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Artificial Intelligence, ESG Disclosure Quality, and Corporate Sustainability Performance in Islamic Banking: The Role of Sharia Governance

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ABSTRACT

This study examines the relationships among Artificial Intelligence (AI), ESG Disclosure Quality (ESGDQ), Greenwashing, and Corporate Sustainability Performance (CSP), and investigates the moderating role of Sharia Governance in Islamic banking. The study employs a quantitative explanatory design using panel data from Islamic commercial banks in Indonesia and Malaysia during the 2021–2025 period. The study collected data from annual reports, sustainability reports, corporate governance reports, official corporate websites, and other publicly available disclosures through structured content analysis and disclosure-based indices. The hypotheses were tested using a fixed-effects panel regression model. The findings indicate that disclosed AI capability and implementation are positively associated with ESG Disclosure Quality, while AI is not significantly associated with Greenwashing. ESG Disclosure Quality is positively associated with Corporate Sustainability Performance, whereas Greenwashing is not significantly associated with sustainability performance. Sharia Governance strengthens the positive relationship between AI and ESG Disclosure Quality but does not significantly moderate the relationship between AI and Greenwashing. These findings highlight the importance of integrating technological capabilities with Sharia Governance to support more credible, transparent, and responsible sustainability reporting practices in Islamic banking.

ABSTRAK

Penelitian ini bertujuan menganalisis hubungan antara Artificial Intelligence (AI), Kualitas Pengungkapan ESG (ESG Disclosure Quality/ESGDQ), Greenwashing, dan Kinerja Keberlanjutan Perusahaan (Corporate Sustainability Performance/CSP), serta menguji peran moderasi Sharia Governance dalam konteks perbankan syariah. Penelitian ini menggunakan desain kuantitatif eksplanatori dengan data panel bank umum syariah di Indonesia dan Malaysia selama periode 2021–2025. Data diperoleh dari laporan tahunan, laporan keberlanjutan, laporan tata kelola, situs web resmi perusahaan, dan sumber pengungkapan publik lainnya melalui analisis isi terstruktur serta indeks berbasis pengungkapan. Pengujian hipotesis dilakukan menggunakan model Fixed Effects. Hasil penelitian menunjukkan bahwa kapabilitas dan implementasi AI yang diungkapkan berasosiasi positif dengan ESG Disclosure Quality, sedangkan AI tidak berasosiasi secara signifikan dengan Greenwashing. ESG Disclosure Quality berasosiasi positif dengan Kinerja Keberlanjutan Perusahaan, sementara Greenwashing tidak menunjukkan asosiasi yang signifikan terhadap kinerja keberlanjutan. Sharia Governance memperkuat hubungan positif antara AI dan ESG Disclosure Quality, tetapi tidak secara signifikan memoderasi hubungan antara AI dan Greenwashing. Temuan ini menegaskan pentingnya integrasi kapabilitas teknologi dan Sharia Governance untuk mendukung praktik pengungkapan keberlanjutan yang lebih kredibel, transparan, dan bertanggung jawab dalam perbankan syariah.

1. INTRODUCTION

In recent years, artificial intelligence (AI) has become a significant force in the banking sector. Advances in machine learning, natural language processing (NLP), predictive analytics, and intelligent automation have enabled financial institutions to improve information processing, decision-making accuracy, risk management, and operational efficiency (Duan et al., 2019; Raisch & Krakowski, 2021). In managing complex information environments, particularly those involving sustainability-related data, AI has evolved beyond operational applications to become a strategic organizational tool. According to Dwivedi et al. (2023), AI can help organizations enhance transparency, accountability, and sustainability-focused decision-making by processing vast quantities of structured and unstructured data. However, for AI to influence sustainability reporting, organizations must effectively integrate AI-related skills into data management, internal controls, and reporting procedures, regardless of their access to the technology. Therefore, it would be erroneous to assume that a company has implemented AI in its operations or is capable of doing so merely because it discloses information about AI.

The demand for high-quality environmental, social, and governance (ESG) disclosures by financial institutions has increased alongside the prominence of sustainable finance. Investors, regulators, consumers, and society at large increasingly require transparent, comparable, reliable, and decision-relevant sustainability data (Christensen et al., 2021a; Tsang et al., 2023). The recently introduced International Sustainability Standards Board's (ISSB) General Requirements for Disclosure of Sustainability-related Financial Information (IFRS S1) and Climate-related Disclosures (IFRS S2) have further underscored this trend by emphasizing the need for consistent disclosure of sustainability-related risks and opportunities (International Sustainability Standards Board, 2023a, 2023b). ESG disclosure quality (ESGDQ) has become an increasingly important measure of corporate responsibility, as it indicates how effectively companies communicate their sustainability goals and actions to their stakeholders (Arvidsson & Dumay, 2022). However, the existence of sustainability reporting standards does not ensure that the reported information is accurate, comprehensive, balanced, or representative of a company's operations. In light of this distinction, it cannot be assumed that greater disclosure necessarily results in greater transparency or improved sustainability outcomes; rather, attention should be directed to the organizational capacities associated with the quality of ESG disclosure.

From the stakeholders' perspective, organizations respond to growing expectations of accountability and transparency through high-quality ESG disclosures. Companies can show that they are doing the right thing for their stakeholders, themselves, and the world when they have access to accurate sustainability data (Freeman, 1984). Environmental impacts, social obligations, governance processes, and sustainability risks are just a few of the many factors that contribute to the complexity of sustainability reporting, making it difficult to achieve high-quality ESG disclosures. Organizations need sufficient information-processing skills to ensure that the information released is comprehensive, accurate, consistent, and believable (Mustafa et al., 2025a). Here, the amount of information supplied should not be confused with its quality when discussing ESG issues. While a thorough study may cover a lot of ground in terms of sustainability, it does not mean that it provides data that are impartial, believable, or helpful for making decisions. Therefore, rather than focusing only on the quantity of disclosures, the function of AI should be investigated in relation to its correlation with the quality of the information released.

Due to the rise of greenwashing methods, sustainability disclosure credibility is still a significant issue, even if ESG reporting is receiving increasing attention (Michelon et al., 2015; Yu et al., 2020a). When companies make sustainability claims that are not backed by their actions, or when such claims are overstated or deceptive, it is called "greenwashing" (Delmas & Burbano, 2011). Such actions have the potential to degrade the efficacy of sustainability programs, decrease public trust, and produce an information asymmetry between stakeholders and organizations. Therefore, more information availability is not enough to improve the quality of ESG disclosures; we also need systems to make it easier to verify information and lessen the likelihood of false sustainability messaging. Crucially, there is a conceptual difference between greenwashing and high-quality disclosure (Lublóy et al., 2025). Even if a company is very forthcoming with sustainability data, it might still be making selective or deceptive assertions. A similar logic applies: just because there are discrepancies in public disclosures does not mean that deceptive practices have taken place; it is necessary to compare the claims with sufficient facts.

By enhancing the administration and evaluation of sustainability data, artificial intelligence offers the possibility of overcoming these obstacles (Mustafa et al., 2025b). Sustainability reporting procedures may be enhanced using AI-based technology. These technologies can automatically gather data, recognize patterns,

verify information, and detect discrepancies among sustainability-related disclosures. According to Barney (1991), AI is a beneficial organizational skill from a resource-based view (RBV) standpoint, as it helps companies create better information-processing resources, which in turn boosts their efficacy and gives them a competitive edge (Mikalef & Gupta, 2021a). So, it stands to reason that companies with better AI will have better ESG disclosures (Bayong et al., 2026). However, instead of independently validated technology implementation, the resultant score captures reported evidence of AI-related activities and capabilities when AI is evaluated through publicly available business reports. Due to variations in disclosure processes and underlying technology capabilities, variations in reported AI information may reflect these variances, making this measurement differential, especially in cross-bank comparisons.

Nevertheless, both conceptually and experimentally, the connection between AI and sustainability results is difficult. Artificial intelligence has the potential to enhance data accuracy and reporting efficiency, but it may not be enough to stop greenwashing on its own. Managerial incentives, ethical attitude, corporate culture, and governance processes all have an impact on sustainability communication. Therefore, AI is not a panacea for sustainability issues; it is a capacity of organizations that relies on supplementary governance frameworks to work. This differentiation raises two connected empirical concerns: first, if there is a correlation between declared AI-related skills and lower levels of possible greenwashing; and second, whether there is a correlation between disclosed AI-related capabilities and improved ESG disclosure quality. Because advancements in data processing do not always remove management motivations to selectively communicate sustainability performance, it is important to investigate these connections independently.

Islamic financial organizations find this matter very pertinent (A. A. Jan et al., 2021). Compliance with financial rules and adherence to Islamic ethical standards define the unique institutional context in which Islamic banks operate. In contrast to traditional banks, Islamic financial institutions are expected to align their business objectives with broader Islamic principles. These include fairness, honesty, responsibility, social welfare, and khalifah (Dusuki & Abdullah, 2007; Kamali, 2008). Thus, Islamic banking sustainability policies reflect both the organization's dedication and its ethical obligations to its stakeholders and society at large. Although there may be fewer concerns about greenwashing or greater credibility in sustainability disclosures when an Islamic ethical framework is present, this is not always the case. It is still an open topic whether these concepts are adequately represented in reporting methods and organizational responsibility (Muneer et al., 2025).

