Policy Consider of Green Chemistry in Indonesia

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Abstract

As Indonesia experiences continued economic growth, the urgency for adopting sustainable industrial practices intensifies. Green chemistry presents a strategic framework by emphasizing the reduction of hazardous substances and environmental impact through principles such as safer solvents, waste minimization, energy efficiency, and renewable resource utilization. This study conducts a systematic review of 11 relevant journals, revealing significant advancements in catalytic process optimization, eco-friendly synthesis, and waste valorization. Notable examples include the green synthesis of MnO_2 for supercapacitor electrodes and innovations in catalytic efficiency that reduce environmental harm. The Omnibus Law on Job Creation (Law No. 11/2020) emerges as a potential regulatory catalyst to support the integration of green chemistry into Indonesia's industrial sector. These developments align closely with the Sustainable Development Goals (SDGs), particularly in areas such as clean water, affordable energy, and public health. Ultimately, green chemistry offers a pathway to enhance industrial competitiveness, environmental protection, and long-term sustainability in Indonesia's journey toward a greener economy.

Keywords: Environmental Impact, Green Chemistry, Omnibus Law, SDGs Indonesia, Sustainable Industrial.

INTRODUCTION

As Indonesia experiences rapid economic development, the urgency to adopt sustainable practices becomes increasingly apparent. One such approach is green chemistry, which focuses on designing chemical products and processes that reduce or eliminate the use and generation of hazardous substances, while minimizing environmental impact. This method has emerged as a vital tool in supporting the transition to more sustainable industrial practices (Cannon *et al.,* 2024; Arfelis *et al.,* 2024).

Green chemistry emphasizes principles such as the use of safer solvents, minimizing waste, improving energy efficiency, and utilizing renewable resources (Koel, 2024). In the context of Indonesia where industrial growth and environmental issues often intersect adopting green chemistry holds significant promise in advancing environmental protection while fostering innovation and economic growth.

In recent years, Indonesia's growing interest in green chemistry aligns with global trends aimed at reducing pollution, enhancing public health, and promoting sustainable development (Sharma *et al.,* 2024). Incorporating green chemistry principles across various industrial sectors could help the country address key environmental challenges, including air and water pollution, hazardous waste, and resource depletion.

A robust regulatory framework is essential to encourage industries to adopt green chemistry practices. Such a framework ensures that chemical processes are not only effective but also safe for people and the environment (Yildiz *et al.,* 2024; Eilks & Linkwitz, 2022). It supports the shift toward environmentally sound innovations by setting clear standards, offering incentives, and guiding compliance efforts (Koel, 2024). In Indonesia, where industrialization and ecological risks are both pressing issues, a structured regulatory environment is critical to promote the consistent application of green chemistry across sectors (Cannon *et al.,* 2024; Slootweg, 2024).

Moreover, these regulations contribute to public health by limiting exposure to toxic substances and managing risks associated with chemical production. They also promote economic resilience by opening pathways for innovation and maintaining Indonesia's competitiveness in global markets for sustainable technologies (Begum *et al.,* 2022). Thus, the development of a comprehensive green chemistry framework is essential for protecting the environment, improving public well-being, and advancing the country's long-term sustainability goals (Becker *et al.,* 2022).

This study aims to analyze the potential impacts of green chemistry on Indonesia's industrial sector, the role of the Omnibus Law on Job Creation (Law No. 11/2020) in facilitating or hindering the adoption of green chemistry, and aligning the green

chemistry practices with Indonesia's Sustainable Development Goals (SDGs).

Green chemistry significantly contributes to reducing environmental pollution by minimizing hazardous substances and enhancing waste reduction efforts. These benefits are critical to protecting Indonesia's natural ecosystems and biodiversity, which are under increasing threat from industrial activities (Hadi *et al.,* 2023). The Omnibus Law, aimed at simplifying regulatory frameworks, presents an opportunity to embed green chemistry into national policy, potentially streamlining adoption across industries (Iwan *et al.,* 2020).

Aligning green chemistry with Indonesia's SDG agenda integrating supports more targeted policy implementation, better allocation of resources, and clearer progress monitoring (Hadi, 2019). The adoption of green chemistry offers Indonesia a multifaceted opportunity to enhance environmental protection, stimulate innovation, improve public health, and strengthen its position in the global economy (Kusumawardani *et al.,* 2024; Nuryanto *et al.,* 2024; Albertini, 2019). By embracing this approach, Indonesia can take a leading role in advancing sustainable industrial practices and shaping a more resilient future.

