

Green Sukuk and Infrastructure Expansion: The Mediating Role of ESG Compliance in Pakistan's sustainable development

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Abstract

This paper examines how Green Sukuk (GS) can finance infrastructure expansion and sustainable development in Pakistan's renewable energy sector, with a focus on the role of ESG compliance. Using data from 233 managers, investors, and policymakers, the study applies structural equation modelling (SEM) to test relationships between GS, ESG, and sustainable infrastructure. The findings show that GS significantly supports renewable energy development and contributes to sustainability goals. However, its full potential is only realized when integrated with ESG frameworks. ESG compliance plays a strong mediating role by enhancing transparency, accountability, and alignment with global sustainability standards. The study highlights that combining GS with ESG can increase investor confidence, attract international funding, and accelerate Pakistan's transition to clean energy. Overall, the paper proposes an integrated approach linking Islamic finance and ESG principles to effectively mobilize green capital and promote sustainable infrastructure in emerging economies.

Keywords: Green Sukuk, ESG Compliance, Renewable Energy, Infrastructure Expansion

INTRODUCTION

Sustainable development in emerging economies has become an increasingly pressing issue in recent decades as governments face the two-fold task of increasing the rate of infrastructure development and reducing the impact of environmental degradation. This dilemma is characteristic of Pakistan whose population is more than 240 million; the annual

financing requirement of its infrastructure is estimated to be over USD 30 billion (Awad et al., 2025). Conventional fiscal borrowing and donor-sponsored projects have not been enough to fund the long-term infrastructure, and continued budgetary deficits and debt to service the external debt have weakened the state capacity to fund the infrastructure. It is on this basis that Islamic finance has been identified as a viable substitute, with Sukuk instruments providing both Shariah-compliant mobilisation of capital and attracting domestic and international investors (Awad et al., 2024).

The issuance of GS and sustainable bonds has grown exponentially all over the world and hit USD 620 billion by 2024 (Nisrina & Pimada, 2024). Meanwhile, in parallel, the global ESG Sukuk market itself reached USD 50 billion, and Malaysia and Indonesia issued the most of them (Qadeer & Awad, 2025). Just a few years ago, Pakistan made its first foray into this sphere, with the inauguration of its sovereign GS in 2025 in the amount of PKR 30 billion (around USD 108 million), which is 5.4 times oversubscribed, to fund renewable energy and hydropower initiatives (Hussain, 2022).

Despite this progress, Pakistan continues to face structural challenges in its energy and infrastructure sectors. As of 2024, the country had an installed electricity capacity of 46.6 GW of installed electricity capacity in 2024 but less than 12% of the mix is renewable energy, with solar and wind combined making less than 6% of actual generation (Andespa et al., 2024). The grid bottlenecks, policy inconsistencies, and integration into the national supply do not correspond to the fivefold increase in imports of solar modules between 2022 and 2024 (Awad et al., 2025). We also have social differences: the wealthy have been over-satisfied with rooftop solar, and middle and low-income families are still forced to use costly electricity via the grid (Awad et al., 2024). Although GS and ESG-related financing are subjects of increasing scholarly and policy attention, the available literature exposes a number of fundamental gaps that should be addressed through further studies (Qadeer & Awad, 2025).

Moreover, ESG compliance has been recognised as a widely accepted practise of improving transparency, investor trust and responsibility of projects (Hussain, 2022), but few empirical research studies have been conducted to test its mediating effect. Most

studies either consider ESG as a normative set of practises or restrict the project to disclosure practises without connecting compliance with ESG to quantifiable developmental impact (Mohanty et al., 2023). These papers indicate that there is an agreement that GS has potential, but systematic gaps remain in three dimensions: first, studies that directly test the influence of GS on the outcomes of infrastructure development are lacking; second, the literature has not examined the mediation role of ESG compliance as a driver of effectiveness; and third, the Pakistani context has been underrepresented, although the country is experiencing an increasing infrastructure financing gap and a recent sovereign issuance.

THEORITICAL BACKGROUND

This study enhances the body of theory and adds to the discussion on sustainable Islamic finance globally by demonstrating that the institutional and stakeholder logics come together to define developmental influence through mediating the role of ESG compliance in a Pakistani energy-sector setting.

Green Sukuk and Infrastructure Expansion

One of the focal points in the emerging discussion on Islamic finance and sustainable development has been the connexion between GS and IE. It has been noted over and over again based on empirical evidence that GS is a good source of life-long funds mobilisation to finance mega-scale infrastructural development, in particular renewable energy and transport (Awad & Ghonim, 2025). Awad (2025) and Li & Khan (2025) derived the conclusion that the sovereign GS of Indonesia is capacity addition driver to renewable energies and the revenue is financed to finance energy efficiency, waste management and sustainable transport.