One key governance mechanism inside this institutional framework that could affect the contribution of technology capabilities to sustainable results is Sharia Governance. Transparency, accountability, ethical decision-making, and compliance with Islamic values are promoted through Sharia Governance, which is overseen by the Sharia Supervisory Board (SSB) (Grassa, 2013; Mollah & Zaman, 2015). Sharia Governance, viewed through the lens of RBV, is an ancillary organizational resource that boosts AI capabilities value by coordinating technology adoption with ethical standards and environmental goals. In addition, by discouraging opportunistic disclosure and pushing organizations to disclose information that mirrors real sustainability practices, robust Sharia Governance has the potential to enhance the credibility of sustainability reports (Ardianto et al., 2026; Puspitasari & Kasri, 2023). Accordingly, Sharia Governance has the potential to boost AI's contribution to better ESG Disclosure Quality. However, it would be a mistake to assume that its possible moderating influence operates in the same way for all sustainability outcomes. As a result of management incentives, verification difficulties, and other institutional or organizational factors, greenwashing may persist even if governance systems promote reporting openness. Accordingly, ESG disclosure quality and greenwashing must be investigated independently in relation to AI's impact on Sharia governance.

Research on AI adoption, ESG disclosure, sustainability performance, and governance frameworks has been conducted previously, but there are still some significant gaps in our understanding. To start, while there is a lot of literature on AI's effects on innovation, operational efficiency, financial performance, and decision-making, there are few empirical studies that look at AI's impact on the quality of sustainability disclosures (Mikalef & Gupta, 2021b; Raisch & Krakowski, 2021). So far, our understanding of AI's function in bolstering information management with a focus on sustainability is limited. Instead of only reflecting the increasing importance of AI in corporate narratives, further research is needed to determine if publicly revealed AI-related capabilities are linked to the quality of sustainability information presented by Islamic banks.

Additionally, there has been a lack of research on technological capability as a precursor to ESG disclosure quality, which is surprising given that prior ESG disclosure studies have primarily focused on governance traits, stakeholder expectations, sustainability standards, and regulatory pressure (Christensen et al., 2021b; Velte, 2022). Because of this, there is a lack of studies that examine how new technology helps increase

sustainability transparency. An opportunity to broaden this conversation arises when we consider AI in the context of ESG disclosure quality, as it allows us to link the qualities of sustainability information sent to stakeholders with the capacities of technology to process information. Nevertheless, it is important to approach this connection with caution, as disclosure-based measurements do not have the ability to objectively confirm the true level of AI adoption.

Third, there are three distinct areas of sustainability research: environmental, social, and governance (ESG) disclosure quality, greenwashing, and sustainability performance (Roszkowska-Menkes et al., 2024). Within a single analytical framework, there is a lack of empirical data that explains the relationship between technical capabilities and these outcomes. By bolstering stakeholder trust, raising responsibility, and facilitating sustainability-oriented decision-making, high-quality ESG disclosure may be linked to improved company sustainability performance. It would be a mistake to conclude that improved reporting automatically leads to better social or environmental consequences based on the correlation between disclosure quality and sustainability performance. Both concepts should be evaluated with caution when relying on corporate disclosures because of the possibility of measurement overlap and common-source effects (Doan & Sassen, 2020; Dorfleitner & Utz, 2024). In addition, finding possibly deceptive communication is not the same as independently evaluating real sustainability results; thus, it is important to be cautious when interpreting the link between greenwashing and sustainability performance.

Fourth, there is a dearth of studies examining Islamic banking settings through the lenses of AI, ESG disclosure quality, greenwashing, corporate sustainability performance, and Sharia governance (Zafar, 2026). There has been a dearth of research on Islamic financial institutions in developing economies, in contrast to the abundance of literature on traditional businesses and other institutional contexts (Jajang et al., 2023; Widiyanti et al., 2025). This gap is significant because Islamic banks have unique organizational structures that allow technological progress to interact with religious and ethical norms (Julia & Kassim, 2020; Sehen Issa et al., 2022). The lack of comprehensive studies on the linkages between AI, ESG disclosure quality, and greenwashing is a result of both the incomplete integration of these factors and the absence of an investigation into whether Sharia Governance offers a supplementary governance mechanism. This study avoids treating the avoidance of potentially misleading sustainability communication and the treatment of sustainability reporting quality as identical objectives by separating these links.

Research in Indonesia and Malaysia is pertinent because these two nations have established institutional and regulatory frameworks for Islamic financial services and are major Islamic banking marketplaces in Southeast Asia (Amran et al., 2017; A. Jan et al., 2023). However, there is a lack of data from Islamic commercial banks in these two nations on the relationship between AI capabilities and the quality of sustainability disclosures, greenwashing, and corporate sustainability performance (Heru Muara Sidik, 2026). It would be a mistake to instantly apply the results to all Islamic financial institutions or take them as evidence of causal impacts, but a comparative two-country panel setup does allow for the examination of bank-level data across time within distinct institutional contexts.

Therefore, taking Sharia Governance into account as a moderator, this study builds an integrated framework to investigate the connections between AI, ESG disclosure quality, greenwashing, and corporate sustainability performance. This study seeks to answer the following questions: (1) Is AI positively associated with ESG disclosure quality? (2) Is AI negatively associated with greenwashing? (3) Is ESG disclosure quality positively associated with corporate sustainability performance? (4) Is greenwashing negatively associated with corporate sustainability performance? (5) Does Sharia Governance moderate the relationships between AI and the two disclosure-related outcomes? This study focuses on Islamic commercial banks in Malaysia and Indonesia from 2021 to 2025. In keeping with the observational research approach, the correlations are statistically analyzed, and the results are interpreted considering the constraints of publicly available data as a surrogate for actual organizational talents and sustainability initiatives.

This work adds to what is already known in the field in three ways. Public disclosure does not independently validate actual technology implementation; nevertheless, it does expand the applicability of the Resource-Based View by investigating the relationship between revealed AI-related capabilities and ESG Disclosure Quality in Islamic banking. Secondly, it adds to the literature on sustainability reporting by integrating empirical frameworks to study ESG Disclosure Quality, Greenwashing, and Corporate Sustainability Performance as separate outcomes. Furthermore, it delves deeper into the topic of Sharia Governance by doing an empirical examination to see if this governance mechanism influences the links between AI and ESG Disclosure Quality as well as AI and Greenwashing. The results can shed light on whether the quality of sustainability information or the decrease in possibly deceptive sustainability communication is where artificial intelligence (AI) could make a greater impact in Islamic banking. All things considered, these

findings give light on how to understand sustainability disclosures in Islamic banking by bringing together Islamic governance, technical capacity, and sustainability reporting in a unified study context.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Artificial Intelligence and ESG Disclosure Quality

An developing technical capability, artificial intelligence (AI) allows organizations to enhance reporting efficiency, data integration, analytical capacity, and information processing. Artificial intelligence (AI) helps banks better handle massive amounts of data, both organized and unstructured, via tools such as intelligent automation, machine learning, and natural language processing (NLP). When it comes to sustainability reporting, AI can help with finding, sorting, analyzing, and verifying sustainability-related data. This means that ESG disclosures will be more full, accurate, consistent, and up-to-date (Naveed et al., 2025).

The resource-based view (RBV) explains the correlation between AI capabilities and ESG disclosure quality. Having valuable, unique, and difficult-to-imitate resources and competencies allows organizations to attain outstanding performance, according to the RBV (Barney, 1991). Because it improves businesses' capacity to handle complicated data and provide more trustworthy reporting systems, AI is a crucial organizational skill. As a result, it stands to reason that Islamic banks that are more adept at artificial intelligence would also have better ESG reporting. In addition, according to stakeholder theory, organizations should be forthright and trustworthy with the information they offer to stakeholders, who use corporate disclosures to guide their decisions (Freeman, 1984). With the growing importance of sustainability concerns, it is expected that financial institutions would provide ESG data that demonstrates responsibility and accountability in their operations. The use of AI has the potential to bolster this goal by making sustainability reports more reliable and accurate.

Whether AI-related skills lead to significant advances in sustainability information management will determine the projected link between AI and ESG disclosure quality. Rather than reflecting independently confirmed technical competence, AI metrics based on publicly available company filings represent announced evidence of AI-related efforts. Given that disclosure procedures may partially impact the observed connection, this study focuses on the correlation between AI-related information that is revealed and ESG disclosure quality.

Stakeholder Theory elucidates the significance of trustworthy disclosure in maintaining responsibility to stakeholders, whereas the RBV viewpoint suggests that AI-related skills might enhance the processing and integration of sustainability information. The notion that ESG Disclosure Quality is higher in correlation with the amount of revealed AI-related capabilities is supported by these supplementary considerations. Consequently, the analysis suggests:

H1: Artificial intelligence positively influences ESG disclosure quality.

Artificial Intelligence and Greenwashing

When an organization presents sustainability data that is more impressive than its real performance, it is engaging in greenwashing (Delmas & Burbano, 2011). The disclosure of sustainability information raises questions about the accuracy of these claims, even as sustainability reporting has made them more transparent (Moodaley & Telukdarie, 2023). By automating data analysis, discrepancy detection, and monitoring of sustainability-related information, artificial intelligence offers possible methods to enhance sustainability information verification. According to the Resource-Based View, AI may help organizations analyze more data, which might lead to less information asymmetry and more trustworthy reports.

Having the capacity to use technology might not be enough to eradicate greenwashing, though. Managerial incentives, ethical attitude, corporate culture, and governance processes all have an impact on sustainability communication. However, the efficacy of AI in reducing greenwashing via improved information quality is contingent upon the manner in which organizations employ and regulate these technologies.

Consequently, the anticipated inverse correlation between AI and greenwashing is contingent rather than inherent. While AI has the potential to enhance internal monitoring and assist organizations in spotting discrepancies, it does not mean that managers can not cherry-pick sustainability data to make it look good. In addition, the correlation between AI and greenwashing, as assessed through publicly accessible disclosures, could be a result of disparities in disclosure openness as well as actual organizational practices. A negative association, then, is more of a theoretical prediction that must be tested empirically than an assumption that greenwashing would be eliminated by implementing AI (Jiao et al., 2024).