METHOD

This research does not employ quantitative methods such as questionnaires or interviews because the chosen methodology—a Systematic Literature Review (SLR)—is more suitable for the objectives of the study. The primary aim is to understand the broader impact of green chemistry on industry in Indonesia by analyzing existing scientific literature and policy-related documents. The SLR method enables the researcher to gather, filter, and synthesize relevant findings from a wide range of peer-reviewed sources, ensuring a comprehensive and evidence-based understanding of the topic.

Unlike quantitative approaches, which may be constrained by limited sample sizes, response bias, or logistical challenges in data collection, the SLR allows for the inclusion of diverse perspectives and empirical studies already conducted within the field. Furthermore, by focusing on literature published between 2020 and 2025 from the Garuda Ristekdikti portal, the research ensures that the analysis remains current and relevant to recent developments, including regulatory frameworks such as the Omnibus Law on Job Creation and the alignment with the Sustainable Development Goals (SDGs). This method provides strategic insights that are both reliable and applicable for policymakers, industry leaders, and stakeholders engaged in promoting sustainable industrial practices in Indonesia.

The research employs a Systematic Literature Review (SLR) approach, consisting of three key stages. The first involves observation through direct monitoring of relevant sources available on academic websites. The second stage is a literature review, focusing on scientific articles using the SLR methodology, specifically sourced from the Garuda Portal (https://garuda.kemdikbud.go.id/). The final stage involves documenting and organizing selected journals for further analysis.

A research question was formulated to guide the investigation: "What is the impact of green chemistry on industry in Indonesia?". Following this, a search process was initiated to gather literature and references relevant to the research question. The primary source for data collection was the Garuda Ristekdikti portal. Search parameters included the keyword "Green Chemistry", and the Advanced Search function was used to filter results by title and restrict outputs to PDF documents only. The publication year filter was set from 2020 to 2025, ensuring the data reflects the most recent and relevant developments.

The inclusion criteria required that:

1. Articles be published between 2020–2025.
2. Data originate from the Garuda Ristekdikti portal.
3. The language of document in English or Indonesia.
4. Articles be directly related to the application of green chemistry in Indonesia.

The search process returned 130 journal documents, as shown in Figure 1, each of which was reviewed and assessed for its relevance to the research themes.

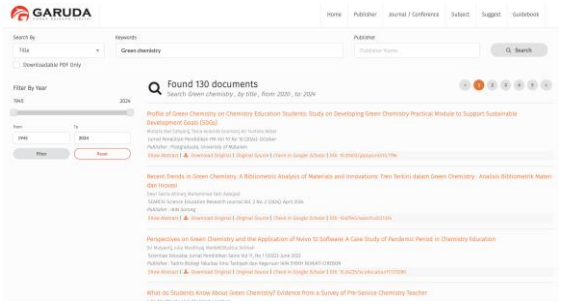

Figure 1. Result From Portal Garuda

From 130 journals found, journals were selected and identified that really discussed Green Chemistry on Indonesian industry, so that we can conclude the various impacts of the writing on the development of Green Chemistry in Indonesia. After sorting, 9 journals were obtained that were related to the theme.

The next step, these documents were subsequently analyzed to assess their connection to the Omnibus Law on Job Creation (Law No. 11 of 2020) and the alignment of their content with Sustainable Development Goals (SDGs). This analysis serves to provide a comprehensive understanding of the current landscape, regulatory context, and potential of green chemistry in supporting Indonesia's sustainable development

agenda. The findings are expected to offer strategic insights for policymakers, industry leaders, and other stakeholders engaged in sustainability efforts

DISCUSSION

Potential Impact Green Chemistry on Indonesian industry

The following 11 journals, listed in Table 1, are recognized as relevant and in line with the theme of Green Chemistry in Indonesian Industry. The reviewed research generally supports the idea that applying green chemistry principles can guide traditional Indonesian industries toward greater sustainability. In recent years, the conversation around green chemistry has expanded beyond laboratory innovations and theoretical models, with a growing focus on social and industrial factors through survey-based studies. Researchers have started to evaluate not only the practical advantages of sustainable chemical technologies but also the perceptions, readiness, and structural barriers that industries encounter when adopting them.

