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AI-BASED DIGITAL TRANSFORMATION, ESG, AND FIRM RESILIENCE: MODERATING ROLE OF ISLAMIC GOVERNANCE IN JAKARTA ISLAMIC INDEX

Wahyu Alya Larasati[1], Savero Darren Fadil Darmawan[2], Arti Widyaningsih[3], Alex Johanes Simamora[4]
[1,2,3,4] Department of Accounting, Faculty of Economy, Universitas Tidar
Email: wahyu.alya.larasati@students.untidar.ac.id[1], savero.darren.fadil.darmawan@students.untidar.ac.id[2], arti.widyaningsih@students.untidar.ac.id[3], alexjohanessimamora@untidar.ac.id[4]

Abstract:
This study aims to examine the effect of AI-based digital transformation and ESG implementation on firm resilience, as well as the moderating role of Islamic governance among firms listed in the JII during the 2022–2024 period. This study employs a quantitative approach using secondary data obtained from annual reports, sustainability reports, and official corporate disclosures. AI-based digital transformation is measured based on AI-related disclosure in corporate reports, ESG implementation is measured using a sustainability disclosure index based on SEOJK No. 16/SEOJK.04/2021, while Islamic governance is measured using the Islamic Ethical Governance Disclosure Index. Firm resilience is measured using a principal component analysis-based index that captures profitability, liquidity, solvency, operational growth, and financial distress avoidance. The findings show that AI-based digital transformation and ESG implementation have positive effects on firm resilience. In addition, Islamic governance strengthens the effects of AI-based digital transformation and ESG implementation on firm resilience. Robustness tests using Altman Z-score, ESG sub-dimensions, and two-stage least squares provide consistent results. This study contributes to the literature by integrating AI-based digital capability, ESG practices, and Islamic governance in explaining firm resilience in the Islamic capital market context. The findings suggest that firm resilience is not only shaped by financial performance, but also by digital readiness, sustainability orientation, and ethical governance based on Islamic values.
Keywords: AI-based Digital Transformation; ESG; Firm Resilience; Islamic Governance

Abstrak
Penelitian ini bertujuan untuk menguji pengaruh AI-based digital transformation dan ESG implementation terhadap firm resilience, serta menganalisis peran moderasi Islamic governance pada perusahaan yang terdaftar dalam JII selama periode 2022–2024. Penelitian ini menggunakan pendekatan kuantitatif dengan data sekunder yang diperoleh dari laporan tahunan, laporan keberlanjutan, dan sumber resmi perusahaan. AI-based digital transformation diukur berdasarkan tingkat pengungkapan terkait AI dalam laporan perusahaan, ESG implementation diukur menggunakan indeks pengungkapan keberlanjutan berdasarkan SEOJK No. 16/SEOJK.04/2021, sedangkan Islamic governance diukur menggunakan Islamic Ethical Governance Disclosure Index. Firm resilience diukur menggunakan indeks berbasis principal component analysis yang mencakup profitabilitas, likuiditas, solvabilitas, pertumbuhan operasional, dan kemampuan menghindari financial distress. Hasil penelitian menunjukkan bahwa AI-based digital transformation dan ESG implementation berpengaruh positif terhadap firm resilience. Selain itu, Islamic governance memperkuat pengaruh AI-based digital transformation dan ESG implementation terhadap firm resilience. Hasil robustness test menggunakan Altman Z-score, sub-dimensi ESG, dan two-stage least squares menunjukkan hasil yang konsisten. Penelitian ini memberikan kontribusi dengan mengintegrasikan kapabilitas digital berbasis AI, praktik ESG, dan Islamic governance dalam menjelaskan firm resilience pada konteks pasar modal syariah. Temuan ini menunjukkan bahwa ketahanan perusahaan tidak hanya ditentukan oleh kinerja keuangan, tetapi juga oleh kesiapan digital, keberlanjutan, dan tata kelola etis berbasis nilai Islam.
Kata Kunci: Transformasi Digital Berbasis AI; ESG; Ketahanan Perusahaan; Tata Kelola Islam

1. Introduction

An In the era of the digital economy, artificial intelligence (AI)-based digital technology leads to big changes in firms' strategy and operations. AI is not considered only as an innovative technology but also brings strategic capability for the improvement of competitive advantages in operational efficiency, business process automation, data-driven decision-making, and risk mitigation. AI integration in digital transformation allows firms to increase adaptation capability to rapid, dynamic, and complex business changes (Cheng & Corsaro, 2026; Gao et al., 2025; Zou & Yang, 2026). In Indonesia, Government Regulation (*PP*) No. 71 of 2019 is the basis regulation for reliable and safe digital system implementation for business.

The urgency of AI-based transformation comes from global uncertainties, including the pandemic, supply chain disruption, inflation, geopolitical conflict, climate change, and technology risk (Dai & Zhang, 2026; Muhammad et al., 2025; Pan et al., 2025). It leads firms to have more survival and adaptation capabilities to face external pressures. In this case, firms' resilience becomes a critical issue in modern business and finance. Firms' resilience shows the firms' ability to survive, adapt, and recover from pressures or crises that disturb firms' operational and financial stability (Safón et al., 2024). Firms with good resilience can look after performance persistence, maintain investor trust, and reduce business risk in the long-term period. Based on dynamic capability theory, AI-based digital transformation allows firms to increase organizational agility, responsiveness, and adaptability to support resilience in facing economic and technological uncertainties.