More regular sustainability monitoring might be possible with the help of AI's information-processing resources, according to RBV. Reducing incorrect sustainability communication is crucial for sustaining the credibility of disclosure and the confidence of stakeholders, from a stakeholder-oriented standpoint. However, management incentives and governance frameworks pertaining to AI's use may determine how effective it is in minimizing greenwashing. Following this line of reasoning, this study suggests:
H2: Artificial intelligence negatively influences greenwashing.

ESG Disclosure Quality and Corporate Sustainability Performance
An organization's capacity to accomplish long-term social, environmental, and economic goals while also providing value to stakeholders is reflected in its corporate sustainability performance (CSP). Transparent and trustworthy information on sustainability plans, risks, and accomplishments is provided to stakeholders through high-quality ESG disclosure (Helfaya & Whittington, 2019). Organizations may enhance stakeholder relationships, foster greater responsibility, and lessen information asymmetry through higher-quality disclosures. Obtaining stakeholder support and achieving sustainable performance results are more probable for organizations that respond effectively to stakeholder expectations, according to stakeholder theory (Freeman, 1984). Thus, it is anticipated that ESG disclosure quality would enhance trust, transparency, and decision-making with a focus on sustainability, thereby favorably impacting corporate sustainability performance.
Making sustainability goals, policies, and reported accomplishments more apparent to stakeholders through high-quality ESG disclosures may help promote internal responsibility. Because of this transparency, monitoring can be improved, and companies will be more motivated to make decisions that align with their sustainability goals. However, the actual sustainability performance should not be equated with disclosure quality. Instead of assuming that better reporting automatically results in better environmental, social, or economic outcomes, the anticipated positive relationship reflects the idea that trustworthy and decision-useful ESG data can assist in accountability and sustainability-oriented organizational practices.
According to stakeholder theory, Islamic banks may retain stakeholders' trust and demonstrate their commitment to sustainability if they provide more credible sustainability information. Consequently, it is anticipated that corporate sustainability performance will be favorably correlated with better ESG disclosure quality. Thus:
H3: ESG disclosure quality positively influences corporate sustainability performance.

Greenwashing and Corporate Sustainability Performance
Disconnecting environmental messaging from real business actions is the essence of greenwashing (Zhang et al., 2023). Organizational credibility and stakeholder confidence can take a hit when stakeholders view sustainability disclosures as symbolic or deceptive. Stakeholder theory posits that in order for an organization to be sustainable over the long run, it is crucial to keep the relationships with its stakeholders good. Stakeholder trust, reputational risks, and sustainability results may all be affected if sustainability messaging is misleading. Consequently, corporate sustainability performance is likely to be affected if greenwashing becomes more common (Sidney & Liao, 2025).
Because greenwashing can damage credibility and accountability, it is reasonable to assume that the two are negatively correlated. Inconsistencies between stated sustainability goals and real organizational practices make it harder for stakeholders to hold companies responsible and assess their sustainability efforts. The ties with stakeholders that are necessary for long-term sustainability might be weakened, and reputational risks can be increased under these situations.
However, the operationalization of these concepts may determine the empirical link between greenwashing and corporate sustainability performance. The results of evaluating them based on company disclosures could not be representative of the true sustainability outcomes or independently confirmed deceptive tactics. Therefore, the study's measuring strategy and empirical data are required to evaluate the provided hypothesis, which predicts a negative correlation in theory. Accordingly:
H4: Greenwashing negatively influences corporate sustainability performance.

The Moderating Role of Sharia Governance
The Sharia Supervisory Board (SSB) oversees Islamic financial institutions' operations to ensure that they adhere to Islamic standards, which is a unique governance method known as Sharia Governance. Financial and ethical-religious responsibility are the two pillars upon which Islamic banks rest. Hence, governance systems are crucial for keeping sustainability practices and technology adoption in line with Islamic

principles, such as fairness (adl), honesty (amanah), responsibility, and community service (maslahah) (Haron et al., 2022).

According to the Resource-Based View, Sharia Governance is an auxiliary resource that an organization may use to its advantage to boost the worth of its technical capacities (Barney, 1991). While AI offers superior data processing capabilities, ethical sustainability practices can only be achieved with strong governance that encourages the deployment of AI. By promoting open reporting, the ethical application of technology, and accountability procedures, strong Sharia Governance has the potential to enhance the connection between AI and ESG Disclosure Quality.

The complementary nature of technology capacities and governance resources sheds light on the regulating function of Sharia Governance. Sharia Governance offers an institutional framework for encouraging responsibility and conformity with Islamic ethical standards, while AI can improve a company's capacity to handle and evaluate sustainability data. Transparent, consistent, and credible ESG disclosures may be more successfully produced when these resources work together and AI-related skills are oriented in that direction. Consequently, the favorable correlation between AI and ESG disclosure quality is anticipated to be further enhanced with more stringent Sharia Governance.

Additionally, Sharia Governance can impact the AI-greenwashing dynamic by limiting opportunistic disclosure behavior via more stringent oversight procedures. Because greenwashing is affected by larger institutional and organizational variables, it is unclear whether Sharia Governance can completely prohibit it through AI-enabled reporting.

Differentiating between the effects on ESG disclosure quality and greenwashing is important. There is no guarantee that deceptive sustainability messaging will disappear simply because Sharia Governance promotes the use of AI for open reporting. The degree of supervision, presence of monitoring processes, managerial incentives, and accessibility of verifiable information may determine how well governance limits greenwashing. Therefore, it is expected that increased Sharia Governance will further strengthen the negative association between AI and greenwashing. However, it is important to conduct empirical examinations to determine the intensity and relevance of this interaction.

Collectively, the complementary-resource thesis posits that Sharia governance has the potential to influence the ways in which various sustainability reporting results are linked to AI-related capabilities. It is not assumed that the same governance mechanism creates similar impacts across both outcomes; hence, this study investigates the moderating function of Sharia governance separately for ESG disclosure quality and greenwashing. Consequently, the analysis suggests:

H5a: Sharia governance positively moderates the relationship between artificial intelligence and ESG disclosure quality.

H5b: Sharia governance strengthens the negative relationship between artificial intelligence and greenwashing**.**

3. RESEARCH METHOD

Research Design

Artificial intelligence (AI), ESG disclosure quality (ESGDQ), greenwashing (GW), and corporate sustainability performance (CSP) are all investigated in this study, along with the moderating effect of Sharia governance (SG) in Islamic commercial banks. The research methodology is based on quantitative explanatory research and panel data. Attention is drawn to the interplay between AI and SG in describing ESGDQ and GW, as well as the links between AI and ESGDQ, GW, CSP, and SG (Bayong et al., 2026; Khan et al., 2024). The secondary data included in the study come from business filings available to the public. To account for common year-specific impacts and unobserved bank-specific traits, panel data regression is used to examine findings across years and banks (Petersen, 2009). Bank fixed effects and year fixed effects are part of the updated specifications; these consider time-invariant variations across banks as well as common shocks impacting banks in a given year. Findings are seen as statistical connections rather than proven causal effects due to the research's use of disclosure-based metrics and observational data.

Population, Sample, and Observation Period

Islamic commercial banks that are active in Malaysia and Indonesia from 2021 to 2025 make up the population. Following these guidelines, a purposive sampling technique was used to select the sample:

1. The bank was officially recognized as an Islamic commercial bank in Indonesia or Malaysia during the observation period.

2. The bank publishes annual reports and relevant corporate or governance disclosures for the period under review.
3. The available documents contain information relevant to the operational indicators of AI, the ESGDQ, GW, CSP, and SG.
4. The information can be assessed using the predefined coding criteria of the study.

The sample uses 125 bank-year observations (25 banks × 5 years), which is intended to represent 25 Islamic commercial banks over a span of five years.

Data Sources and Collection Procedure

Primary data for the study came from official bank websites, reports on Sharia Supervisory Boards, corporate governance, sustainability, and annual reports that were available to the public (Beattie et al., 2004). Structured content analysis was used to examine the documents and find any material pertaining to the five study variables. There was a four-step process of gathering data. It all starts with gathering the appropriate reports for every bank and year. Subsequently, details pertaining to every predetermined indicator were located. Third, a score was awarded to the detected information after evaluating it against the coding criteria. The fourth step in calculating the indices is to record the scores in a bank-year dataset and verify their consistency. The coding process differentiates between pledges or broad declarations and proof of actions taken and results provided. For instance, just because something says "AI is becoming more popular" does not necessarily illustrate a particular use of the technology. In addition, just because something says "we will be sustainable" does not necessarily mean it will actually be. To make the coding process repeatable, the records must include the following information: the bank, the reporting year, the title of the document, the page number, any pertinent disclosure or proof, the awarded score, and the reasoning behind the coding decision. All financial institutions and fiscal years should use the same coding standards (Beattie et al., 2004).

Variable Operationalization and Measurement

The study examines five variables: AI, ESGDQ, GW, CSP, and SG. Each variable was measured using a disclosure-based index constructed from predefined indicators. A binary coding scale was used to determine whether each indicator satisfied the specified measurement criterion.

Binary Coding Scale and Index Calculation

Each indicator was coded as follows:

- **1** = The reviewed information satisfies the predefined operational criterion.
- **0** = the reviewed information has been assessed and does not satisfy the predefined operational criteria.
- **Missing** = the indicator cannot be assessed because relevant information is unavailable or insufficient.

A score of zero was assigned only after the relevant information was reviewed and the criterion was not satisfied. If an indicator cannot be assessed because the relevant document or information is unavailable, the observation is treated as missing rather than automatically assigned a zero score.

General index formula:

Index(i,t) = [Sum of X(j,i,t) for j = 1 to n] / n

Where:

- Index(i,t) = index value for bank i in year t.
- X(j,i,t) is the binary score for indicator j of bank i in year t.
- j = indicator being assessed.
- n = number of applicable indicators used to calculate the index.

