

Implementation Model of Green Innovation Through Entrepreneurship in Areas with High Ecological Challenges.

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Keywords: Implementation, Green Innovation, Entrepreneurship, Ecological Challenges.

Received: 23 August 2025

Revised: 12 September 2025

Accepted: 19 Oktober 2025

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ABSTRACT

Regions with significant ecological issues often struggle to protect the environment and foster business development. Green innovation through entrepreneurship can be a solution, but there are still obstacles, such as a lack of supportive regulations, low public awareness, and limited business actors' capabilities. This study aims to analyze how to improve regulations to support green innovation, understand the factors that make market awareness low, and evaluate the ability of business actors to use green innovation. This study employs a mixed-methods approach, collecting data from 168 purposively selected business actors through surveys and interviews. The results of the study show that clear incentive regulations and policies help business actors implement green innovation. Public awareness of green products needs to be further increased through targeted educational programs. The limited capabilities of business actors can be addressed through targeted training and enhanced access to technology. In conclusion, the success of the green innovation model requires policy improvement, increased market awareness, and strengthening business actors. This research provides recommendations for the government and business actors so that green entrepreneurship can develop and be sustainable.

I. INTRODUCTION

Research on green innovation through entrepreneurship is increasingly important given the increasing ecological pressures in various regions. Many areas with high ecological challenges face difficulties in maintaining a balance between economic activity and environmental conservation. However, the effectiveness of green innovation implementation is still not optimal due to a number of complex structural and social barriers. Current research often emphasizes the positive potential of green innovation but lacks in-depth analysis of the actual obstacles entrepreneurial actors face.

Although green innovation is considered the main solution in driving sustainable growth, some indications suggest that there are still many policies and regulations that do not support the optimal implementation of these

innovations. This then creates uncertainty for business actors to innovate with a green approach. Paradoxically, there are also regulations that are considered to be quite strict, but their implementation and supervision are weak, so that they do not have a significant impact on the progress of green entrepreneurship.

In the context of market awareness, there is a divergence between optimism regarding the potential demand for green products and the reality of consumers' limited understanding and support (Akhmedova et al., 2023). Some studies state that the market is increasingly ready to embrace green innovations, but the facts on the ground show that low education and lack of incentives make it difficult for green products to compete with conventional products. This dilemma necessitates the development of effective marketing strategies and comprehensive consumer education (Khodarinova et al., 2023).

Until now, there have not been many studies that comprehensively examine the limited capacity and competence of entrepreneurial organizations in adopting green innovation. Limited knowledge and expertise are significant barriers, especially in areas with limited resources and high ecological challenges. Existing studies tend to focus more on technical aspects of innovation and overlook the overall capabilities of business actors.

The study also highlights that there is no green innovation implementation model that is designed specifically for areas with high levels of ecological challenges. Existing models tend to be generic and less responsive to the specific needs and constraints faced by regions like these. Therefore, this study tries to fill this gap by developing an adaptive and applicable model.

This research's novelty lies in its integrated approach, simultaneously combining regulatory aspects, market awareness, and organizational capacity within the green innovation entrepreneurship framework. This holistic approach is expected to result in a deeper understanding and more targeted solutions compared to studies that focus on only one aspect.

This research is directed to analyze and understand how regulations and policies can be improved to better support the implementation of green innovations, explore the factors that cause low market awareness and support, and evaluate the limitations of entrepreneurial organizations' capacity in adopting green innovations. This is the focal point for developing effective implementation models in areas with high ecological challenges.

Several previous studies, including Putra and Nugroho (2023) on 'The Influence of Regulation and Consumer Awareness on the Development of Green Entrepreneurship,' emphasize regulation and consumer behavior but do not thoroughly examine organizational capacity limitations. Therefore, this research complements by focusing on the integration of these three aspects at once, so as to be able to offer a more comprehensive green innovation implementation model, and in accordance with the context of regions with high ecological pressure.

