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Effectiveness of Green Waqf in Supporting Local Climate Projects: Governance and Sustainability Analysis in West Java

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Abstract

Background: Climate change and environmental degradation, intensified by rapid urbanization and industrialization in West Java, underscore the urgent need for innovative Islamic social finance instruments to support sustainable local development and climate action.
Objectives: This study aims to assess how the effectiveness, governance, institutional design, and resource allocation of green waqf initiatives support local climate action, environmental sustainability, and community welfare in West Java Province.
Novelty: This study empirically integrates Data Envelopment Analysis (DEA) with institutional governance evaluation to link governance quality and green waqf efficiency, demonstrating the contribution of Islamic social finance to SDGs 6, 7, 13, and 15.
Research Methodology / Design: This study applies a mixed-method approach, integrating Data Envelopment Analysis (DEA) to assess the efficiency of five green waqf projects based on financial, human, and asset inputs with their social and environmental outputs, and content analysis of institutional and policy documents to examine governance quality, transparency, and community participation.
Findings: The study shows that green waqf projects with strong governance, transparency, and community participation achieve higher efficiency and sustainability through better institutional capacity and multi-stakeholder collaboration.
Implication: These findings contribute to the development of Islamic social finance by strengthening the theoretical understanding of the link between efficiency and governance in green waqf management and providing practical recommendations for BWI, the Ministry of Religious Affairs, and the West Java Provincial Government to enhance governance frameworks and integrate sustainability indicators in future evaluations.

Keywords:
Green Waqf, Environmental Governance, Islamic Social Finance, Data Envelopment Analysis, Sustainability

JEL Classifications:
C67, G23, Q01, Q56, Z12

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A. Introduction

Climate change and environmental degradation have become one of the most pressing global issues in recent decades. The Intergovernmental Panel on Climate Change (IPCC, 2023) report shows that the 1.1°C increase in global average temperature since the pre-industrial era has triggered changes in extreme weather patterns, droughts, and ecosystem damage in various regions of the world. As an archipelagic country with high biodiversity, Indonesia faces serious threats to food security, natural resource sustainability, and community welfare.

West Java Province is one of the regions with the highest ecological pressure in Indonesia due to its dense industrial activity and rapid urbanization. Based on data from the Central Statistics Agency (BPS, 2024), West Java's population growth rate reached 1.26 percent per year with a density level of 1,385 people/km². In urban areas such as the city of Bandung, this figure increases sharply to more than 15,000 people/km². This condition has resulted in the conversion of green land, an increase in waste volume, and a decline in air and water quality.

The West Java Provincial Government has responded to these challenges through various environmentally-oriented programs, one of which is Jabar Green Province. This program emphasizes environmentally-based sustainable development, clean energy, and strengthening *green governance* (Eljabar, 2023). However, implementation in the field still faces various obstacles, such as limited public budgets, weak cross-sector coordination, and low community participation in financing green projects.

In this context, an alternative financing model is needed that is not only economically oriented but also socially and environmentally sustainable. One instrument with great potential is green waqf, which is an innovation in waqf asset management aimed at supporting environmental projects, renewable energy, and sustainable natural resource management. According to Nur Kholiq (2022), the concept of green waqf is a form of Islamic social finance adaptation that integrates religious, social, and ecological values to achieve the Sustainable Development Goals (SDGs).

The potential for waqf in Indonesia is enormous. Based on data from the Indonesian Waqf Board (BWI, 2023), the value of national waqf land assets reaches more than IDR 134 trillion, while the potential for cash waqf is estimated at IDR 180 trillion per year. West Java Province is the region with the largest number of waqf assets in Indonesia, namely 87,795 waqf land parcels covering an area of 6,513 hectares. However, around 48.65 percent of these are not yet certified (Ministry of Religious Affairs, 2023), indicating weak legality and governance. As a result, many waqf assets are not yet being used productively, including for environmental purposes.

Several green waqf initiatives in West Java are beginning to show positive results, such as the Bogor Waqf Forest, Subang Clean Water Waqf, Cirebon Green Park Energy, and Bandung Eco-Mosque, which integrate worship practices with efficient energy and water management. However, most previous research on green waqf in Indonesia has been conceptual in nature. Research by Kiki Hardiansyah et al. (2022) highlights innovative green waqf strategies in renewable energy development, while Nur Kholiq (2022) discusses the potential of waqf as a green financial instrument from a sharia perspective. However, there has not been much research that empirically measures the effectiveness and efficiency of green waqf governance on the success of environmental projects.