According to these findings, not only GS generate capital, but also make project financing consistent with national sustainability agendas. Outside of Southeast Asia, Khan et al (2025) and Mohanty et al (2023) also stated that Sukuk structure with the inbuilt Shariah-compliant risk-sharing components is well placed to finance long-term

infrastructure, where the predictability and stability of returns are highly important. Yusuf et al (2025) describes proceeds as another demonstration of how GS support investor confidence because proceeds are correlated to real infrastructure benefits, which increase transparency and accountability relative to standard instruments.

However, there are challenges that are also identified. In the absence of favourable institutional mechanisms, Aziz et al (2025) observed that Sukuk issuance will only be symbolic as it raises funds without guaranteeing that the proceeds translated into sustainable infrastructure development. This is close to the Pakistani context, where Ikhsan & Wulandari, (2024) found that even though sovereign Sukuk have been oversubscribed, the absence of effective ESG and governance, has restricted their developmental role. However, Hassan & Pandey (2020) observe, the infrastructure deficit and energy financing gap in Pakistan provide a good prospect of GS turning into transformative tools, low financing cost and increased investor confidence, yet the effectiveness of their development require that they are effectively aligned with project execution frameworks. On the basis of this empirical and theoretical work, the hypothesis is as follows:

H1: GS have a positive and significant impact on IE.

Green Sukuk and ESG Compliance

The correlation between GS and ESG compliance has become a topic of growing discussion as sustainable financial instruments are not only measured by their financial results but also deemed by their compliance with the environment and governance standards. As the case of Malaysia shows, GS is best issued in solid ESG models (Bayram et al., 2022). Wahid & Awad (2025) also discovered that the regulators in Malaysia were also thinking the ESG when designing the Sukuk. On the same note, Boafu et al (2025) has opined that GS inherently institutionalise ESG concepts because Shariah-compliant contracts already focus on ethical investment and responsibility, making the transition between an Islamic finance system. Empirical evidence also indicates that GS may be utilised as drivers of intensified ESG practises in the emergent markets. According to Hussain et al (2022) issuing ESG-based Sukuk in the Gulf region motivated firms to pursue

more rigorous disclosure policies because investors were increasingly insisting on demonstrable ESG compliance prior to subscribing.

Hassan & Pandey (2020) showed that issuers incorporating ESG principles into Sukuk structures not only increased the variety of investors to their portfolio. Brahmi et al., (2025) noted that in most emerging markets, such as Pakistan, the level of ESG integration is uneven, with most disclosed information being expressed as generalised comments as opposed to quantifiable benchmarks. As pointed out by Hasan et al (2024), though the issuance of sovereign Sukuk in Pakistan was an indication that the country was trying to be sustainable, the lack of proper implementation of ESG frameworks undermined its credibility among foreign investors.

Likewise, Cai & Song (2024) observed that a significant obstacle to realising sustainability in Islamic financial instruments in Pakistan is institutional gaps and the absence of a standardised system of ESG reporting. These results indicate that GS, by its very definition, is aligned with the principles of ESG but needs intentional institutional and market instruments to transform potential into practise. On this basis, the hypothesis is as follows:

H2: GS have a positive and significant relationship with ESG compliance.

ESG Compliance and Infrastructure Expansion

Sustainable development finance and the investors and regulators now demand the infrastructure projects to be more than financially viable, they demand the project demonstrate that it is also environmentally and socially responsible. As the available literature suggests, in the vast majority of the settings, sustainability, inclusiveness, and efficiency of infrastructure development models might prove useful in enhancing this type of development over the long-term (Tufail et al., 2025). Maas et al (2024) highlighted the importance of ESG principles integrated in Islamic finance to create more efficient governance systems. Shafi et al (2025) also observed that ESG-compliant framework-funded projects in Malaysia were more resilient and aligned in terms of serving national climate targets than traditional ones.

In addition to compliance, the integration related to ESG has a direct impact on investor engagement and project implementation. Qadeer et al (2025) and Ghonim & Awad (2024) also indicated that the application of ESG not only builds financial credibility, but also reduces chances of project delays, cost increases, and reputational damage and, therefore, accelerates the process of IE. Meanwhile, obstacles also emphasise the contingency of such a relationship. Saad et al (2025) commented that the IE in markets with weakly developed ESG that is poorly implemented would be unsustainable and both environmental and social externalities would disrupt further development. However, Nasir et al (2024) proposed that outcomes in the places where ESG practises were adopted meaningfully, e.g. in small-scale solar and wind projects, were fairer and more developmentally effective. The hypothesis proposed is, therefore, the following:

H3: ESG compliance has a positive and significant impact on IE.