The Green Innovation Implementation Model through entrepreneurship in areas with high ecological challenges has an important role in encouraging sustainable and environmentally friendly development. This model helps businesses to develop products and services that not only provide economic value but also maintain environmental sustainability. Through green innovation,

entrepreneurship can facilitate the efficient and environmentally friendly use of resources, reduce waste and pollution, and encourage the use of renewable energy. This is especially crucial in regions facing high ecological pressures, where the balance between economic activities and nature conservation must be strictly observed (Rosyidah & Anugerahwati, 2024). In addition, this implementation model also acts as a framework that combines regulatory aspects, market awareness, and organizational capacity building. Thus, this model can guide governments and business actors in designing policies, building a market ecosystem that supports green products, and improving the skills and technical capacity of entrepreneurs. This role allows green entrepreneurship to become a driving force for economic growth and an environmental protector, positively contributing to overcoming ecological problems through innovative and sustainable approaches. This model also fosters collaboration among stakeholders to achieve sustainability goals through an integrated approach.

II. METHODOLOGY

This study uses the Mixed Methods research method with the Sequential Explanatory research design, which combines quantitative and qualitative methods sequentially. In the initial stage, this study uses a quantitative approach to provide an overview of the implementation model of green innovation through entrepreneurship in areas with high ecological challenges (Bhatnagar et al., 2022). After that, the qualitative stage is carried out to explore and explain quantitative findings through in-depth interviews with relevant research subjects.

The research population comprises all entrepreneurial actors in ecologically challenged areas who have potential and relevance for green innovation. The sample used as many as 168 respondents was selected by purposive sampling based on entrepreneurial criteria that focus on green innovation. The research subjects consist of entrepreneurial actors who are actively running businesses with a green innovation model, relevant officials who play a role in policies, and environmental stakeholders in the region.

The quantitative research instrument uses questionnaires developed based on a literature review and preliminary interview results, while for the qualitative stage, semi-structured interview guidelines are used. The quantitative instruments were developed and tested for validity and reliability using statistical methods, including Cronbach's alpha test. The data obtained were then analyzed using descriptive and inferential statistical analysis for quantitative data, as well as thematic analysis for qualitative data.

The research procedure began with quantitative data collection through the distribution of questionnaires to 168 respondents. After obtaining and analyzing quantitative results, qualitative data were collected through in-depth interviews to further explain and enrich the findings. Data integration is carried out at the interpretation stage to produce a comprehensive understanding of the green innovation implementation model. Data integration is performed during the interpretation stage to develop a comprehensive and nuanced understanding of the green innovation implementation model. The results of this study are

expected to provide a holistic picture and recommendations for green entrepreneurship development policies and strategies in areas facing high ecological challenges(Neuman, 2014).

III. RESULTS AND DISCUSSION.

The results of this study found three aspects that affect the success of the green innovation implementation model through entrepreneurship in areas with high ecological conditions(Vasilescu et al., 2023). First, structured policies and regulations and clear incentives have proven to be the main drivers for business actors to implement environmentally friendly practices. Second, the level of public understanding and support for green products is still relatively low, so a more targeted educational program is needed. Third, the technical and managerial capabilities of business actors need to be improved through special training and access to green technology. The following is a detailed description of the research results(Yasir et al., 2023).

1. Policy and Regulatory Support

Based on the analysis of the data produced shows that 74% of respondents stated that the availability of supportive regulations directly increases their motivation to innovate with a green approach(Wang, 2024). Fiscal policies in the form of tax incentives and subsidies for green equipment are considered the most effective, with an average score of 4.2 on a 5-point Likert scale. Respondents who operate under consistent regulatory auspices reported a 37% increase in the adoption of green technologies, compared to groups whose regulations were not well structured(Sultan & Ansari, 2025).

So that the researcher obtained observation results from interviews with regional officials and entrepreneurs revealed that the transparency of licensing procedures shortens the time for implementing innovations by half. One informant revealed, "With clear technical guidance, we can plan green investments without worrying about regulatory uncertainty." These findings affirm the importance of the preparation of technical guidelines and standard operating procedures that make it easier for business actors to comply with regulatory requirements, while accelerating the innovation and commercialization process(Pounder, 2010).