The indices were calculated as follows:

Artificial Intelligence (AI):

AI(i,t) = [Sum of AI(j,i,t) for j = 1 to 6] / 6

ESG Disclosure Quality (ESGDQ):

ESGDQ(i,t) = [Sum of ESGDQ(j,i,t) for j = 1 to 4] / 4

Greenwashing (GW):

GW(i,t) = [Sum of GW(j,i,t) for j = 1 to 4] / 4

Corporate Sustainability Performance (CSP):

CSP(i,t) = [Sum of CSP(j,i,t) for j = 1 to 4] / 4

Table 1. Operational Definitions and Measurement of Variables

Variable and role	Operational definition	Indicators	Measurement	Data sources	References
Artificial Intelligence (AI), independent variable	The extent of publicly disclosed AI-related capabilities and implementation in bank activities.	(1) AI adoption initiatives; (2) machine learning implementation; (3) natural language processing applications; (4) AI-based risk management; (5) AI-supported fraud detection; and (6) AI-enabled reporting and information management.	Six binary indicators, coded 0 or 1. The sum of the applicable scores was divided by 6.	Annual reports, sustainability reports, technology disclosures, and official bank publications were also included.	Barney, 1991; Mikalef & Gupta, 2021b; Raisch & Krakowski, 2021
ESG Disclosure Quality (ESGDQ), dependent variable in Model 1 and explanatory variable in Model 3	The quality of disclosed environmental, social, and governance information in terms of transparency, completeness, consistency, and relevance.	(1) Transparency, (2) completeness, (3) consistency, and (4) relevance.	Four binary indicators coded 0 or 1. The sum of the applicable scores was divided by 4.	Annual reports, sustainability reports, ESG reports, and official bank disclosures	Christensen et al., 202; Global Sustainability Standards Board, 2021
Greenwashing (GW), dependent variable in Model 2 and explanatory variable in Model 3	The presence of predefined characteristics is associated with potentially misleading sustainability communication.	(1) exaggerated sustainability claims; (2) selective sustainability disclosure; (3) unsupported sustainability statements; and (4) inconsistency between sustainability disclosures and other disclosed practices or performance information.	Four binary indicators were coded 1 only when evidence satisfies the specified criterion and 0 when the assessed criterion is not met. The sum of the applicable scores was divided by 4.	Annual reports, sustainability reports, ESG reports, and other relevant official disclosures	Delmas & Burbano, 2011; Yu et al., 2020
Corporate Sustainability Performance (CSP), dependent variable in Model 3	Disclosed sustainability-related activities and outcomes across environmental, social, governance, and sustainable finance areas.	(1) Environmental sustainability initiatives and outcomes; (2) social responsibility activities and outcomes; (3) governance-related sustainability outcomes; (4) sustainable finance activities and outcomes.	Four binary indicators coded according to the predefined performance-related criterion. The sum of the applicable scores was divided by 4.	Annual, sustainability, and ESG reports and other official bank publications.	Dusuki & Abdullah, 2007; Freeman, 1984
Sharia Governance (SG), moderator in Models 4 and 5	The extent of disclosed Sharia oversight arrangements and related governance activities is also examined.	(1) Sharia Supervisory Board characteristics; (2) frequency of Sharia supervision activities; (3) Sharia compliance reporting; (4) ethical governance mechanisms.	Four binary indicators coded 0 or 1. The sum of the applicable scores was divided by 4.	Annual reports, corporate governance reports, Sharia Supervisory Board reports, and official bank publications were also used.	Grassa, 2013; Mollah & Zaman, 2015 Grassa (2013)

Operational Definitions of Variables

Sharia Governance (SG):

SG(i,t) = [Sum of SG(j,i,t) for j = 1 to 4] / 4

All indicators necessary for the relevant index were evaluated according to these algorithms. Researchers are required to use a consistent missing-data criterion when an indicator is absent, record their choice, and be

transparent about any decrease in the estimation sample that may occur as a result. It is important to avoid treating missing indicators as zero by default.
Zero to one is the range of all indices. A larger range of qualities is captured by the relevant construct when the value is higher. The meaning changes depending on the variable: a higher GW score means that more specified features linked to possibly deceptive sustainability communication have been discovered, whereas a higher ESGDQ score means that disclosure quality is greater.

Artificial Intelligence Measurement
Machine learning, artificial intelligence (AI)-based risk management, AI-supported fraud detection, AI-enabled reporting or information management, and AI-based natural language processing are the six metrics that quantify AI. When disclosure provides measurable proof that meets the applicable requirement, the indicator receives a score of 1. Without evidence to back up the AI-related signal, broad statements like digital transformation, IT, or automation will not suffice. Information on AI capabilities and their public disclosures is captured by the AI index. Expenditure on AI, technical proficiency, computer infrastructure, and the real intensity of AI application are not clearly measured. As a result, rather than being seen as proof of better technical skill, a higher AI score should be seen as more revealed AI-related capacity and implementation.

ESG Disclosure Quality Measurement
Clarity, comprehensiveness, consistency, and relevance are the four aspects that make up ESGDQ. Information must be clear and explicit for it to be transparent. As far as completeness is concerned, it all comes down to how well covered the pertinent material is. The question of consistency is to what extent are disclosures similar and comparable across reporting periods or relevant parts. Relevance is about how useful the data are for comprehending the risks, repercussions, and operations of the bank in relation to sustainability. Only when the revealed information meets the indicator's specified quality threshold does it obtain a score of 1. A generic sustainability statement or the use of ESG terms does not guarantee high-quality disclosure. Potentially influencing the evaluation criteria include GRI Standards and relevant IFRS Sustainability Disclosure Standards. Avoiding the assumption that all banks in both nations and during the observation period are subject to the same reporting standards necessitates that the researcher disclose the provisions utilized to generate each indicator.

Table 2. Greenwashing Coding Manual

Indicator	Score 1: qualifying evidence	Score 0: criterion not satisfied	Evidence to record
Exaggerated sustainability claims	A sustainability claim is materially broader or stronger than the evidence presented in the reviewed documents.	The claim is appropriately qualified or supported by information consistent with the stated scope.	Exact claim, scope of the claim, supporting evidence, and identified discrepancy.
Selective sustainability disclosure	Favorable sustainability information is presented while material contextual information identifiable in the reviewed sources is omitted, thereby affecting fair interpretation of the claim.	No qualifying evidence of materially selective presentation was identified in the reviewed sources.	Favorable claim, relevant omitted context, and the reason the omission changes the interpretation.
Unsupported sustainability statements	A specific sustainability claim lacks identifiable supporting information or evidence in the reviewed documents under the coding protocol.	The claim is supported by identifiable information, or the available evidence does not justify classifying it as unsupported.	Exact statements, expected supporting evidence, documents reviewed, and coding rationale.
Inconsistency between sustainability disclosures and other disclosed practices or performance information	A sustainability claim conflicts with relevant information about practices or performance disclosed elsewhere in reviewed documents or other reliable public sources.	No identifiable inconsistency was found in the sources reviewed.	The claim, conflicting information, source and page for each item, and explanation of the discrepancy.

Greenwashing Measurement and Coding Manual

Greenwashing was measured using four indicators designed to identify potentially misleading characteristics in sustainability communication. The index captures evidence identified in public disclosures and should not be interpreted as definitive proof of deliberate deception in financial statements.

The following rules apply to all four indicators.

1. A score of 1 required identifiable evidence that satisfied the corresponding criterion. General sustainability-oriented language is not automatically classified as greenwashing.
2. However, a lack of disclosure alone does not establish greenwashing. The coder must identify evidence that meets relevant operational criteria.
3. An unverifiable claim is not automatically treated as deliberately deceptive. The coding record should explain which criterion was satisfied and what evidence was reviewed.
4. The same evidence should not be counted under multiple indicators unless it independently satisfies each indicator's criterion and the coding record explains the distinction.
5. For each positive score, the coding record must include the bank, year, report title, page number, relevant claim, supporting or conflicting evidence, assigned score, and the justification.
6. When the available sources do not permit a reliable assessment, the indicator should be treated as missing, rather than automatically assigned a score of zero.

The GW index is calculated as the sum of the four binary scores divided by four. Higher values indicate that a greater number of predefined characteristics associated with potentially misleading sustainability communication has been identified. The index does not establish the intention behind the communication and does not capture every possible form of greenwashing.

Corporate Sustainability Performance Measurement

Four categories were used to evaluate CSP: actions and achievements linked to environmental sustainability, social responsibility, sustainability in governance, and sustainable finance. Instead of simply having rules, goals, or broad promises, coding should emphasize proof of actual actions taken or results recorded. It is not fair to give an outcome-oriented indication a perfect score based on a claimed environmental commitment unless that commitment is specifically included in the set of criteria. Environmental indicators might consist of environmental initiatives that have been publicized, as well as the results of these activities. Some social indicators may consist of records of actions taken and outcomes from corporate social responsibility initiatives. Governance indicators should not only reflect the presence of broad governance policies but also document relevant sustainability results. Indicators of sustainable finance should represent recorded financial transactions that meet the sustainability-related criteria set out by the research.

By dividing the total of the four binary scores by four, we can determine the CSP index. Rather than providing a thorough and impartial evaluation of real sustainability performance, the metric represents declared sustainability-related actions and results, as the statistics are built from public disclosures. To reduce duplication of ESG disclosure quality, the final coding manual should outline the proof needed for each indication.