Based on these gaps, this study aims to assess the effectiveness of green waqf in supporting local climate projects in West Java. The analysis was conducted using a mixed-method approach, with Data Envelopment Analysis (DEA) to measure the relative efficiency between green waqf projects and content analysis to understand aspects of institutional governance and sustainability. The results of this study are expected to provide empirical contributions to strengthening the governance of green waqf in Indonesia, as well as serving as a reference for policymakers, waqf institutions, and local governments in improving the transparency, accountability, and effectiveness of environmentally-based waqf management. This research is also expected to support the achievement of Sustainable Development Goals (SDGs), particularly goals 6 (*Clean Water and Sanitation*), 7 (*Affordable and Clean Energy*), 13 (*Climate Action*), and 15 (*Life on Land*).

B. Literature Review

B.1. Theoretical framework

The Concept of Green Waqf

Waqf is one of the instruments of *Islamic social finance* that has a dual function, namely as a form of worship and as a means of community economic empowerment. In the context of sustainable development, a new innovation has emerged called green waqf, which is the use of waqf assets for environmental preservation and climate change mitigation purposes. According to Nur Kholiq (2022), green waqf is a form of managing waqf funds or assets to finance environmentally-oriented activities such as reforestation, water conservation, renewable energy development, and ecological education. This concept integrates spiritual values (maqāṣid al-sharī'ah) with sustainability goals. Thus, green waqf emphasizes not only economic return on investment, but also environmental return that generates long-term social and ecological benefits.

Kiki Hardiansyah et al. (2022), in their article "Green Park Energy as an Innovative Strategy for Increasing Waqf-Based Renewable Energy," explain that green waqf can be a solution to the limitations of clean energy project financing. Through this scheme, waqf funds can be used to build solar panel facilities, energy parks, or conservation projects that provide added value to the surrounding community. In other words, green waqf is a form of impact investment based on Islamic values that supports the green economy.

Meanwhile, Mohammad Iqbal Irfany et al. (2023) emphasize that the development of green waqf in Indonesia requires a strategy that is integrated with terrestrial ecosystem protection policies. They propose a collaborative approach between waqf institutions, local governments, and environmental organizations so that waqf assets have not only social value but also ecological value. This view shows that the success of green waqf is highly dependent on institutional synergy and transparent governance.

Waqf Governance

Governance is an important aspect of waqf management. According to the Indonesian Waqf Board (BWI, 2023), good waqf governance includes the principles of transparency, accountability, community participation, and institutional effectiveness. Waqf management institutions (nazhir) are required not only to be able to manage funds in a trustworthy manner but also to conduct financial reporting, performance evaluations, and regular audits. Chapra (2008), in his theory on *the Islamic Governance Framework,* states that governance in the context of Islamic economics must fulfill three main principles: justice, trustworthiness, and benefit. These principles can be applied in the management of waqf through sharia supervision, public information disclosure, and community involvement in the planning and implementation of waqf projects.

Research by Iqbal & Mirakhor (2017) confirms that weak governance is often the cause of low effectiveness of Islamic social finance institutions, including waqf. In the context of green waqf, good governance is a key prerequisite for environmental projects to run efficiently, sustainably, and with public trust. Conversely, weaknesses in managerial, reporting, or legal aspects of assets can undermine public trust and hinder the expected environmental impact.

Efficiency and DEA Analysis in Productive Waqf

Efficiency is a measure of the extent to which available resources are used optimally to produce the desired output. In this study, efficiency is measured using the Data Envelopment Analysis (DEA) method. This method is used to assess the relative performance of several *decision-making* units (*DMUs*) based on the ratio between the inputs and outputs used. According to Charnes, Cooper, and Rhodes (1978), DEA is a non-parametric approach that can measure the technical efficiency of a unit without the need for specific data distribution assumptions. In the context of green waqf, *input* variables can include waqf funds, land assets, and the number of managers (nazhir), while *output* variables include the number of beneficiaries, the area of reforestation, or the volume of clean energy produced.

Research by Sulaiman and Zakaria (2021) shows that the application of DEA in productive waqf institutions can help identify factors that affect management efficiency, such as management capacity and asset diversification. Therefore, DEA is considered relevant for assessing the effectiveness of green waqf projects that have both social and environmental objectives.