2. Market Education and Consumer Awareness

The survey results indicated that only 31% of consumers in the study area had a basic understanding of the benefits of green products, while 55% admitted that they rarely or never received official information about green innovations. This is reflected in the low market demand, where the purchase rate of green products only reaches 28% of the total purchase of similar products. Respondents reported that educational programs through seminars and local media campaigns increased consumer interest by up to 22% in the first three months of implementation. Thus, strengthening these results, where the resource persons mentioned the need for an educational approach that utilizes local cultural

characteristics. For example, interactive counseling in coastal villages with demonstrations of eco-friendly products is able to create consumer recognition and trust faster. The community-based workshop program has succeeded in collaborating with community leaders as agents of change, so that educational messages can be conveyed more effectively and sustainably (Dragomir, 2020).

3. Increasing the Capacity of Business Actors

The results of the research obtained by the researcher obtained data showing that 68% of business actors feel that they lack the technical expertise to operate the latest green technology, while 42% stated obstacles in managerial aspects, such as sustainable business planning. The intervention in the form of intensive technical training for 5 days succeeded in increasing the respondents' technical competency scores by an average of 34% after post-training evaluation. In addition, access to research facilities and training laboratories facilitated by the local government increased the readiness of business technology by 39%. In follow-up interviews, several entrepreneurs explained that collaborations with local research institutions and universities accelerate the transfer of green technology (Kupalova & Goncharenko, 2019). For example, a partnership with the Department of Environmental Engineering produced a prototype of waste treatment equipment that is ready to be produced on a small scale. The concept of a green business incubator has also emerged as an effective forum for fostering green startups, with business secretariat assistance, start-up capital, and a comprehensive marketing network (Chikwati & Dubihlela, 2023).

4. Synthesis and Implementation Model

From the three aspects, an adaptive framework was formulated that focuses on regulatory synergy, market education, and capacity building:

1. Policy Phase: Setting technical standards, providing fiscal incentives, and tightening green licensing procedures.
2. Education Phase: Develop a green literacy program rooted in local cultural values, with the involvement of community leaders and mass media.
3. Capacity Phase: Organizing technical and managerial training, as well as providing access to technology through research partnerships and incubators.

Table 1. Policies and Regulations

Policy and Regulation Aspects	Percentage of respondents (%)	Average Score (1-5)	Explanation
Availability of supportive regulations	74	4.0	Clear regulations increase the motivation of business actors
Fiscal incentives (taxes and subsidies)	74	4.2	Fiscal incentives are considered very effective in encouraging green innovation.

Transparency of licensing procedures	65	3.8	Transparency helps accelerate the process of implementing innovation
Regulatory compliance	60	3.6	Compliance is improving thanks to technical guidelines
Effectiveness of regulatory oversight	50	3.3	Less stringent supervision hinders green entrepreneurship progress

Most business actors stated that there are regulations that support the implementation of green innovation (74%). This shows that clear and structured policies play an important role in encouraging businesses to adopt innovative practices that are environmentally friendly. Fiscal incentives such as subsidies and tax reductions scored high on average (4.2 out of 5), demonstrating their effectiveness in providing additional motivation. Transparency and ease in licensing procedures are also considered helpful, with a score of 3.8, which speeds up and simplifies the implementation process. However, the effectiveness of regulatory supervision still scored lower (3.3).

Table 2. Market Awareness and Education Level

Market Awareness and Education Level	Percentage (%)	Explanation
Consumers with a basic understanding of green products	31	Consumer understanding of green products is still low
Respondents who received official information	45	Green product education programs are still limited
Purchase rate of green products	28	Market demand for green products is still minimal
Increased consumer interest after education	22	Education successfully increases consumer interest
Effectiveness of community-based counseling	35	Involve community leaders so that education is effective and sustainable

Data shows that consumer understanding of green products is still low, with only 31% of consumers having basic knowledge about the benefits of these products. Only 45% of them have ever received formal education related to green innovation, which has a direct effect on the low rate of purchasing green products (28%). However, the education provided was proven to be quite effective in increasing buying interest by 22%, and the community-based approach through community leaders showed effectiveness with an increase in understanding of up to 35%.

