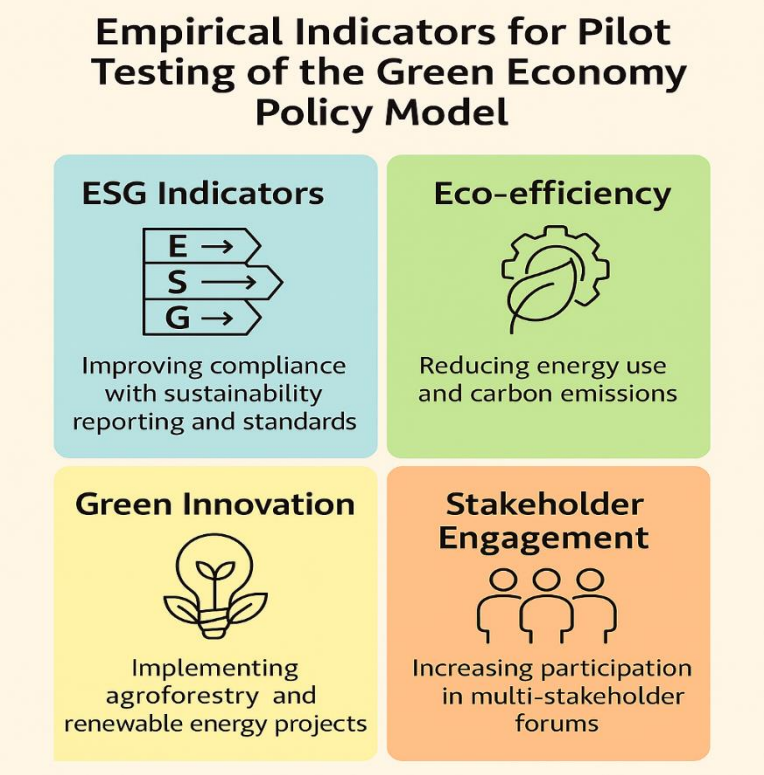
Source: Authors' own elaboration (2025)

The preliminary pilot testing results were displayed in tabular format and also represented using an infographic to elucidate the relationships among indicators more thoroughly (Agley *et al*., 2021; Asgari & Hurtut, 2024). Figure 3 illustrates a dashboard that encapsulates the four principal dimensions ESG, eco-efficiency, green innovation,

and stakeholder engagement as essential components in evaluating the efficacy of the Green Economy policy model implementation.

Figure 3

Displays the dashboard of indicators utilized in the preliminary pilot testing of the Green Economy policy model.



Source: Authors´ owm elaboration (2025)

Each element signifies a vital aspect of sustainability:

1. ESG metrics signify corporate adherence to sustainability reporting standards and governance transparency.
2. Eco-efficiency demonstrates endeavors to enhance resource efficiency and diminish carbon emissions in mining operations.
3. Green innovation emphasizes novel activities, such agroforestry and renewable energy, that assist the transition to a green economy.

Stakeholder engagement illustrates the active participation of Pentahelix entities (government, industry, academia, community, media) in bolstering policy legitimacy. This visualization underscores that the four variables are interdependent and collectively

assess the relevance and feasibility of implementing the GE policy model in post-mining regions.

5 DISCUSSION

This study's findings indicate that the RE-ACTIVE technique can generate a Green Economy (GE) policy model that is both academically sound and practically implementable. In comparison to the worldwide literature, the model corresponds with the policy frameworks established by UNEP (2011) about the transition to a green economy, highlighting the importance of regulation, market incentives, and multi-stakeholder involvement. The essential difference resides in the incorporation of Pentahelix and culture, a topic seldom explored in international research. Global research (Manikas *et al*., 2021; Tregidga & Laine, 2022; Ulpiani *et al*., 2025) predominantly underscores formal legislation and economic tools, but this study accentuates local socio-cultural factors as critical determinants of policy legitimacy.

The primary innovation of this research is the creation of the RE-ACTIVE methodology as a systematic framework for the design, testing, and evaluation of GE policies. The use of Pentahelix-based stakeholder involvement, attuned to local cultural values, differentiates this paradigm from traditional normative or technocratic methodologies (Zhao *et al*., 2022). This study's contribution transcends the creation of an actionable policy prototype; it also enhances sustainability governance theory by highlighting cross-actor collaboration and cultural factors.