Javaid (2023) highlights how optimizing catalytic processes can increase production efficiency and lower environmental impact, establishing an important technological foundation for greener industrial practices. This catalytic innovation is complemented by Izzah et al., (2022), who demonstrate the synthesis of MnO_2 for supercapacitor electrodes using green techniques, underscoring how tailored catalytic methods can facilitate the development of energy storage devices with reduced hazardous waste. Together, these studies underscore that green chemistry-driven enhancements at the catalytic level are pivotal for overall process transformation.

Table 1. 11 Journal Identified to Potential Impact Green Chemistry on Indonesian industry

No.	Nama Penulis	Judul	Tahun
1.	Izzah, *et al.,*	Synthesis of MnO_2 as Supercapacitor Electrodes Material by Green Chemistry Method Through Dehydroxylation of Tangerine Peel (Citrus reticulata) Essential	2022
2.	Javaid, H.	The Role of Catalysts in Green Chemistry: Towards Sustainable Chemical Processes.	2023
3.	Khaira, *et al.,*	Synthesis of Magnetic Iron Oxide (Fe_3O_4) Nanoparticles Using the Green Chemistry Method with Red Betel Leaf (*Piper crocatum*) Extract.	2020
4.	Khasanah, *et al.,*	Application of Green Chemistry in the Detection of Hazardous Dye Content (Rhodamine B) in Cosmetic Products Circulating in the Pekalongan Area.	2022
5.	Latifah, N.R.	Preparation and Characterization of Adsorbent From Natural Zeolite Mixed Chicken Feather in Degradation of Batik Waste Dyes Based Green Chemistry.	2021
6.	Listyarini, *et al.,*	Guided-inquiry of Green Chemistry-Based Experiments in Biodiesel Synthesis.	2020
7.	Marisa & Astutik	The Utilization of Waste Paper Into Recycle Seed Paper as an Eco-Friendly Product Supporting the Principles of Green Chemistry.	2024
8.	Ratnasonia, *et al.,*	Extraction of Antioxidant Compounds from Sargassum sp. Using Water and Ultrasound Assisted Extraction Method as a Derivation of Green Chemistry Principles.	2022
9.	Rinawati, *et al.,*	Review: Green analytical chemistry: Utilization of Supercritical Fluid Extraction (SFE) and Microwave-Assisted Extraction (MAE) as Extraction Methods for Diterpene Compounds in Roasted Coffee Seed Oil.	2020
10.	Samuel, *et al.,*	Green Chemistry Strategies for Mitigating Microplastic Pollution in Aquatic Environments.	2024
11.	Thohir & Wijaya	Characterization of Activated Charcoal Produced Using Green Chemistry Principle Approach Number 7.	2024

Advancing from catalytic improvements, innovative synthesis methods based on green chemistry further contribute to sustainable industrial practices. Khaira *et al.,* (2020) report a successful eco-friendly synthesis of magnetic iron oxide nanoparticles using red betel leaf extract, thereby replacing traditional methods that rely on hazardous reagents. In addition, Listyarini *et al.,* (2020) document a guided-inquiry approach for biodiesel synthesis that fosters a hands-on understanding of green methods, effectively linking academic training with industrial application. These innovative synthesis processes pave the way for incorporating renewable resources and safer reaction conditions, which are essential for sustainable product development.

Green chemistry's influence extends into waste management and product innovation, as evidenced by multiple studies. Marisa and Astutik (2024) illustrate how waste paper can be repurposed into recycled seed paper an eco-friendly product that embodies the principles of green chemistry. This concept of waste valorization is echoed by Latifah (2021), who demonstrates the preparation and characterization of an adsorbent derived from natural zeolite mixed with chicken feathers for degrading batik waste dyes. Both studies highlight the practical benefits of converting industrial by-products into value-added materials, which reduce environmental waste and open new revenue streams, thereby reinforcing the shift toward a circular economy in the industrial sector.

Beyond synthesis and waste valorization, green chemistry plays a critical role in refining analytical methods and ensuring product safety. Rinawati *et al.,* (2020) provide an in-depth review of modern green analytical techniques such as Supercritical Fluid Extraction (SFE) and Microwave Assisted Extraction (MAE) which offer efficient alternatives for extracting bioactive compounds from roasted coffee seed oil. Alongside this, Khasanah *et al.,* (2022) apply green chemistry approaches to detect hazardous dye content (Rhodamine B) in cosmetic products, ensuring safer consumer products and stricter quality control. These advancements not only enhance environmental safety but also strengthen consumer confidence, further supporting green chemistry as an integral part of modern industrial practices.