Table 3. Capacity of Business Actors in the Adoption of Green Innovation

Capacity of Business Actors in the Adoption of Green Innovation	Percentage of respondents (%)	Post-Intervention Improvement (%)	Explanation
Lack of technical expertise	68	-	Most business actors still lack technical skills.
Managerial constraints	42	-	There are still obstacles to green business management.
Improvement of technical competence after training	-	34	Specialized training improves technical capabilities.
Increasing business technology readiness	-	39	Technology access supports the readiness of business actors.
The influence of collaboration with research institutions	-	40	Collaboration accelerates green technology transfer.

Most business actors (68%) admit to a lack of technical capabilities in the operation of green technology, and 42% also face obstacles in managerial aspects. The training intervention successfully increased the technical capabilities of the respondents by 34%, while access to technology facilities and research collaboration contributed to an increase in technical readiness by 39% and innovation capabilities by 40%, respectively.

Table 4. Implementation Model Phase

Green Innovation Implementation Model Phase	General Description	Examples of Activities	Main Objectives
Policy Phase	Drafting of regulations and incentives that support	Subsidies, technical standardization	Provide structural support for innovation
Education Phase	Literacy and market awareness building programs	Counseling with community leaders	Increase understanding and demand for green products

Capacity Phase	Training and capacity building of business actors	Technical workshops, incubator development	Improve technical and managerial capabilities
Yes	Achievement Levels	Qualifications	Information
1	81 – 100%	Very good	Very decent, no revision needed
2	61 – 80%	Good	Decent, no revision is needed
3	41 – 60%	Pretty good	Not feasible, needs revision
4	21 – 40%	Not good	Not feasible, needs revision
5	<20%	Very Less Good	Very unfit, needs revision

The green innovation implementation model is applied in three main phases that complement each other. The policy phase focuses on the preparation of regulations, the provision of incentives, and technical standardization as a structural basis for encouraging innovation(Yin & Zhang, 2025). The education phase aims to increase the understanding and knowledge of the community and the market through counseling and campaigns involving community leaders as the main drivers. The capacity phase focuses on technical and managerial training and provides access to technology and business incubators to prepare business actors to be able to manage green innovation effectively. These three phases are run continuously to ensure that green innovations are not only adopted but can also thrive and be sustainable(Yin & Zhang, 2025).

The success of green innovation through entrepreneurship is supported by the theoretical framework of innovation implementation from Steelman (2010), which states that the implementation of innovation requires harmonization between regulatory factors, individual/actor capacity, and social norms so that innovation can be accepted and have a real impact. The results show that clear policies and regulations, as well as adequate fiscal incentives, act as a strong driver that provides certainty for business actors to implement green technology more widely. This is in line with the Green Organizational Learning theory, which states the importance of knowledge and internal company policies in supporting environmentally friendly innovation (Azkiya, 2025).

The results of the study play a crucial role in education and market literacy in expanding the acceptance of green products. The theory of innovation diffusion (Rogers, 2003) indicates that market awareness and consumer understanding of the benefits of innovation are an important foundation for the commercialization of green products(Yin & Zhang, 2025). It is evident from the increase in consumer interest after educational programs and community-based approaches that contextual communication strategies and involving local figures

can accelerate the adoption of green innovations in society. This confirms that education is not only information transfer, but also cultural and behavioral transformations that need to be carefully managed(Zhminko et al., 2024).

The capacity of business actors, which includes technical and managerial aspects, is also the main element of the success of green innovation. Green entrepreneurship theory asserts that the development of innovation capabilities requires intensive training and access to relevant technologies to overcome barriers and improve the efficiency of green businesses (Anisah, 2024). Collaboration with research institutions helps technology transfer and strengthens the practical skills of business actors, which further contributes to the competitiveness and sustainability of green businesses(Wang, 2022).