The model's efficacy may be comprehended through the integration of adaptive local regulations, environmental audit frameworks, transformative corporate social responsibility, post-mining area rejuvenation, and ongoing assessment and evaluation. Prior literature has emphasized the significance of legislation and environmental audits (Harrer & Lehner, 2024). According to Hou *et al*., (2022) and Tregidga & Laine, (2022), this study illustrates that authentic success necessitates comprehensive synergy across these elements. Empirical evidence indicates that ESG indicators, eco-efficiency, green innovation, and stakeholder involvement mutually enhance one another in promoting long-term sustainability.

Nevertheless, this investigation also uncovers various obstacles. Initially, small-scale mining enterprises frequently oppose the implementation of sustainable standards

owing to financial and technological limitations. Secondly, the capability of local human resources is constrained, especially in executing green audits and employing eco-friendly technologies. Third, collaboration among stakeholders is hindered, particularly between local governments, communities, and medium-scale mining enterprises (Ofosu & Sarpong, 2023).

These findings align with the research objective of developing an evidence-based, participative, and contextual GE policy model. This study's contributions are categorized into two dimensions: (1) theoretical, by introducing a novel methodological framework (RE-ACTIVE) that enhances the literature on Green Economy policy; and (2) practical, by offering a policy prototype suitable for implementation by local governments and mining companies in Indonesia, with potential for replication in other developing nations (Chen *et al*., 2025; Diva Adisti *et al*., 2024; Wang, 2024).

This conversation confirms that the RE-ACTIVE method is not only a technical tool but also a conceptual framework that connects global policy theory with local practice. This facilitates opportunities for additional study, encompassing the enhancement of local human resource capabilities and the investigation of economic incentives that could expedite the integration of the Green Economy within the sustainable mining industry.

6 CONCLUSION

This study confirms that RE-ACTIVE is an innovative methodological framework pertinent to the creation, testing, and evaluation of evidence-based policies in the sustainable mining industry. This research successfully developed the Green Economy Model for Responsible and Transformative Mining Policy (GE-MRTP) as an applicable, inclusive, and empirically verified policy prototype through the stages of Research, Analyze, Construct, Test, Implement, Validate, and Evaluate. The concept significantly contributes to achieving the green economic transition in Indonesia’s mining districts by incorporating legislative aspects, a green audit system, transformational CSR, post-mining territorial rehabilitation, and monitoring and evaluation procedures.

The resultant model can function as a policy framework for local governments in crafting adaptive rules, for mining corporations in executing sustainability initiatives, and for local communities as engaged collaborators in the development process. This study

theoretically advances policy assessment approaches grounded in realist evaluation and the theory of change (ToC), ultimately enhancing the global discourse on environmental policy and sustainability governance.

This study, however, possesses drawbacks. The model's application is now confined to the pilot project phase in East Luwu, necessitating a cautious approach to the generalization of findings. Moreover, the quantitative metrics included in the assessment necessitate additional refinement to more accurately reflect the intricacies of green economy dynamics within the mining industry.

Future research ought to concentrate on reproducing the model in additional mining districts of Indonesia and on formulating more extensive quantitative indicators, including integration with global sustainability indices. The GE-MRTP model is anticipated to function as both a local prototype and an international benchmark for the formulation of Green Economy policies based on best practices in the mining industry.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support provided by the Directorate General of Higher Education, Research, and Technology (DPPM Ristek DIKTI) for funding this research project. We also extend our sincere appreciation to the Local Government of Luwu Timur for supporting the implementation of the proposed prototype model, including the provision of co-funding and the dedicated team appointed directly by the Regent to accompany and complement this research process. Special thanks are also due to the Regional House of Representatives (DPRD) of Luwu Timur for generously providing access to the Hearing Room facilities and for ensuring that the results of this study will serve as a foundation for the drafting of a regional regulation (*Peraturan Daerah*).

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Authors' Contribution

Both authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA):

Rismawati, Haedar, Suaedi, & Elliyana, E. A RE-ACTIVE APPROACH TO DESIGNING GREEN ECONOMY POLICIES: EVIDENCE FROM SUSTAINABLE MINING CONCESSIONS IN INDONESIA. *Veredas Do Direito*, e223583. https://doi.org/10.18623/rvd.v22.n4.3583