Mediating Role of ESG Compliance

Although GS offer a potential solution to capital mobilisation, Sukuk will remain just a tower of moneymaking tools, which have no connexion with developmental results. Khemiri et al (2024) and Awad et al (2024) pointed out that sovereign GS of Indonesia created global investor confidence exactly since the issuance was accompanied by rigid ESG disclosure and monitoring programmes. Hussain (2023) opined that issuing Sukuk not translate to sustainability unless the compliance frameworks are made to provide transparency, accountability, and environmental protection; only at this point can infrastructure projects be made legitimate and sustainable.

Awad (2024) demonstrate, the ESG disclosure mediated the one-to-one connection between the sustainable financial products and the investor trust in the Gulf, which implied that the capital flows to the infrastructure was conditional on a plausible ESG integration. Aziz et al (2025) was that the supportive role of Shariah principles in the context of ethical finance needed to be reinforced by ESG frameworks, in order to transform Islamic finance into developmental infrastructure deliverables.;In less developed institutional environments, ESG compliance played an even more critical mediating role. Hussain

(2024) cautioned that as long as there are no enforceable ESG standards, GS funds collected may be redirected to projects with little or no sustainability value. In the same study, Shafi et al (2025) noted that investors were hesitant to invest in the energy sector of Pakistan on a long-term basis due to the lack of standardised ESG reporting, which constrained the developmental translation of Sukuk proceeds. On this premise, the hypothesis below is formulated:

H4: ESG compliance mediates the relationship between GS and IE.

METHODOLOGY

This study focuses on Pakistan's energy and financial sectors, where sustainable infrastructure financing is highly relevant. A purposive sampling approach was employed to target professionals with relevant expertise, including top managers, financial officers, sustainability officers, and project managers. A total of 350 questionnaires were distributed, resulting in 248 responses (70.8% response rate). After data screening to remove incomplete and inconsistent responses, 233 valid responses were retained, meeting the minimum requirement for Structural Equation Modeling (SEM). Data quality was ensured through tests of normality, outliers, and multicollinearity.

The survey instrument was translated into Urdu and validated through a pilot study involving 30 respondents. All constructs were measured using a five-point Likert scale. Measurement items were adapted from prior studies on Islamic finance and green sukuk, capturing respondents' perceptions of green sukuk (GS) as a financing mechanism for sustainable infrastructure and its compatibility with Shariah principles. Reliability values exceeded the acceptable threshold (Cronbach's alpha > 0.70), indicating strong internal consistency.

Data analysis was conducted using SPSS version 29 and AMOS. Descriptive statistics were used to summarize respondent characteristics, while SEM was applied to test the hypothesized relationships. Convergent validity was confirmed through average variance extracted (AVE > 0.50), and discriminant validity was established as the square root

of AVE exceeded inter-construct correlations. These results demonstrate that the measurement model is robust and suitable for analyzing the relationships among the study variables.

RESULTS AND DISCUSSION

Measurement Model

To determine the internal consistency of all three constructs GS, ESG Compliance, and IE All alpha was calculated, and all alpha values were found to be above the recommended value of 0.70 (see Table 2) meaning they all exhibited high reliability. Three latent variables, and their observed measures were then defined. Confirmatory factor analysis (CFA) demonstrated that the measurement model fits very well: $\chi^2 = 196.27$; $df = 55$; $p = 0.01$; Comparative Fit Index (CFI) = 0.97; Goodness-of-Fit Index (GFI) = 0.93; Tucker-Lewis Index (TLI) = 0.96; Root Mean Square Error of Approximation (RMSEA) = 0.05; and Standardised root mean square residual (SRMR) The results confirm congruent validity by demonstrating statistically significant standardised loadings on the corresponding constructs by the three measurement indicators, ranging between 0.64 and 0.88 (t -values = 8.1214.05; $p = 0.001$). Higher than the recommended composite reliabilities (CRs) of 0.70 are 0.78 to 0.94 (Awad, 2025). The values of the AVE were between 0.53 and 0.72, which exceeded the stipulated limit of 0.50 (Shafi et al., 2025), and therefore validated convergent validity.

The discriminant validity was also determined as the square roots of the AVE values were higher than the inter-construct correlations. The relation between the GS and ESG Compliance was moderate ($r = 0.61$) but the AVE score of both variables was far greater and it has showed the fact that each of the constructs had some variance that the rest did not share. On the basis of these findings, it can be concluded that the measurement model has convergent and discriminant validity and it serves as a valid basis to test the structural relationships between GS, ESG compliance, and IE in Pakistani energy sector.