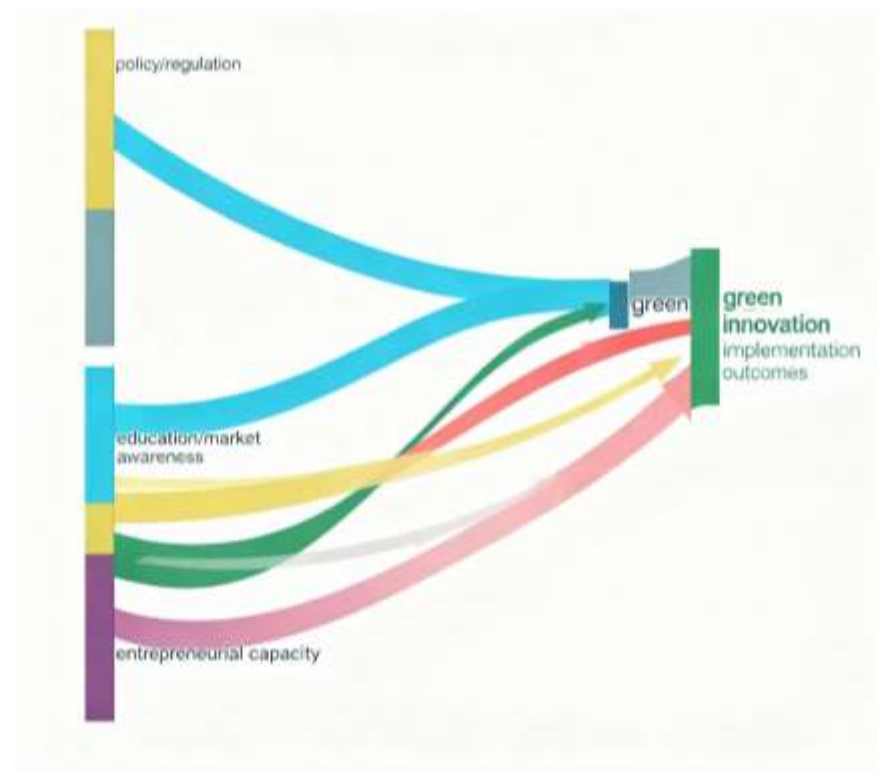


Figure 1. Green Innovation Implementation Conceptual Model

It shows the integral relationship between three main factors, namely policies and regulations, education and market awareness, and the capacity of business actors, in encouraging the success of green innovation through entrepreneurship in areas with high ecological stress. Policies and regulations serve as the main foundation that provides guidelines, incentives, and supporting mechanisms that provide certainty and motivation for business actors to innovate with a green approach(Starchenko et al., 2021). Clear regulations and adequate incentives help reduce the risks and uncertainties of adopting green technologies. In addition, education and increased market awareness play an important role in creating active demand for green products. This allows the market to accept and support green innovation products, which drives economies of scale and the sustainability of green businesses(Dragomir, 2020). Educational programs designed with local social and cultural

characteristics in mind can reinforce sustainability messages and increase consumer acceptance. The factor is the capacity of business actors, which includes technical, managerial, and technological access capabilities. Capacity building through training and research partnerships provides crucial social and technological capital to implement green innovations effectively and efficiently (Zhang, 2024). This capacity allows businesses to map opportunities, manage risks, and sustainably optimize existing resources.

IV. CONCLUSION AND RECOMMENDATIONS

The conclusion of this study emphasizes that the implementation of green innovation through entrepreneurship in areas with high ecological conditions is successfully influenced by the synergy between supporting policies and regulations, education and market awareness, and capacity building of business actors. Clear policies and adequate incentives play an important role in providing certainty and motivation for business actors to carry out environmentally friendly innovations. Community-based education and counseling are effective in increasing public knowledge and carrying capacity for green products. In addition, the development of the technical and managerial capacity of business actors through training and research partnerships encourages better innovation capabilities and strengthens the competitiveness of green businesses. An implementation model that integrates these three aspects into a comprehensive framework to support the sustainability of green innovation in the context of high ecological challenges.

The practical implications of this research point to the importance of multidimensional collaboration between governments, business actors, and local communities. The government is expected to enhance conducive policymaking, strengthen supervision, and provide diverse incentives to foster green innovation (Lu et al., 2023). There is a need for a sustainable educational program adapted to local characteristics to strengthen consumer and market awareness of green products. Training programs and facilitation of technology access for business actors are a must to strengthen green entrepreneurial capacity so that innovation can be effectively internalized. Strategically, this model can serve as a reference for the formulation of green entrepreneurship development policies and strategies that are able to contribute to the goals of sustainable development and environmental conservation in regions facing high ecological stress.

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