Sharia Governance Measurement

Four variables are used to measure SG: the features of the Sharia Supervisory Board, the frequency of Sharia supervision activities, the procedures for ethical governance, and the reporting of Sharia compliance. When the applicable disclosure meets the specified requirement, an indicator receives a score of 1. For instance, the first indicator may be backed by the presence and composition of a Sharia Supervisory Board, whereas the related indicators could be backed by recorded supervisory activity or reporting. It is not sufficient to show that a governance system is in place for it to be effective. By dividing the total of the four binary scores by four, we can determine the SG index. Although its focus is on the quantity rather than the quality of stated Sharia governance systems and activities, it does reflect their scope. Before we can estimate the moderation models with fixed effects for the banks, we need to examine how SG changes throughout the years inside each one. It is not possible to isolate the main influence of SG from the fixed effects of the bank if SG remains constant inside the bank during the observation period.

Coding Consistency and Construct Validity

A standardized coding manual is used to define the indicators, decision rules, inclusion criteria, and evidence Significance, decision-making processes, inclusion criteria, and proof needed for each score are defined in a standardized coding handbook. A distinct disclosure and reporting page must be tracked for every code

decision. Coding agreement should be evaluated and reported appropriately when several coders are engaged. When working with a single coder, it is important to only discuss reviews or recoding procedures that were actually carried out. Prior to their reporting, reliability statistics must be computed.A conceptual distinction is drawn between ESGDQ, GW, and CSP in the study. The ESGDQ evaluates the accuracy of ESG data, GW identifies certain traits in sustainability messaging that might be deceptive, and CSP records all actions and results connected to sustainability that have been made public. One cannot use one for the other. By reducing measurement overlap, we do not see disclosure completeness as proof of greenwashing on its own, and we do not consider sustainability reporting as proof of sustainability performance. While GW requires concrete proof of possibly deceptive communication, CSP coding standards emphasize actions and results. However, the observed associations might be impacted by common-source measurement and reporting standards, since the measures are drawn from public disclosure. Consequently, the results need to be understood in the context of the operational definitions and constraints of disclosure-based proxies.

Panel Data Estimation and Diagnostic Procedures

The repeated data from the sampled banks from 2021 to 2025 are analyzed using panel regression. There are two types of fixed effects in the updated specification: bank and year. Unobserved features that remain consistent across all banks are accounted for by bank fixed effects. Changes in the overall economic, regulatory, and reporting climate, as well as other typical shocks or changes impacting banks in a given year, are taken into consideration by year fixed effects. Tests for selecting appropriate models should back up the choice of estimator. To evaluate pooled regression against bank fixed effects, one may apply the redundant fixed-effects or Chow test. If you want to compare specifications with fixed effects with those with random effects, you may apply the Hausman test. If you want to compare random effects using pooled regression, you may apply the Breusch-Pagan Lagrange multiplier test. The reported tests must match the actual parameters estimated, and the appropriate test results, p-values, and judgments should be included in the publication.

Multicollinearity, heteroscedasticity, serial correlation, and cross-sectional dependency should all be evaluated in the analysis, provided that the data and specifications chosen permit it.

Robust standard errors should not be used to define the present estimations. Because they account for heteroscedasticity and within-bank dependence, bank-clustered standard errors provide an appropriate basis for the updated analysis. However, traditional cluster-robust inference may be unreliable with this small sample of 25 banks, given the limited number of clusters. Where feasible and supported by the software and study design, an appropriate small-sample correction or wild cluster bootstrap approach should be considered. Because financial institutions may be exposed to similar shocks, cross-sectional dependence should also be taken into account. The choice of covariance estimator should reflect the available estimation methods, limited sample size, diagnostic evidence, and panel structure. The baseline specification does not include additional control variables, which may result in the omission of important time-varying, bank-specific factors. This limitation should be acknowledged, and the coefficients should be interpreted as conditional associations within the specified models rather than as absolute causal effects.

Econometric Models

Five regression models were used to examine the proposed relationships. All revised models include bank fixed effects and year fixed effects. The notation is as follows: i denotes the bank, t denotes the year, α denotes the intercept, β denotes a regression coefficient, μ(i) denotes bank fixed effects, λ(t) denotes year fixed effects, and ε(i,t) denotes the idiosyncratic error term.

Model 1: Artificial Intelligence and ESG Disclosure Quality

$ESGDQ(i,t) = \alpha 1 + \beta 1\ AI(i,t) + \mu(i) + \lambda(t) + \varepsilon(i,t)$

This model examines the association between AI and the ESGDQ. A positive β1 is consistent with the expectation that greater AI capability and implementation are associated with higher ESG disclosure quality.

Model 2: Artificial Intelligence and Greenwashing

$GW(i,t) = \alpha 2 + \beta 2\ AI(i,t) + \mu(i) + \lambda(t) + \varepsilon(i,t)$

This model examined the association between AI and the GW index. A negative β2 is consistent with the expectation that greater disclosed AI capability and implementation are associated with fewer identified characteristics of potentially misleading sustainability communications.

Model 3: ESG Disclosure Quality, Greenwashing, and Corporate Sustainability Performance
$CSP(i,t) = \alpha 3 + \beta 3\ ESGDQ(i,t) + \beta 4\ GW(i,t) + \mu(i) + \lambda(t) + \varepsilon(i,t)$
This model examines the association between ESGDQ, GW, and CSP. A positive β3 is consistent with the expectation that higher ESG disclosure quality is associated with better sustainability performance. A negative β4 is consistent with the expectation that a greater presence of greenwashing is associated with lower sustainability-performance disclosure.

Model 4: Moderating Role of Sharia Governance in the AI–ESGDQ Relationship
$ESGDQ(i,t) = \alpha 4 + \beta 5\ AI(i,t) + \beta 6\ SG(i,t) + \beta 7\ [AI(i,t) \times SG(i,t)] + \mu(i) + \lambda(t) + \varepsilon(i,t)$
This model examines whether the SG moderates the association between AI and ESGDQ. Coefficient β7 is the interaction coefficient. A positive and statistically significant β7 is consistent with the hypothesis that the positive association between AI and ESGDQ strengthens at higher levels of SG.

Model 5: Moderating Role of Sharia Governance in the AI–GW Relationship
$GW(i,t) = \alpha 5 + \beta 8\ AI(i,t) + \beta 9\ SG(i,t) + \beta 10\ [AI(i,t) \times SG(i,t)] + \mu(i) + \lambda(t) + \varepsilon(i,t)$
This model examined whether SG moderated the association between AI and GW. A negative and statistically significant β10 is consistent with the hypothesis that the negative association between AI and GW becomes stronger at higher SG levels. The inclusion of bank fixed effects means that a time-invariant SG variable cannot be estimated separately from the bank fixed effects. Therefore, the within-bank variation of SG must be checked before interpreting its main effect coefficient. The interaction term can be estimated only if it has sufficient variation and is not perfectly collinear with other regressors and fixed effects. Any variable dropped by the software because of collinearity should be reported and interpreted.

Hypothesis Testing and Interpretation
Standard errors, p-values, test statistics, and predicted regression coefficients were used to evaluate the hypotheses. Consistency should be maintained in reporting the significance level and decision criteria throughout the book. For each predicted coefficient, we compared its expected theoretical direction with the direction reported in the literature. In Models 1 and 2, the relationships between AI and ESGDQ and between AI and GW are evaluated using β1 and β2, respectively. In Model 3, the relationships between ESGDQ and CSP and between GW and CSP are evaluated using β3 and β4, respectively. The principal coefficients used to assess the moderating effect of SG in Models 4 and 5 are β7 and β10, respectively. The regression tables should report the standard errors, number of observations, number of banks, R^2, adjusted R^2 (where appropriate), fixed-effects specification, and covariance estimation. The final estimates should be consistent with the abstract, findings, discussion, hypothesis-testing table, and conclusion. The results should be interpreted as statistical relationships within the specified models, given that the study uses disclosure-based indices and observational panel data. The measurement process and empirical data should not be used to make claims that extend beyond what can be demonstrated regarding actual AI capabilities, intentional greenwashing, governance effectiveness, or improvements in sustainability outcomes.

4. DATA ANALYSIS AND DISCUSSION

DATA ANALYSIS

Descriptive Statistics

Table 3. Descriptive Statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
AI	0.582	0.164	0.167	0.833
ESGDQ	0.716	0.128	0.250	1.000
GW	0.357	0.172	0.250	0.750
CSP	0.754	0.116	0.250	1.000
SG	0.687	0.151	0.250	1.000

The descriptive data show that Islamic commercial banks exhibited a range of characteristics. The average level of stated AI-related capabilities and practices was modest, with a mean of 0.582. This metric does not account for independently confirmed technology deployment or organizational integration but rather the amount of AI-related information that banks report. The study's coding scheme indicates that ESGDQ has a

reasonably wide disclosure quality, with a mean score of 0.716. The sustainability communication practices that were found by the disclosure-based measuring technique show variance, with an average value of 0.357 for GW. There is some diversity in the stated sustainability-related activities and Sharia governance practices, as indicated by the CSP mean of 0.754 and the SG mean of 0.687.
The ranges and standard deviations show that the measured variables vary among banks and time periods. However, descriptive statistics cannot determine whether these variations are due to substantial organizational procedures, variations in reporting techniques, or a combination of the two. Given that the variables are derived from publicly available company filings, this constraint becomes all the more apparent.

Correlation Analysis
Pearson 'scorrelation analysis was conducted to examine the direction and strength of the relationships among the main variables and to provide a preliminary assessment of potential multicollinearity.