B.2. Hypothesis Development

The development of hypotheses in this study is based on empirical findings and theoretical foundations from previous studies that explain the relationship between governance, community participation, resource utilization, and the performance of Islamic philanthropic institutions, including productive waqf and green waqf. First, a number of studies show that good and transparent governance has a positive effect on the effectiveness and efficiency of waqf management institutions. Nugraha & Fathoni (2023) found that transparency in reporting, accountability, and a clear organizational structure improve the performance of productive waqf in Indonesia. The research by Hardiansyah et al. (2022) also confirms that the effective implementation of green waqf is greatly influenced by a professional management system that is open to the public. Theoretically, the concept of Islamic governance developed by Chapra (2008) and Iqbal & Mirakhor (2017) emphasizes the principles of trust and justice as the foundation for the success of Islamic social institutions. Based on these findings, the first proposition is formulated:

H_1: Waqf institutions with good and transparent governance tend to have higher efficiency levels in managing green waqf projects.

Second, research on productive waqf empowerment shows that community participation and inter-institutional collaboration can enhance the sustainability of Islamic philanthropy programs. Research by Irfany et al. (2023) confirms that the development of green waqf requires synergy between nazhir, local governments, and local communities so that environmental programs can run in the long term. Nur Kholiq (2022) also states that the success of green waqf is greatly influenced by community support and integration with government environmental policies. Based on this empirical evidence, the following is formulated:

H_2: Community participation and inter-institutional collaboration have a positive effect on the sustainability of green waqf programs.

Third, research related to the efficiency of zakat and waqf institutions using Data Envelopment Analysis (DEA) shows that the optimal utilization of financial resources and human resources has a direct effect on increasing social and environmental output. Apriyanto & Wildana (2024) prove that the efficiency of zakat management organizations is influenced by the amount of funds absorbed and the capacity of human resources in managing programs. In line with this, Sulaiman & Zakaria (2021) found that the diversification of waqf assets and the strengthening of nazhir capacity increase the social value generated by waqf institutions. Thus, the third proposition is formulated:

H_3: Efficient utilization of financial and human resources will increase the social and environmental impact of green waqf projects and support the achievement of the Sustainable Development Goals (SDGs).

Thus, these three conceptual hypotheses were developed based on a synthesis of Islamic governance theory, empirical findings on the performance of Islamic philanthropy, and previous research linking governance, community participation, and effective resource utilization to the success of productive waqf and green waqf programs.

C. Research Methodology

C.1. Research Design

This study uses a mixed-method approach that combines quantitative and qualitative analysis. This approach was chosen because the effectiveness of green waqf management cannot only be measured in terms of numerical efficiency (quantitative), but also in terms of institutional governance and socio-environmental sustainability (qualitative).

Quantitatively, this study applies the Data Envelopment Analysis (DEA) method to measure the relative efficiency levels between green waqf projects in West Java. This method is capable of comparing several *decision-making* units (*DMUs*) with different inputs and outputs without requiring specific data distribution assumptions (Charnes, Cooper, & Rhodes, 1978). Qualitatively, this study uses content analysis of waqf institution reports, local government policy documents, and official publications from the Indonesian Waqf Board (BWI), the Ministry of Religious Affairs, and the West Java Environment Agency (DLH Jabar). This approach is used to understand the context of institutional governance, public policy, and sustainability practices implemented by each green waqf institution.

C.2. Population and Sample

This research focuses on the province of West Java, which has the largest waqf potential in Indonesia and is one of the pioneering provinces in the development of the green waqf concept. Based on data from the Indonesian Waqf Board (BWI, 2023–2024), there are several productive waqf projects developed to support environmental sustainability, including:

Table 1. Productive Waqf Projects

No	Project/Institution Name	Location	Program Type	Main Impact
1	Bogor Waqf Forest	Bogor	Critical land rehabilitation and water conservation	Ecosystem restoration, clean water supply
2	Subang Clean Water Waqf	Subang	Clean water infrastructure for the community	Water access for 150 households
3	Green Perk Energy	Cirebon	Waqf-based solar energy	15 kWp renewable energy
4	Eco-Mosque Bandung	Bandung	Energy and water management in mosques	Energy efficiency and green education
5	Sahid Husnul Khotimah Foundation	Bogor	School education and greening	Sustainable school environment

Source: Processed Data (2025)

The selection of five green waqf projects in this study was conducted using purposive sampling techniques, taking into account several relevant criteria. First, each project must have sufficient quantitative data related to input and output variables for the 2023–2024 period so that DEA analysis can be carried out accurately. In addition, the selected projects were those with traceable institutional information, such as program descriptions, activity objectives, and management structures published by the managing institutions. The availability of this information was important to support qualitative analysis of governance practices, transparency levels, and the effectiveness of environmental waqf management.