The environmental benefits of green chemistry are further underscored by strategies aimed at pollution control. Samuel *et al.,* (2024) propose innovative methods to mitigate microplastic pollution in aquatic environments through green chemistry approaches, illustrating how sustainable practices can directly contribute to environmental remediation. Meanwhile, Thohir and Wijaya (2024) explore the production and characterization of activated charcoal via green methods, an innovation that not only optimizes resource use but also supports energy efficiency and reduces operational costs. Together, these studies emphasize that the integration of environmental protection strategies into industrial processes is critical for reducing the ecological footprint of industrial activities.

Recent developments in green chemistry in Indonesia have increasingly employed survey-based methods to evaluate not only the technical and economic benefits of sustainable chemical processes but also industry readiness, awareness, and the barriers encountered during implementation. For example, Wibowo *et al*., (2019) conducted a structured survey targeting small and medium enterprises (SMEs) across Indonesia to assess the relationship between green innovation, competitiveness, and business performance. Their study found that while green innovation contributes positively to competitive advantage, its direct impact on environmental performance was less clear largely due to financial limitations and operational constraints.

In another notable study, Ye & Dela (2023) investigated foreign chemical firms operating in Indonesia and explored how green investment and financing contribute to sustainable business outcomes. Their findings emphasized the critical mediating role of corporate social responsibility (CSR), showing that companies with integrated CSR and green financing strategies experienced improved environmental and financial performance. However, the adoption of such strategies was still uneven across the sector.

Panuju & Bakri (2021) focused on innovation challenges in food-processing SMEs, highlighting the importance of leadership commitment and employee innovation potential. Their analysis suggested that although many SMEs recognize the long-term value of adopting greener practices, the lack of access to green technologies and inadequate policy direction continue to hinder progress. These barriers are consistent with earlier findings from Wibowo *et al*., (2019), who reported that over 60% of surveyed SMEs acknowledged the market potential of green products, but fewer than half had initiated substantial process changes.

Ye & Dela (2023) also noted that while 72% of companies in their sample identified green financing as a strategic priority, less than half had dedicated financial systems in place or had received external incentives. This gap between awareness and execution underscores a broader implementation lag common to both local SMEs and international firms operating within the country.

The convergence of these findings suggests that while awareness of green chemistry and sustainable innovation is rising, effective implementation depends heavily on structural support. As Panuju & Bakri (2021) concluded in their review of sustainable innovation in Indonesian food SMEs, successful adoption is closely tied to institutional backing in the

form of government incentives, technical guidance, and financial support. Without these enabling factors, even environmentally motivated firms may find the transition toward green chemistry economically or operationally unfeasible.

In summary, while there is growing recognition of the strategic and environmental value of green chemistry, widespread adoption in Indonesia requires a comprehensive framework that combines education, funding, and regulatory alignment. Government, industry, and academia must collaborate to accelerate this shift and close the gap between intention and practice.

The Integration of Green Chemistry Practices within The Framework of the Omnibus Law on Job Creation (No. 11/2020)

The enactment of Indonesia's Omnibus Law on Job Creation (Law No. 11/2020), also known as *Undang-Undang Cipta Kerja*, was designed to overhaul the country's regulatory system, foster investment, and stimulate employment by simplifying legislation across key sectors, including labor, environmental management, and business licensing. Although its core objective is economic progress, the law presents a strategic opening to embed sustainability principles particularly green chemistry into Indonesia's industrial transformation. Leveraging this legal framework to support eco-friendly industrial practices could ensure that economic growth is pursued in tandem with environmental protection and public health improvement.

Green chemistry, which focuses on designing chemical products and processes that reduce or eliminate the use and generation of hazardous substances, inherently supports sustainable development. Its principles align with the broader goals of the Omnibus Law by promoting innovations that not only foster industrial growth but also minimize environmental harm (Sichigra *et al*., 2024; Zhang *et al*., 2022). Incorporating green chemistry into national legislation ensures that advancements in industry contribute positively to ecological balance and long-term sustainability.

One of the key features of the Omnibus Law is the simplification of business licensing to attract investment (Ashford & Caldart, 2023). Embedding green chemistry standards into these streamlined licensing procedures offers a way to maintain environmental integrity without hindering business development. For instance, industries adopting sustainable practices could be prioritized or rewarded through faster permit processing. Additionally, requiring compliance with green chemistry principles during environmental impact assessments (EIA) could ensure that industrial projects are evaluated not only for profitability but also for sustainability and safety (Peleckiene & Peleckis, 2014).