Table 4. Correlation Matrix

Variable	AI	ESGDQ	GW	CSP	SG
AI	1.000	0.654***	−0.318***	0.483***	0.426***
ESGDQ	0.654***	1.000	−0.284***	0.702***	0.511***
GW	−0.318***	−0.284***	1.000	−0.591***	−0.467***
CSP	0.483***	0.702***	−0.591***	1.000	0.498***
SG	0.426***	0.511***	−0.467***	0.498***	1.000

Correlation data show a positive link between AI and ESGDQ (r = 0.654) and a negative association between AI and GW (r = −0.318). The correlation between ESGDQ and CSP is positive (r = 0.702), whereas the correlation between GW and CSP is negative (r = −0.591). For AI, ESGDQ, and CSP, SG has a positive correlation, whereas GW has a negative one. When comparing ESGDQ with CSP, the highest possible pairwise correlation is 0.702. Although this number falls short of the frequently accepted preliminary screening criterion of 0.80, it does not rule out the possibility of multicollinearity. Since both ESGDQ and CSP are assessed using publicly accessible information, it is important to analyze their link with caution. Rather than a direct correlation between transparency and independently confirmed sustainability results, their link can be due to shared data sources or reporting methods. Unconditional relationships characterize these correlations. They should not be used as proof of the links after fixed effects because they do not account for bank-specific traits or common yearly effects.

Diagnostic Tests and Panel Model Selection

Table 5. Diagnostic and Panel Model Selection Tests

Test	Result	Interpretation
Maximum pairwise correlation	0.702	No pairwise correlation above 0.80
Heteroskedasticity test	p = 0.274	No significant evidence detected by the specified test
Serial correlation test	p = 0.083	No significant evidence at the 5% level
Cross-sectional dependence test	p = 0.121	No significant evidence at the 5% level
Redundant fixed effects (bank) test	p < 0.001	Bank fixed effects preferred to pooled estimation
Hausman test	p = 0.019	Fixed effects preferred to random effects
Breusch–Pagan LM test	p < 0.001	Panel effects preferred to pooled estimation
Joint test of year effects	p = 0.041	Year effects jointly significant at the 5% level

Instead of using pooled estimation, the results suggest using bank fixed effects. Another test that helps fixed effects more than random effects is the Hausman test. Additional support for adding year indicators to the regression models is provided by the assumption of statistical significance in the joint test of year effects.
Since panel-data inference may be impacted by deviations from traditional error assumptions, we incorporate the heteroscedasticity, serial correlation, and cross-sectional dependency tests. The absence of these issues cannot be inferred from diagnostic data that are not statistically significant. Therefore, the regression tables suggest using bank-clustered standard errors to consider the time-varying within-bank dependency. A suitable small-sample correction or wild cluster bootstrap inference, if possible, should be

included in the final analysis because of the relatively small number of bank clusters.
Year-fixed and bank-fixed effects are included in the final specification. Common yearly shocks and time-invariant unobserved bank characteristics are the sources of bias that this specification aims to mitigate. On the other hand, it is not foolproof against omitted-variable bias; this is especially true when it comes to time-varying bank-specific variables that were not taken into account.

Regression Results
The regression analysis uses a two-way fixed-effects specification incorporating bank and year fixed effects. Five model columns are presented: the AI–ESGDQ relationship, the AI–GW relationship, the ESGDQ–GW relationship with CSP, and the two moderation models.

Table 6. Two-Way Fixed Effects Regression Results

Variables	ESGDQ	GW	CSP	ESGDQ Moderation	GW Moderation
AI	0.421*** (0.108)	−0.094 (0.097)	–	0.409*** (0.112)	−0.091 (0.101)
ESGDQ	–	–	0.498*** (0.142)	–	–
GW	–	–	−0.096 (0.086)	–	–
SG	–	–	–	0.163** (0.071)	−0.135** (0.063)
AI × SG	–	–	–	0.207** (0.088)	−0.061 (0.070)
Bank fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	125	125	125	125	125
Number of banks	25	25	25	25	25
Within R^2	0.712	0.398	0.694	0.724	0.407
Adjusted R^2	0.674	0.354	0.651	0.681	0.362
Prob. (F-statistic)	0.000	0.000	0.000	0.000	0.000

The findings indicate that AI is positively and statistically significantly associated with ESGDQ ($\beta = 0.421$, $p < 0.01$). This result supports the hypothesis that financial institutions would offer better ESG disclosures if they disclosed more information about their AI capabilities and practices. The coefficient may not directly imply that implementing AI enhances ESG reporting, but it does indicate a correlation between reported AI-related information and disclosure quality, which is a reasonable interpretation given that public disclosures are the primary means of measuring AI.
The AI coefficient in the GW model was -0.094, which was negative but not statistically significant. Thus, there is no evidence to support the claim that there is a statistically significant link between the disclosure of AI capabilities and a reduction in greenwashing instances. It is not possible to determine the substantive implementation of AI systems or the veracity of sustainability claims using the measuring technique alone, and there may be conflicting disclosures regarding AI and sustainability communication practices.
A positive and statistically significant coefficient ($\beta = 0.498$, $p < 0.01$) was assigned to ESGDQ in the CSP model, whereas GW's coefficient ($\beta = -0.096$) was negative but not statistically significant. The study's disclosure-based CSP metric is associated with disclosure quality, according to the positive ESGDQ coefficient. We should not jump to the conclusion that more transparency leads to greater social or environmental results. Given that both metrics are based on publicly available information, it is possible that the correlation is due in part to shared reporting or similar ideas.
A positive and statistically significant interaction existed between AI and SG in the ESGDQ moderation model ($\beta = 0.207$, $p < 0.05$). Based on the other factors in the model, the positive interaction suggests that the link between AI and ESGDQ grows stronger as SG rises. This finding is in line with the idea that Sharia law

may strengthen the connection between the quality of disclosure and the reported AI capabilities by providing an institutional framework that does just that.
The AI × SG coefficient in the GW moderation model was negative (β = −0.061), which did not indicate statistical significance. Consequently, we cannot conclude that SG substantially moderates the AI–GW link based on the data. The final model estimates should inform the interpretation of the interaction coefficients, which should consider whether SG fluctuates sufficiently within banks over the observation period.
The values within the range of R^2 are between 0.398 and 0.724. Under the assumed specification, these figures show the amount of variance within banks that can be explained by the estimated models. Do not take them as proof of their ability to explain causes and effects.

Hypothesis Testing

Table 7. Hypothesis Testing Results

Hypothesis	Relationship	Coefficient	p-value	Expected Direction	Decision
H1	AI → ESGDQ	0.421	0.001	Positive	Supported
H2	AI → GW	−0.094	0.341	Negative	Not supported
H3	ESGDQ → CSP	0.498	0.002	Positive	Supported
H4	GW → CSP	−0.096	0.267	Negative	Not supported
H5a	AI × SG → ESGDQ	0.207	0.024	Positive	Supported
H5b	AI × SG → GW	−0.061	0.389	Negative	Not supported

As AI was positively and statistically significantly associated with the ESGDQ (β = 0.421; p = 0.001), the findings of the hypothesis testing show that H1 is validated. Owing to the negative but statistically insignificant AI coefficient in the GW model (β = −0.094; p = 0.341), H2 cannot be justified. This is because ESGDQ is positively and statistically significantly associated with CSP (β = 0.498; p = 0.002). In the CSP model, GW has a negative coefficient (β = −0.096; p = 0.267), which does not support H4. Because the AI × SG interaction has a positive and statistically significant coefficient in the ESGDQ model (β = 0.207; p = 0.024), H5a is supported for moderating connections. The lack of statistical significance of the negative interaction coefficient in the GW model (β = −0.061; p = 0.389) disproves H5b.

Discussion

Artificial Intelligence and ESG Disclosure Quality
Regression analysis shows that ESG disclosure quality (ESGDQ) is positively and statistically associated with artificial intelligence (AI). After controlling for bank-and year-specific factors, this result implies that Islamic banks with more publicly known AI capabilities also tend to provide better ESG data. This finding should not be seen as proof of real AI deployment or organizational integration, but rather as a relationship between declared AI-related capabilities and ESG disclosure quality, as AI is measured using publicly accessible disclosures. This result aligns with the Resource-Based View (RBV), which provides an explanation for how an organization's resources might provide value when they are well integrated into internal processes (Barney, 1991). Sustainability data may be easier to gather, process, organize, and evaluate with the use of AI-related resources. Raisch & Krakowski (2021) examine the symbiotic relationship between AI-enabled businesses' reliance on automation and their reliance on human decision-making, whereas Mikalef and Gupta (2021) define AI competence as an organizational capability that involves the mobilization of AI-related resources. According to these points of view, AI's capacity to improve ESG reporting is contingent upon a number of factors, including the accessibility of the technology, its integration with organizational information systems, the level of knowledge among employees, and the reporting processes in place. This finding is also pertinent to Stakeholder Theory, which, according to Freeman (1984), stresses the significance of responding to stakeholder interests and accountability demands with information. Islamic financial institutions must be open and accountable to those who have a stake in their Shariah compliance and ethical practices, as well as in their sustainability efforts. AI-related skills might make sustainability data organization easier and provide a hand with better organized reporting. However, it is not proven in our investigation that AI enhances the underlying information's quality or completeness on its own. The significance of this research rests in the fact that it takes Sharia Governance into account as a possible moderator of the relationship between Islamic banks' ESG disclosure quality and their declared AI-related capabilities. The research questions the assumption that AI is a panacea for all technical problems by instead

asking if the nature of the link between AI and disclosure quality varies depending on the framework of institutional governance. This viewpoint is pertinent because disclosures pertaining to technology do not always show real implementation, and that the effectiveness of sustainability reporting could rely on supplementary governance and organizational structures. Results support the idea that AI-related skills, when integrated into suitable organizational procedures, may improve the quality of ESG disclosure. Nevertheless, this reading is still dependent on the disclosure-based evaluation method. To bolster the evidence, future studies should separate claims about AI from their independently validated implementation, such as AI apps with documentation, information management systems with a known track record, or proof of integration into reporting and internal control procedures.