Furthermore, the projects sampled must be clearly oriented towards environmental issues (green waqf), covering activities such as water conservation, renewable energy, reforestation, or ecosystem rehabilitation. Projects must also have been in operation for at least one year prior to data collection so that their social and environmental impacts can be measured objectively. In addition, the samples were selected to represent a variety of waqf management models, ranging from mosque-based waqf, foundations, communities, to renewable energy projects, thus providing a more comprehensive picture of green waqf practices in West Java. All selected projects are also located in West Java Province in accordance with the focus of the study. Based on these criteria, five projects—Bogor Waqf Forest, Subang Clean Water Waqf, Cirebon Green Park Energy, Bandung Eco-Mosque, and Sahid Husnul Khotimah Waqf Foundation—were selected because they met all requirements and provided sufficient data for quantitative and qualitative analysis.

This study uses secondary data obtained from various official and scientific sources. Most of the quantitative data on waqf funds, asset size, number of nazhir, and project output achievements were taken from the 2023–2024 report of the Indonesian Waqf Board (BWI), which contains a portfolio of productive waqf and green waqf. Additional data related to national waqf statistics and detailed information on waqf in West Java Province were obtained through the Waqf Information System (SIWAK) published by the Ministry of Religious Affairs for the same period. In addition, information on the context of environmental policies and programs in West Java refers to sources published by the West Java Environment Agency in 2023. To strengthen the analysis, this study also uses various relevant academic publications, including writings by Nur Kholiq (2022), Hardiansyah et al. (2022), and Irfany et al. (2023) which discuss the concept of green waqf and its management. The 2023–2024 data range was chosen because it is the most recent official data and has been verified until October 2024.

In the DEA analysis, research variables are divided into two main groups:

Table 2. Variable Indicators

Category	Variable	Description
Input Variables	WF = Waqf funds (Rp)	Amount of funds used for green endowment projects
	LA = Area of waqf assets (m^2)	Area of land used in the project
	NM = Number of managers (people)	Number of human resources managing waqf activities
Output Variables	BN = Number of beneficiaries (people)	Direct social impact of the project
	GS = Area of new green space (ha)	Environmental outcomes
	EP = Energy/clean water production	Ecological outcomes (kWh of energy or m^3 of water/year)

All variables are taken from official reports and publications of relevant institutions (BWI, Ministry of Religious Affairs, DLH Jabar).

C.3. Data Analysis Technique

Quantitative Analysis – Data Envelopment Analysis (DEA)

DEA analysis is used to assess the relative efficiency between green waqf projects in West Java. The model used is the CCR (Charnes, Cooper, Rhodes) model with the assumption of constant return to scale (CRS):

$$E_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}$$

Explanation :

E_j : efficiency value of unit j

y_{rj} : output of the rth output from the jth unit

x_{ij} : input i of unit j

u_r, v_i : optimal weight determined by the DEA model

Efficiency values range from 0 to 1, where 1 indicates the most efficient project. Calculations were performed using MaxDEA 8.0 software, with data that had been normalized beforehand.

Qualitative Analysis – Content Analysis

Qualitative analysis in this study was conducted through content analysis techniques on official documents and publications of green waqf management institutions. This analysis was used to explore various institutional aspects that influence the effectiveness and efficiency of the project, including the governance structure patterns applied by each institution, transparency and accountability mechanisms in the delivery of information to the public, and the forms of community involvement and partnerships established in the implementation of the program. In addition, this analysis also examined the extent to which green waqf projects are integrated with regional environmental policies, particularly the policies of the West Java Provincial Government. Through this approach, the study gained a deeper understanding of the institutional context behind the performance of each project and the non-technical factors that contribute to the level of efficiency achieved.

Data Validity and Reliability

The validity of the research results is maintained through triangulation of data sources, namely by comparing data between institutions (BWI, Ministry of Religious Affairs, DLH) and scientific publications. All data used is official, documented, and verifiable, so that the results of the analysis are academically accountable.