Structural Model

SEM was used to test the proposed structural model, and overall fit statistics revealed that the model fitted the data very well: $\chi^2 = 842.36$; $df = 310$; $p = 0.01$; CFI = 0.96; NFI = 0.95; TLI = 0.95; RMSEA = 0.046; and SRMR = 0.041. The values exceed the recommended levels, which proves that the model is sufficient to describe the assumed relationships between GS, ESG compliance, and IE. Adjusted multiple correlations (R^2) were used to identify that the integrated model explained 47.3 percent of the variation in ESG compliance and 56.4 percent of the variation in IE suggesting that the proposed framework has high explanatory power.

Hypotheses Testing

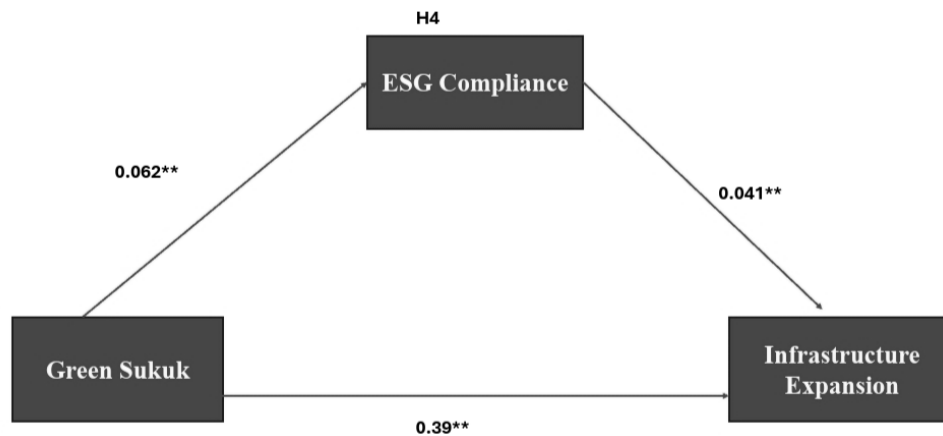
The GS to IE (H1) was positive and statistically significant ($b = 0.39$, $t = 10.21$, $p < 0.001$), which underlines the claim that Sukuk-based financing has a direct positive impact on the infrastructure growth. Similarly, the relationship between GS and ESG compliance (H2) was very significant ($b = 0.62$, $t = 14.47$, $p < 0.001$), which confirms that the issuance of Sukuk encourages sustainable investment practices in accordance with ESG standards. In H3, the ESG compliance was found to be a significant predictor of IE ($b = 0.41$, $t = 9.78$, $p < 0.001$), which means that the ESG compliance is a predictor of the sustainable development of energy and infrastructure projects. Lastly, the mediating role of ESG compliance (H4) in the correlation between GS and IE was also tested by bootstrapping. $P =$ The indirect route was meaningful ($b = 0.25$, $t = 7.15$, $p = 0.001$), which shows partial mediation. This implies that although the contribution of GS to IE is direct, a significant part of this influence works via the reinforcement of ESG practises. Taken together, these findings not only affirm that GS are effective financial tools to mobilise capital, but they are also a mechanism that instils sustainability compliance, increasing their developmental effect in the banking and energy sector within Pakistan.

Table 3
Structural Path Estimates

Path	Path Estimate (β)	t-value	Hypothesis Testing
H1: GS \rightarrow IE	0.39	10.21	Supported
H2: GS \rightarrow ESG Compliance	0.62	14.47	Supported
H3: ESG Compliance \rightarrow IE	0.41	9.78	Supported
H4: GS \rightarrow ESG Compliance \rightarrow IE	0.25 (indirect)	7.15	Supported

Source: Authors' own work.

Figure 1
Mediation Analysis



DISCUSSION

The results of this research provide strong empirical evidence on the existence of relationships between the hypothesised variables of GS financing, ESG compliance, and IE in the Pakistan energy and Banking industry. The findings demonstrate that GS is a significant contributor to IE, both directly and indirectly along the mediator of ESG compliance, in turn justifying the hypothesised mechanisms informed by Institutional Theory and the stakeholder theory.

Besides the fact that these findings confirm the hypothesised structural model, the findings have the added advantage of contributing to the growing literature on sustainable Islamic finance, ESG-based investment practises, and infrastructure development in emerging economies. The GS and IE relationship is positive, as prior studies have found.