Artificial Intelligence and Greenwashing

There is a negative correlation between AI and GW, although it is not statistically significant. There is insufficient statistical evidence to support the correlation between AI-related skills and less deceptive sustainability communication in the sample, even though the coefficient is in line with expectations. From an RBV perspective, AI may offer technical means of analyzing and comparing data on sustainability. However, having access to technology does not guarantee fair or open reporting. Whether or if they are subject to organizational controls, management supervision, and ethical standards determines their usefulness (Barney, 1991). While AI may be useful for finding discrepancies in data, it could also lead to the creation of more complex sustainability stories without checking that they represent actual practices. Therefore, the notion that more AI competence is inevitably related to decreased greenwashing is qualified by the non-significant outcome. The disparity between organizational incentives that impact sustainability communication and technology competence is one probable cause. A bank's reporting decisions may still be influenced by managerial goals, internal accountability, external scrutiny, and the availability of trustworthy sustainability data, even if the bank has the ability to handle information more effectively. Because these mechanisms are not explicitly measured in the current investigation, they should be considered as hypotheses rather than proven causes of the observed outcome. It is also necessary to consider the method of measuring. The disparity between stated sustainability goals and actual actions taken or results achieved is what "greenwashing" is all about. Claims that lack evidence, assertions that are not backed by facts, or discrepancies with other revealed information can all be found using a disclosure-based index. It may be difficult to determine if a claim is materially misleading based on public reporting alone, especially in the absence of independent performance data or external verification. Instead of looking at the index as proof of deliberate deceit, you should see it as a measure of disclosed greenwashing indicators. When trying to make sense of the connection between AI and GW, this difference is crucial. Just because the coefficient isn't statistically significant doesn't mean there is no correlation between AI and greenwashing. It instead says that there isn't enough proof of a statistically significant link using the given model and measurements. Their functions need direct empirical investigation, although variations in reporting, governance, and implementation procedures could also be significant. The takeaway here is that you can not rely on AI-related skills to vouch for things like independent verification or good sustainability governance. Technical instruments, established data controls, review procedures, suitable assurance, and methods for finding discrepancies between stated claims and accessible evidence should be utilized by Islamic banks that intend to enhance the credibility of sustainability communication. The non-significant regression result does not explicitly establish these suggestions; rather, they are precautionary implications of the measurement and theoretical framework.

ESG Disclosure Quality and Corporate Sustainability Performance

Corporate Sustainability Performance (CSP) is positively and statistically associated with ESG Disclosure Quality. This data implies that the disclosure-based CSP metric tends to provide better scores to Islamic banks that provide higher-quality ESG disclosures. This finding aligns with Stakeholder Theory, which supports Freeman (1984) contention that stakeholders should be kept informed and held accountable. To make sense of this connection, however, we need to separate disclosure quality from real sustainability performance. Information completeness, consistency, relevance, and transparency are all aspects of information quality that ESGDQ addresses. In contrast, the purpose of CSP is to symbolize actions and results connected to sustainability. In this study, the operational measurements for both domains are generated from publicly available business filings, notwithstanding their conceptual differences. Hence, it is possible that the positive correlation between the two is due to shared reporting techniques or overlapped information rather than a causal link between high-quality reporting and independently confirmed social or environmental effects.

Although this constraint does not render the association useless, it does restrict the range of inferences that may be derived from it. Stakeholders may be able to see and evaluate sustainability initiatives better with higher-quality transparency. There may be better organized internal procedures for gathering and sharing sustainability data, which might explain it as well. On the other hand, this observational study can not tell you if stronger sustainability practices cause better transparency, if greater disclosure leads to higher sustainability performance, or if both are linked to other organizational traits. When it comes to Islamic finance, the difference is crucial. Reports on sustainability may include details on a company's social responsibility, ethics, sustainable finance, and governance procedures. Stakeholders, such as those worried about Shariah compliance and larger societal obligations, can hold companies accountable through these disclosures. However, one should not immediately correlate the quantity and quality of published information with the real social and environmental impacts of a bank's operations. According to the International Sustainability Standards Board (2023b, 2023a), structured sustainability reporting frameworks, such as IFRS S1 and IFRS S2, emphasize the significance of clear sustainability-related information that is relevant for decision-making. Using these frameworks as measurement standards does not prove that disclosure quality generates improved sustainability results, but they can help develop disclosure-quality criteria when appropriate. The reporting requirements of the institutions and countries under consideration should also be taken into account when determining their relevance. Therefore, this study's contribution is to investigate how Islamic banks' ESG disclosure quality relates to a disclosure-based sustainability performance metric. Instead of drawing firm conclusions about better sustainability outcomes in the actual world, the results should be seen as evidence of a link between the two assessed dimensions. Separation of constructs should be improved in future studies by using ESG evaluations conducted by third parties, external assurance data, or alternative outcome metrics that are not based on the same reporting documents.

Greenwashing and Corporate Sustainability Performance

There is a negative correlation between greenwashing and corporate sustainability performance, although it is not statistically significant. The expected association between possibly deceptive sustainability communication and poor sustainability performance is corroborated by the direction of the coefficient. But there isn't enough proof from the statistics to say that GW is significantly linked to CSP in this group. According to Freeman (1984), stakeholders may evaluate an organization's accountability and sustainability efforts using sustainability disclosures. Stakeholders may have difficulty assessing an organization's true sustainability stance if stated assertions do not fairly represent underlying actions. This concern emphasizes the theoretical significance of differentiating between the things that groups say they will do and the things that they really do. One possible explanation for the lack of statistical significance is that the measuring method used had its limits. In the same way that CSP is assessed using data from public reporting, the GW index finds observable signs in public disclosures. Given the difficulty of independently observing the underlying results, these indicators may fall short of capturing the whole disparity between sustainability promises and actual performance. Furthermore, greenwashing cannot be proven simply by demonstrating the lack of a specific disclosure. The results of a disclosure-based evaluation are constrained by these factors. This finding in no way disproves the significance of greenwashing or the relevance of perhaps deceptive communication to long-term viability. The results show that there is no statistically significant correlation between the GW indicators and the CSP proxy when using the given model. To find out if the association becomes more obvious when longer observation periods, external verification, or independent sustainability outcomes are taken into account, further research is needed. This means that Islamic financial institutions need to look at the results and actions behind sustainability claims to determine how credible their claims are. Simply having Shariah monitoring and ethical obligations in place does not guarantee that all sustainability claims are true or that sustainability results are robust; they only offer a pertinent institutional framework. Enhancing accountability might be achieved by independent assurance, verifiable indicators, and maintaining consistency between stated promises and observable behaviors. Prior to asserting that these techniques may effectively decrease greenwashing or enhance CSP, they need be tested empirically.

The Moderating Role of Sharia Governance

In the ESGDQ model, the results show that AI and Sharia Governance (SG) interact positively and statistically significantly. Depending on the final specification and the validity of the underlying metrics, this conclusion indicates that as SG levels increase, the positive connection between revealed AI-related skills and ESG disclosure quality grows greater. Based on the findings, governance can be considered as a possible supplementary component in the connection between AI-related capacities and sustainability reporting.

According to the RBV theory, AI-related assets can process data, and governance systems might control and oversee the usage of organizational assets (Barney, 1991). A reason for the variation in the connection between AI and ESGDQ across governance contexts might be their possible complementarity. Nevertheless, the current outcome does not definitively prove the methods by which Sharia Governance functions. Rather than being proof of a particular governance mechanism, the interpretation should be seen as congruent with the offered theoretical explanation. Concerning Islamic banks' duties of responsibility, the discovery is pertinent as well. Organizational contexts that analyze data pertaining to ethics and sustainability may find Sharia Governance, which deals with monitoring adherence to Shariah principles, to be pertinent. More organized methods of gathering, evaluating, and conveying sustainability data may be possible with the use of AI-related skills and this kind of supervision. However, the disclosure-based metrics used in the study can not prove anything about how well real supervisory actions work or how much of an impact governance systems have on ESG data creation. By looking at Sharia Governance in a moderating role instead of seeing it as an independent governance feature, the outcome provides a contextual contribution. The findings imply that the governance framework plays a role in determining the link between AI-related competences and ESG disclosure quality. By looking at it from this angle, we can see that technological capabilities do not necessarily correlate with high-quality reporting in every company. Statistically speaking, however, the GW model's AI and SG relationship is negative. The coefficient's predicted direction suggests that stricter Sharia governance might mitigate the correlation between AI and deceptive sustainability claims. However, there is not enough proof from the data to say that SG acts as a moderator in this connection. Thus, drawing the conclusion that Sharia Governance, in conjunction with AI, significantly decreases greenwashing in the sample under consideration would be improper. When looking at the moderation outcomes separately, there is a theoretically significant difference. Making sure sustainability promises match up with actual practices is a different corporate responsibility than creating more thorough and organized disclosure. It may be necessary to verify the underlying evidence and compare it with independently observed results in order to identify and avoid false statements; reporting methods may also be impacted by governance frameworks. Rather than being established by the present regression results, these potential pathways are still up for additional exploration. As a result, Islamic financial institutions should not assume that Sharia Governance and AI-related competencies are mutually exclusive but should instead view them as supplementary components of sustainability reporting. The findings provide credence to the idea that the interplay between technology capabilities and processes for data verification, independent assurance, internal controls, and governance supervision warrants more investigation. There has to be proof that separates reporting quality from real sustainability performance in order to assess how well these arrangements work.

Theoretical Contributions and Practical Implications

Taken together, these findings provide a basis for discussing the relationship between AI-related capabilities, sustainability disclosure, and governance in Islamic banking. The positive association between AI and ESGDQ is consistent with the RBV proposition that organizational resources may be valuable when integrated into an organization’s internal processes. The positive interaction between AI and SG suggests that the association between technological capability and disclosure quality may depend on the governance environment. These results qualify a technology-centered interpretation by highlighting the potential relevance of complementary organizational and governance arrangements.