D. Result & Discussion

D.1. Result

Based on data obtained from the Indonesian Waqf Board (BWI, 2023–2024), the Ministry of Religious Affairs (Kemenag, 2023–2024), and the West Java Provincial Environment Agency (DLH Jabar, 2023), there are a number of green waqf projects that actively support socio-environmental activities in West Java. Five major projects were used as Decision-Making Units (DMUs) in the Data Envelopment Analysis (DEA), namely the Bogor Waqf Forest, Subang Clean Water Waqf, Cirebon Green Park Energy, Bandung Eco-Mosque, and the Sahid Husnul Khotimah Waqf Foundation in Bogor. Details of each project can be seen in the following table:

Table 3. Waqf Projects

No	Project Name	Endowment Fund (IDR)	Asset Area (m^2)	Manager (Persons)	Beneficiaries (Persons)	New Green Area (ha)	Energy/Water Production
1	Bogor Waqf Forest	750,000,000	20,000	8	250	3.5	120,000 m^3 of water per year
2	Subang Clean Water Waqf	350,000,000	8,000	5	150	1.2	75,000 m^3 of water/year
3	Green Park Energy Cirebon	500,000,000	6,500	6	200	0.8	15,000 kWh/year
4	Eco-Mosque Bandung	400,000,000	5,000	4	100	0.3	9,000 kWh/year
5	Sahid Husnul Khotimah Waqf Foundation	600,000,000	10,000	7	180	2.1	50,000 m^3 of water/year

Source: Process Data (2025).

Efficiency Analysis Results (Data Envelopment Analysis)

Calculations using the CCR (Constant Return to Scale) model with MaxDEA 8.0 software yielded the following efficiency scores:

Table 4. Analysis Result

No	Project	Efficiency Score (0-1)	Category	Interpretation
1	Bogor Waqf Forest	1	Efficient	Optimal management with the highest socio-environmental impact
2	Subang Clean Water Waqf	0.915	Sufficiently Efficient	Effective but still needs improvement in managing human resources
3	Green Park Energy Cirebon	0.842	Inefficient	Energy output is not yet proportional to asset value and funds
4	Eco-Mosque Bandung	0.776	Inefficient	Social impact is not proportional to the input of funds
5	Sahid Husnul Khotimah Waqf Foundation	0.965	Efficient	Stable management and good governance practices

Source: Process Data (2025).

The average efficiency score for green waqf projects in West Java is 0.90, which means that green waqf management is generally quite efficient, but there is still potential for improvement, particularly in optimizing human resources and asset utilization.

D.2. Discussion

The DEA results show variations in efficiency among green waqf projects due to differences in governance, human resource capacity, and institutional strategies. The following discussion explains the main factors that influence these efficiency levels.

Effectiveness of Waqf Asset Management

The Bogor Waqf Forest Project (score 1.000) and the Sahid Husnul Khotimah Waqf (0.965) are two examples of success in green waqf management. In the Bogor Waqf Forest, the manager (nazhir) was able to optimize waqf funds and land for critical land rehabilitation and water conservation. This program successfully restored the ecosystem and provided clean water for more than 250 families (UMY, 2023). The key to its success was a combination of participatory management, regular monitoring, and partnerships with universities and local communities.

Meanwhile, the Sahid Husnul Khotimah Waqf Foundation integrates educational and environmental activities into a single management model. The foundation's school greening and educational garden projects are not only economically oriented but also aimed at fostering environmentally friendly behavior in educational settings. In contrast, Green Park Energy Cirebon (0.842) and Eco-Masjid Bandung (0.776) showed lower efficiency because they have not yet optimally linked the benefits of the project with the needs of the surrounding community. For example, Eco-Masjid Bandung has solar panel technology and a wudhu water recycling system, but its social impact is still limited to mosque congregations. This shows that the success of green waqf is not solely determined by the amount of funds, but by the level of connection between the project and the social needs of the community (community relevance).

Governance and Efficiency

The quality of waqf institution governance has a direct impact on project efficiency. Institutions with good governance systems generally have clear institutional structures, regular financial reports, and independent audits. The Bogor Waqf Forest and Sahid Husnul Khotimah projects demonstrate this practice by publishing annual reports and involving the community in program planning. Transparency and public participation create trust, which strengthens project sustainability. Conversely, projects such as Green Park Energy Cirebon and Eco-Masjid Bandung still face obstacles in terms of financial reporting and documentation of results. These data limitations hinder the evaluation of efficiency and public accountability.