In indicative terms, Saad et al (2025) and Yusuf et al (2025) affirmed the channeling of necessary resources to projects with long payback period in the infrastructure sector and more so renewable energy through Shariah compliant financing instruments. Similarly, Aziz et al (2025) and Hussain et al (2022) concluded that the Islamic debt instruments provide governments with a feasible, moral, and sustainable alternative to conventional borrowings, therefore, enabling the expansion of the energy infrastructures at the cost of fiscal constraints.

These similarities also support the notion that Green Sukuk is not a tool with small niche, the instrument could be developed and used to foster sustainable infrastructure. The evidence of the study also shows that the issuance of GS has a positive effect on its compliance with ESG, which is consistent with Zulfiqar et al (2024) and Qadeer et al (2025) who stated that Islamic financing mechanisms are internally compatible with its environmental stewardship, social justice, and ethical governance. This coincidence is explained by the very structure of Sukuk which does not allow investing in socially or environmentally disastrous or exploitative actions.

Besides, the report by Cai & Song (2024) and Hasan et al (2024) also stated that Sukuk is not only a tool to promote the compliance with Shariah principles but also promotes transparency, accountability, and governance frameworks that also correlate with the dimensions of ESG. The present results support these arguments by empirically showing that ESG compliance is greatly enhanced in organisations financed by GS. The findings also suggest that ESG compliance and IE have a powerful positive connexion, which aligns with international evidence by Yusuf et al (2025) who concluded that organisations that are more compliant with ESG standards attract more investment, minimise risk at the project level, and gain better acceptance of their infrastructure projects by society members.

Evidence has shown that ESG compliance assists in reducing financing costs, reputational risks, and increasing stakeholder trust, all of which are key in large scale IE where these issues play a critical role in sensitive sectors such as energy. The results in this paper, therefore, substantiate the compliance of ESG as not just an ethical requirement, but

also as a practical facilitator of infrastructure development in Pakistan. Probably the most importantly, the research confirms the mediating effect of ESG compliance in the relationship between GS and IE. According to this mediation, although GS has a direct effect on infrastructure projects, its effect is strong when issuers are characterised by high levels of ESG compliance.

These are the same findings that Mohanty et al (2023) and Zulfiqar et al (2024) have proposed, which contend that ESG compliance increases the credibility and acceptability of Sukuk to local and foreign investors and, therefore, the financial base to fund infrastructure projects. This observation also echoes the sentiments of Ghonim & Awad (2025) and Hussian (2025) who emphasised that ESG-based Sukuk are becoming considered as low-risk and socially useful tools, a fact that explains their rising popularity across the globe. All of the findings, in general, are in agreement with the prior research, all of which lead to the same convergent evidence that Islamic sustainable financing, especially GS, in combination with ESG compliance, is an effective tool to speed up the infrastructural development.

Nevertheless, the present research contributes to the body of literature by placing such dynamics within the framework of the Pakistani energy industry, where financing, regulatory, and sustainability issues intersect. In contrast to the previous studies that were mostly performed in Malaysia, Indonesia, or the Gulf states, this study emphasises the role of GS and ESG compliance based on the unique socio-economic environment in Pakistan, its regulatory framework, and energy transition challenges. Simultaneously, the results should be critically reflected. Although the observed strong positive relationships are similar to the findings of previous empirical studies, one should not overgeneralize (Nagi & Mohammed Ali, 2020). The results of infrastructure development based on GS and ESG compliance depend on contextual aspects including the quality of governance, investor trust, regulatory practises, and cultural acceptance of Shariah-compliant instruments.

Indicatively, although the positive impacts described in Hassan & Pandey (2020) and Brahma et al (2025) were similar in Southeast Asian markets, institutional capacity differences can affect whether the same results can be replicated in Pakistan. With these

caveats, the findings indicate that the energy sector in Pakistan has the potential to experience significant improvement through the upscaling of the GS issuance coupled with ESG frameworks. In so doing, the nation does not only overcome its long-term infrastructure deficit, but also establishes itself as a leader in Islamic sustainable finance in the region.

CONCLUSION

Green Sukuk (GS) positively influence infrastructure development and ESG compliance. ESG plays a crucial mediating role in strengthening the impact of GS. GS are not only financial instruments but also tools for sustainable development. Their effectiveness depends on alignment with ESG principles. Empirical results confirm strong relationships between GS, ESG, and infrastructure growth. Integrating ESG enhances transparency, accountability, and investor confidence. GS are especially relevant for addressing energy and infrastructure gaps. They offer significant potential in emerging economies like Pakistan. Policy support and strong governance frameworks are essential for success. Overall, GS become transformative when finance is aligned with sustainability goals.

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