Stakeholder theory provides a complementary perspective by emphasizing accountability and the need for information that enables stakeholders to assess organizational conduct. In Islamic banking, the relevance of this perspective extends to stakeholders concerned with ethical responsibilities and Shariah compliance. Nevertheless, the non-significant results for AI and GW, GW and CSP, and the AI × SG interaction in the GW model indicate that improvements in reporting capability should not automatically be interpreted as evidence that potentially misleading sustainability communication has been reduced.

Therefore, practical implications should be differentiated. For sustainability reporting, banks should consider improving the integration of AI-related tools with data management, documentation, review procedures, and governance oversight. For sustainability performance, banks should complement disclosure practices with measurable environmental and social outcomes and, where feasible, with independent verification. For Sharia Governance, the relevant question is not only whether governance structures exist but also whether their activities and reporting responsibilities are clearly documented and appropriately assessed.

These implications should be interpreted in light of the study's limitations. The analysis focuses on Islamic commercial banks in Indonesia and Malaysia during 2021–2025, and the variables are constructed from publicly available disclosures. Therefore, the findings may not generalize to all financial institutions or

jurisdictions. The observational panel design also supports interpretation in terms of statistical associations rather than causal effects. Future studies could strengthen the evidence by using independently verified AI implementation measures, external greenwashing assessments, non-disclosure-based sustainability outcomes, and alternative specifications that address potential omitted-variable bias and measurement overlap.

5. CONCLUSION, IMPLICATIONS, SUGGESTIONS, AND LIMITATIONS

With Sharia Governance (SG) as a moderator, this study examined Islamic commercial banks in Malaysia and Indonesia to determine how AI, ESG disclosure quality (ESGDQ), greenwashing (GW), and corporate sustainability performance (CSP) relate to each other. According to the results, there is a positive and statistically significant relationship between AI and ESGDQ. This means that Islamic banks' disclosure of AI-related capabilities might improve the credibility of their sustainability reports. This conclusion should not be seen as proof of real AI deployment or operational performance, but rather as a relationship between declared AI-related capabilities and ESG disclosure quality, as AI is measured using publicly accessible disclosures.

Additionally, there is a negative but statistically negligible correlation between AI and greenwashing. Accordingly, there is insufficient evidence from the results that the sampled banks with AI-related skills engage in less greenwashing. The significance of differentiating between technical capacities and their disclosure and the veracity of sustainability claims is emphasized by this outcome. Similarly, this analysis found a positive and statistically significant relationship between ESGDQ and CSP, suggesting that higher-quality ESG disclosures lead to greater sustainability performance. However, this correlation does not show that more transparency leads to greater sustainability results. Under the used measurement and model parameters, there is insufficient evidence to support the claim that there is a statistically significant correlation between greenwashing and CSP. The calculated model shows that the link between AI and ESG disclosure quality is stronger at higher levels of Sharia Governance, suggesting that Sharia Governance has a moderating function. The interaction between AI and SG is positive and statistically significant for ESGDQ. Greenwashing, on the other hand, does not show a statistically significant interaction between AI and SG. The findings indicate that Sharia Governance might enhance sustainability reporting with AI-related skills; however, its moderating effect on the greenwashing outcome is not substantiated.

This study adds to the existing literature by using an Islamic banking integrated sustainability reporting framework to investigate AI-related skills, ESG disclosure quality, greenwashing, and Sharia governance. This study expands previous work that applies the resource-based view and stakeholder theory in a context where governance arrangements and technical capabilities may influence sustainability-related disclosure. It does this by taking Sharia governance into account as a moderating mechanism. The results also show that we should not assume that better sustainability reporting means less false sustainability claims; instead, we should look at disclosure quality and greenwashing as separate outcomes.

Implications

Theoretical Implications

This study adds to the Resource-Based View by showing that revealed AI-related skills are positively associated with ESG disclosure quality. Organizational information-processing and reporting capacities may be bolstered by technical resources, according to the results. The study's findings should not be used as proof that real AI deployment improves reporting quality; it depends on disclosure-based AI measures. The results add to Stakeholder Theory by showing how important it is to be transparent about sustainability to keep stakeholders accountable. Strengthening sustainability performance within the study's assessment framework is associated with higher-quality sustainability disclosure, according to the positive connection between ESGDQ and CSP. Since disclosure is insufficient to determine the full scope of a company's real social or environmental effect, the difference between reporting quality and underlying performance is crucial. Sharia Governance may influence the correlation between AI-related skills and the quality of sustainability reports, according to the substantial AI × SG connection for ESGDQ. Extending theories of organizational reporting in Islamic banking based on governance, this research offers a context-specific perspective. We should not generalize the possible complementary function of Sharia Governance across all sustainability-related outcomes, though, because the interaction for Greenwashing was minor. In light of these findings, it is clear that the connection among sustainability reporting, governance, and technology must be better understood.

Practical and Policy Implications

The results indicate that reputable data governance, internal controls, clear reporting processes, and suitable Sharia supervision should accompany AI-related endeavors for Islamic commercial banks. Financial institutions should examine the data, processes, and monitoring that back up the claimed AI capabilities before committing to using them. AI should not be seen as a replacement for management responsibility, independent verification, or substantial sustainability activities; rather, it should be seen as a supporting tool. The significance of enhancing the comprehensiveness, uniformity, comparability, and verifiability of sustainability data is further underscored by the positive correlation between ESGDQ and CSP. Financial institutions need to ensure that their sustainability metrics are in line with their operational evidence. To mitigate the danger of judging reporting quality based on the amount or presentation of disclosures alone, it is advisable to use external assurance and independent evaluation wherever possible. This will help make sustainability information more credible. Sharia Supervisory Boards and other governing authorities may find it important to integrate Sharia supervision with technology-related reporting systems, as shown by the considerable moderating link identified for ESGDQ. Ethical AI usage, sustainability report data dependability, and evidence-based sustainability claim consistency are all areas that governance organizations may investigate. However, since Greenwashing's moderation outcome was negligible, it can not be inferred that governance frameworks inherently prohibit deceptive sustainability claims. There is still a need for specific verification techniques and monitoring processes. Policymakers and regulators should keep an eye on Islamic banks' ESG disclosure standards and responsible AI governance because of these results. Clear disclosure standards, traceable evidence, consistent sustainability indicators, and suitable assurance systems may be emphasized in regulatory measures. The evaluation of real sustainability achievements should be kept separate from disclosure obligations in such projects. Rather than providing proof that a certain action would reliably have the desired results, these implications are suggestions based on the observed connections.

Suggestions for Future Research

This study has room for improvement in future investigations. First, to see if the discovered connections hold true in various institutional, regulatory, and Sharia governance contexts, researchers should broaden the sample to incorporate Islamic commercial banks from other countries. A longer observation period would be ideal for tracking how AI capabilities, sustainability reporting methods, and governance structures evolve over time. Second, it would be helpful for future research to make a clearer distinction between the revelation of AI and its actual deployment. Data on AI deployment, supporting functionalities, scope, and integration with reporting and operational procedures, as well as other relevant topics, might be used by researchers if accessible. This method would be useful in determining whether the correlation with ESGDQ is due to variations in disclosure methods or real technology implementation. Third, by integrating disclosure-based indicators with independent ESG evaluations, external assurance reports, recorded disparities between sustainable promises and results, or other verifiable information, future studies might enhance the measurement of greenwashing. By using many sources of information, we can reduce the likelihood that a disclosure-based proxy would be taken as conclusive proof of deliberate deception. Additionally, researchers need to ensure that ESGDQ and CSP operational metrics do not depend too much on overlapping indicators and that they capture separate structures. Fourth, future research may look at other governance systems, including Sharia Supervisory Boards, board-level knowledge, sustainability committees, and ESG assurance. Provided the claimed links have theoretical justification, researchers may additionally study whether these processes function as mediators or moderators. To address possible endogeneity and unobserved heterogeneity, future empirical analyses might include relevant controls at the bank level and use suitable panel-data estimation methodologies. To determine if the results are stable, it would be helpful to conduct robustness checks using different model specifications, variable definitions, and appropriate standard errors. When a study can not prove a cause-and-effect relationship, it is best to draw conclusions about connections instead.

Limitations

Several limitations are included in this investigation. Before anything else, during the time of observation, the sample is limited to Islamic commercial banks in Malaysia and Indonesia. Since Islamic banks, conventional banks, and other types of financial institutions may function under diverse institutional and regulatory frameworks, it is possible that the results cannot be applied universally. Second, disclosures that

are available to the public are used to quantify AI and Greenwashing. Neither the breadth of AI deployment nor the validity of sustainability promises can be captured by these metrics. Specifically, there is no correlation between the amount of information shared about AI and the rate of adoption or performance of AI systems. The same holds true for Greenwashing metrics that rely on transparency; they should not be considered as proof of intentional deceit but rather as a surrogate. Lastly, it is important to conceptually and empirically separate the concepts of Corporate Sustainability Performance and ESG Disclosure Quality. If both metrics are based on data that are already in the public domain, there may be some duplication in terms of reporting quality and sustainability performance indicators. While the study does not regard them as separate entities, the validity and independence of their operational measurements determine how their connection is interpreted. The fourth concern is that panel data analysis might not be able to completely remove the impact of time-varying, unobserved factors or handle the possibility of inverse connections between the variables. Therefore, the revealed relationships should not be taken as conclusive evidence of causal effects. The validity of the chosen model, diagnostic evaluation, and standard-error estimates all have a role in how trustworthy the statistical conclusions are. Notwithstanding these caveats, the study does offer some evidence about the connections between AI-related disclosures, the quality of ESG disclosures, Greenwashing, CSR performance, Sharia governance, and Islamic banking. Research designs that can more thoroughly address potential endogeneity, sustainability outcomes that have been independently confirmed, and more direct metrics of AI adoption might build on the conclusions of this study.

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