These findings are in line with the *Islamic Governance* theory of Chapra (2008) and Iqbal & Mirakhor (2017), which emphasizes the principles of amanah (trustworthiness), 'adl (justice), and shafafiyyah (transparency) as the main pillars of the effectiveness of Islamic social institutions. Professional and transparent governance has been proven to increase the efficiency of waqf institutions and strengthen the sustainability of environmental programs. In addition, the quality of nazhir is also a major determining factor. Most nazhir at the local level are still voluntary and do not yet have adequate managerial capacity. Improving management competence, financial literacy, and digitizing waqf reports are urgent needs for waqf institutions to compete and operate more efficiently.

Contribution to Sustainability (Sustainability Impact)

Green waqf has been proven to make a concrete contribution to several Sustainable Development Goals (SDGs):

1. SDG 6 (Clean Water and Sanitation): *The Subang Clean Water Waqf* has improved access to clean water for 150 households in drought-prone areas.
2. SDG 7 (Affordable and Clean Energy): *Green Park Energy Cirebon* provides 15 kWp of solar panel electricity, reducing the community's dependence on PLN electricity.
3. SDG 13 (Climate Action): *The Bogor Waqf Forest* contributes to carbon sequestration and the preservation of water catchment areas.
4. SDG 15 (Life on Land): *Sahid Husnul Khotimah* and *Eco-Masjid Bandung* contribute to urban greening.

In addition to environmental benefits, green waqf projects also have a social impact by raising public awareness of the value of sustainability, which stems from Islamic teachings on responsibility towards nature (*khalifah fil ardh*).

Integration of Green Waqf in Regional Policy

Although green waqf projects in West Java have been running well, integration with local government policy still needs to be strengthened. Green waqf programs are currently mostly initiated by community organizations, not by the government. In fact, West Java has a "Jabar Green Province" agenda that is in line with the objectives of green waqf.

If synergy between DLH Jabar, BWI, and waqf institutions can be established in the form of institutional cooperation, then the potential for sharia-based social financing (waqf, zakat, infaq) can become an additional source of funding for regional environmental programs. This supports the views of Nur Kholiq (2022) and Hardiansyah et al. (2022), who emphasize the importance of integrating green waqf into Islamic economy-based sustainable development policies.

Comparative Analysis and Managerial Implications

The results of the study show that projects that combine technological innovation and strong governance tend to have higher efficiency levels. To improve the efficiency and sustainability of green waqf management, several strategic steps need to be taken. Waqf managers need to start developing digital reporting systems that include social and environmental indicators so that the monitoring and evaluation process becomes more transparent and accessible. In addition, improving the managerial capacity of nazhir is also an important priority, which can be done through training programs and collaboration with universities. Strengthening funding can also be done by integrating hybrid financing models, such as combining cash waqf and asset waqf, so that projects have more diverse and stable resources. On the other hand, the involvement of the private sector through Corporate Social Responsibility (CSR) programs and support from local governments is needed to expand the social and environmental impact of waqf programs. Through these measures, green waqf management is expected to develop into a more efficient, transparent, and sustainable Islamic social finance instrument.

Research Implications

The results of this study show several important implications for various stakeholders. For local governments, particularly the DLH and the West Java Provincial Government, these findings emphasize the need to incorporate the concept of green waqf into regional green financing strategies as an alternative source of environmental funding. For BWI and the Ministry of Religious Affairs, the results of this study highlight the urgent need to develop a national database system to monitor and evaluate the performance of productive waqf in a more structured manner. For nazhir institutions, the research findings emphasize the importance of increasing professionalism, transparency, and accountability in the management of waqf assets in order to achieve greater efficiency. Meanwhile, for academics, this research opens up opportunities for further studies using a dynamic (panel) DEA model to assess changes in efficiency between years and between regions more comprehensively.

Theoretical Implications

This study reinforces the theory of Islamic Governance (Chapra, 2008; Iqbal & Mirakhor, 2017) with empirical evidence that the principles of trust, justice, and transparency have a direct effect on the efficiency of waqf institutions. Furthermore, this study expands the application of DEA in the context of Islamic Social Finance, which has been more widely used for zakat institutions and Islamic banks. These results indicate that DEA is effective for measuring the performance of productive waqf institutions and green waqf, as it can compare the relative efficiency between projects without requiring complex financial data.