Financial incentives also play a critical role in promoting greener industrial practices. The law could introduce tax deductions, grants, or subsidies for companies investing in green chemistry research and sustainable technologies (Zhu & Yang, 2024). Such economic tools would reduce the financial barriers to adopting eco-friendly innovations and encourage industries to transition toward safer and cleaner production systems. These measures not only lead to improved environmental performance but also stimulate investment in the green technology sector, generating new economic opportunities.

Furthermore, integrating green chemistry within the legal framework supports the creation of green jobs especially in sectors like eco-friendly manufacturing, waste treatment, and environmental consultancy (Mitarlis *et al*., 2023; Listyarini *et al*., 2019). The law can drive the development of workforce training programs focused on sustainability and green chemistry skills (Akib, 2021). This ensures that industries have access to a pool of qualified professionals capable of implementing and maintaining sustainable systems, while simultaneously addressing employment goals.

Corporate social responsibility (CSR) provisions in the Omnibus Law could also be tailored to reinforce green chemistry. Encouraging or requiring companies to adopt sustainability-focused CSR initiatives would further promote the integration of eco-friendly processes, enhance public trust, and improve corporate reputation. Multi-stakeholder collaborations involving government bodies, industry leaders, and academic institutions can also foster knowledge exchange and innovation, enabling widespread adoption of green chemistry practices.

In addition to environmental benefits, green chemistry directly contributes to health and safety improvements. By prioritizing safer chemicals and production processes, it minimizes risks of exposure to hazardous substances among workers and nearby communities (Constable, 2021). The production of non-toxic, environmentally safe consumer goods can also be encouraged through supportive regulations, aligning industrial output with public health goals (Sembiring *et al*., 2020).

To ensure the effective adoption of green chemistry, the Omnibus Law can establish clear, enforceable standards for industries (Sihombing & Hamid, 2020; Constable, 2021). These standards would provide consistency across sectors and simplify regulatory monitoring. Coupling these guidelines with robust inspection systems and regular environmental audits would strengthen compliance, reduce violations, and foster continuous improvement in industrial sustainability (Kusumastuti & Samadi, 2022; Slootweg, 2024; Sudarwanto & Kharisma, 2020).

The Alignment of Green Chemistry with the Sustainable Development Goals (SDGs) in Indonesia.

Integrating green chemistry into Indonesia's pursuit of the Sustainable Development Goals (SDGs) offers a comprehensive strategy to tackle the nation's intertwined environmental, economic, and social challenges. By aligning scientific innovation with sustainability targets, green chemistry supports safer, more efficient, and less polluting chemical processes (Anastas & Zimmerman, 2018; Clune & Zehnder, 2018). This approach not only advances technological progress but also contributes directly to multiple SDGs, offering practical solutions for pollution control, energy efficiency, responsible production, and climate action.

To address environmental pollution (SDG 6: Clean Water and Sanitation; SDG 14: Life Below Water; and SDG 15: Life on Land), green chemistry promotes the design of chemical processes that minimize or eliminate hazardous waste. In Indonesia, where pollution of air, water, and soil remains a serious concern, implementing green chemistry principles can significantly reduce the release of toxic substances into ecosystems. The adoption of safer chemicals and sustainable agricultural inputs helps improve water quality and protect aquatic and terrestrial biodiversity, directly supporting the achievement of SDGs 6, 14, and 15.

In the energy sector, green chemistry plays a vital role in supporting SDG 7 (Affordable and Clean Energy) by promoting energy-efficient processes and encouraging the use of renewable resources. Indonesia's commitment to expanding renewable energy use can be strengthened by applying green chemistry innovations to optimize chemical production with lower energy demands. This reduces dependence on fossil fuels and greenhouse gas emissions while promoting the development of bio-based alternatives an essential step toward achieving a cleaner and more sustainable energy future.

Moreover, green chemistry fosters innovation within industrial sectors, aligning with SDG 9 (Industry, Innovation, and Infrastructure). By encouraging the creation of sustainable materials and technologies, green chemistry enables cleaner manufacturing processes, reduces waste generation, and improves workplace safety in Indonesia's growing industrial base. These contributions help build more sustainable infrastructure and drive innovation, making Indonesian industries more competitive globally while reducing their environmental footprint.