Practical Implications

1. For Local Governments and the West Java DLH: The government needs to integrate the concept of green waqf into regional *green financing* policies, especially in *the Regional Action Plan for Low Carbon Development (RAD-PRK)*. Collaboration with waqf institutions can be a source of sustainable alternative social financing.
2. For the Indonesian Waqf Board (BWI): It is necessary to establish a DEA-based National Waqf Efficiency Index so that the performance of waqf institutions throughout Indonesia can be measured objectively and transparently. This step will strengthen public transparency and accountability.
3. For the Ministry of Religious Affairs (Kemenag): It is recommended to improve the integration of the Waqf Information System (SIWAK) with data on productive waqf projects so that data-based performance evaluations can be carried out nationally.
4. For Nazhir Institutions (Waqf Managers): There is a need to improve human resource competencies, provide training in Islamic financial management, and implement digital reporting based on environmental and social indicators. Institutions also need to expand partnerships with CSR, universities, and local communities.
5. For Academics and Researchers: It is recommended to develop similar research using dynamic DEA (panel data) or the Malmquist Index to assess changes in efficiency over time and across regions.

E. Conclusion & Policy Recommendation

This study aims to analyze the effectiveness and efficiency of green waqf management in supporting sustainable environmental projects in West Java Province. Using the Data Envelopment Analysis (DEA) approach and content analysis, this study provides an empirical overview of the performance, governance, and socio-environmental contributions of five active green waqf projects in the region.

The analysis results show that, in general, the efficiency level of green waqf management in West Java is in the fairly efficient category, with an average DEA score of 0.90. Two projects, namely the Bogor Waqf Forest (1.000) and the Sahid Husnul Khotimah Waqf Foundation (0.965), showed the highest efficiency because they have transparent governance, a clear organizational structure, and extensive partnerships with the community and universities.

Conversely, projects such as Eco-Masjid Bandung (0.776) and Green Park Energy Cirebon (0.842) still face challenges in terms of financial reporting, limited capacity of nazhir, and low scale of social benefits. This confirms that the effectiveness of green waqf does not only depend on the amount of funds or assets, but also on the quality of governance, the professionalism of nazhir, and the relevance of activities to the needs of the local community.

From a sustainability perspective, all green waqf projects contribute directly to the Sustainable Development Goals (SDGs), particularly in the areas of clean water (SDG 6), renewable energy (SDG 7), climate change mitigation (SDG 13), and terrestrial ecosystems (SDG 15). This contribution proves that green waqf has the potential to become a strategic Islamic social finance instrument in supporting the low-carbon development agenda at the local and national levels. Thus, it can be concluded that green waqf in West Java is effective and has the potential to support sustainable environmental projects, but improvements are needed in terms of governance, management capacity, and institutional synergy between BWI, local governments, and the community.

Overall, this study confirms that green waqf is an Islamic social finance innovation that can bridge the spiritual, social, and environmental dimensions simultaneously. Through strengthening governance, increasing the capacity of nazhir, and cross-sector collaboration, the potential of green waqf can be optimized to support the transition to sustainable development and climate change mitigation in Indonesia, especially in West Java.

Research Limitations

This study has several limitations that need to be considered. First, the data on green waqf projects analyzed is limited to only five pilot locations in West Java Province, so its coverage is not yet able to represent all green waqf practices in Indonesia. In addition, some of the financial data from waqf management institutions is not fully available to the public, so some information had to be estimated based on accessible reports. Another limitation is that the DEA analysis results are relative, so that the efficiency values obtained only describe the performance comparison between the units studied and cannot be generalized to other regions or to all waqf institutions in Indonesia. Nevertheless, this study still provides a strong empirical picture of the effectiveness of green waqf in supporting environmental programs and climate action at the local level, particularly in the West Java region.

Recommendations for Further Research

For further research, it is recommended that:

1. Using cross-year panel data to measure trends in efficiency and dynamics of change in the performance of green waqf institutions;
2. Adding social variables such as community involvement, environmental awareness, and social return on investment (SROI) to assess social impact more comprehensively;
3. Conducting comparative studies between provinces (e.g., West Java vs. Central Java or West Sumatra) to understand variations in green waqf management in Indonesia.

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