Responsible consumption and production (SDG 12) also benefit directly from green chemistry. By reducing waste and designing safer, more sustainable products, this approach supports the development of eco-friendly supply chains, recyclable materials, and environmentally conscious packaging. In Indonesia, increasing public and industrial awareness of green chemistry principles can foster more sustainable consumer behavior and production practices, advancing the shift toward a circular economy.

Addressing climate change (SDG 13: Climate Action) is another critical area where green chemistry can make a difference. By enhancing energy efficiency in chemical manufacturing and encouraging the use of materials with lower carbon footprints, green chemistry helps Indonesia mitigate greenhouse gas emissions. These practices contribute to the country's transition to a low-carbon economy and support its commitments to climate resilience under SDG 13.

Public health and well-being (SDG 3: Good Health and Well-Being) are also closely linked to green chemistry practices. A core principle of green chemistry is minimizing toxicity, which protects workers, communities, and consumers from exposure to harmful substances. In Indonesia, adopting safer chemical practices in industries and consumer products directly supports SDG 3 by reducing health risks and enhancing quality of life.

From an economic perspective, green chemistry presents opportunities to stimulate inclusive and sustainable growth. By opening new markets for green technologies, encouraging entrepreneurship, and creating green jobs in research, development, and manufacturing, this approach enhances Indonesia's industrial competitiveness. These economic opportunities contribute across multiple SDGs by fostering innovation, reducing inequalities, and supporting workforce development in sustainable sectors.

To fully realize these benefits, robust policy and regulatory frameworks are essential. Indonesia can accelerate green chemistry adoption through targeted regulations, financial incentives, and the establishment of safety standards for chemical use (Wira *et al*., 2017; Anastas & Zimmerman, 2018). Good governance ensures industries comply with environmental norms while advancing national sustainability goals (Loste *et al*., 2020; Widyantoro, 2017).

Equally important is raising awareness and building knowledge among stakeholders. Incorporating green chemistry into education, training, and public campaigns is crucial to developing a sustainability-oriented culture. Empowering students, professionals, and consumers through education will increase the capacity to implement green chemistry in various sectors, supporting long-term SDG achievement (Caroline, 2023; Kusumastuti & Samadi, 2022).

In conclusion, the integration of green chemistry into Indonesia's SDG agenda represents a holistic pathway toward achieving environmental sustainability, economic resilience, and societal well-being. Through innovation, responsible industry practices, and supportive policy frameworks, green chemistry can help the country overcome pressing

environmental challenges and progress toward a greener, healthier, and more equitable future (Purvis *et al*., 2019; Constable, 2021; Tremblay *et al*., 2020).

CONCLUSION

Based on a review of 11 selected journals, it is clear that the application of green chemistry principles has yielded significant advances in Indonesian industrial practices, ranging from catalytic process optimization to the synthesis of high-tech materials and waste valorization. Innovations such as the green synthesis of MnO_2 for supercapacitor electrodes, the production of nanoparticles via fermentation using red betel leaf extract, and the development of batik-waste adsorbents from zeolite and chicken feathers demonstrate how green chemistry approaches can reduce the use of hazardous substances, minimize waste, and improve energy efficiency. However, survey-based studies also reveal structural barriers—especially among SMEs—related to limited funding, insufficient access to green technologies, and a lack of targeted policy support. Although the Omnibus Law on Job Creation (Law No. 11/2020) provides a more flexible regulatory framework, concrete technical guidelines and incentives are still needed to effectively support green chemistry adoption.

To strengthen green chemistry uptake in Indonesia's industrial sector, future research should explore business models and case studies on the implementation of fiscal incentives and fast-track permitting mechanisms that genuinely stimulate green-technology investment, develop and test an integrated curriculum for vocational training and professional certification in green chemistry, including long-term impact evaluations on industrial productivity, design R&D collaboration protocols between universities, government agencies, and industry to facilitate technology transfer such as piloting Mobile Technology Labs and conduct longitudinal studies on the effectiveness of environmental performance indicators (emissions, energy, waste) and regular audits to map continuous improvement trends. Additionally, it is important to examine consumer perceptions and the impact of public-awareness campaigns on demand for eco-friendly products so that green-marketing strategies can be integrated into sustainable-industry roadmaps. By focusing on the technical, policy, and social dimensions together, future research will provide a stronger foundation for the advancement of green chemistry in Indonesia.

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