In addition, there is also a concern for environmental, social, and governance (ESG). ESG becomes one of the important indicators for investors, regulators, and stakeholders to assess corporate governance and sustainability. ESG promotes more transparency, better risk mitigation, and a stronger commitment to long-term sustainability orientation (Yu et al., 2024). In Indonesia, Financial Service Authority Regulation (*POJK*) No. 51/POJK.03/2017 regulates the obligation for firms on the stock exchange to implement sustainable finance through ESG implementation. ESG plays an important role for firms' resilience since ESG implementation can mitigate risks of environmental, social, reputation, and governance (Özer et al., 2024). Environmental aspects help firms to anticipate climate risk, energy saving, and regulatory pressure. Social aspects help firms to get support from employees, customers, or society to face pressures. Governance aspects help firms to maintain strong transparency, monitoring, and accountability. Stakeholder theory puts the fulfilment of stakeholders' interests as a priority so that firms can be resilient when they fulfil stakeholders' interests.

AI and ESG implementations also give a signal for investors and stakeholders. Based on signaling theory, AI and ESG are signals that firms have adaptation ability, sustainability orientation, and strong risk management to face pressure and crises.

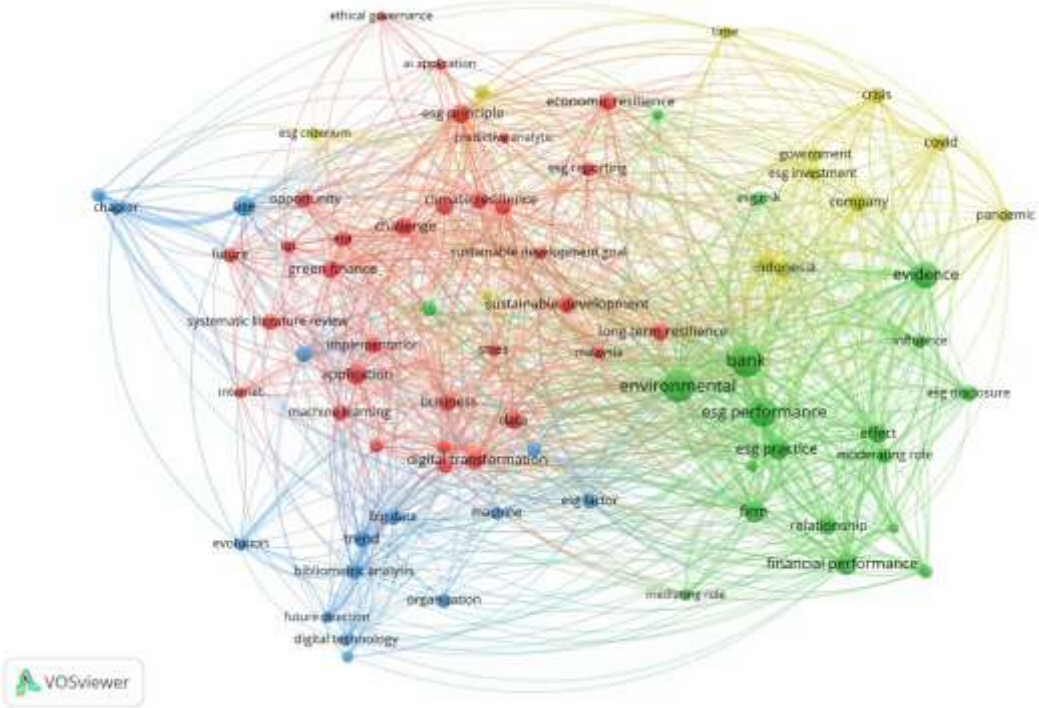

Figure 1. Previous Studies

As in Figure 1, some studies find that digitalization correlates with agility (Zhang et al., 2024), operational efficiency (Peng, 2025), and the ability to face crises (Beglaryan et al., 2025). Some studies also find that ESG improves business sustainability (Aydoğmuş et al., 2022), trust (Guo et al., 2025), and resilience in economic uncertainty (H. Wang et al., 2024). However, there are some studies that show digital transformation creates cyber risk (Saeed et al., 2023; Türegün, 2025) and operational complexity (Jöhnk et al., 2022). There are also some studies that find that ESG is just greenwashing that cannot give significant implications to firms' resilience (Munonye & Munonye, 2026; Wu et al., 2025). The inconsistent findings show that the effectiveness of AI and ESG needs to be ensured by using a monitoring role.

In this case, the quality of the monitoring role depends on the factor of Islamic governance. Different from non-Islamic governance, Islamic governance is not only concerned with economic and stakeholders' interests but also brings the moral and ethical obligations that come from religious dogma (Rahma et al., 2025), which can reinforce the quality of the monitoring role. Islamic governance becomes an important factor that can explain the previous inconsistent findings. Islamic governance focuses on Maqasid al-Shariah (the objectives of Shariah), where creating welfare (goodness and prosperity) and preventing damage based on Islamic law align with principles of business ethics and sustainability (Sulaeman et al., 2025).

In the AI-based digital transformation, Islamic governance becomes an ethical monitoring mechanism that can ensure AI is implemented transparently, responsibly, and in a sustainable orientation. Digital transformation without effective governance has some consequences, such as cyber risk, information asymmetry, and opportunistic behavior (Y. Li & Zhu, 2026). In this case, Islamic governance increases the benefit of AI to improve firms' resilience.

The concept of ESG is basically close to Islamic values such as environmental conservation, social responsibility, economic fairness, and transparency (Tumewang & Fakhrunnas, 2026). In this case, Islamic governance encourages ESG implementation more than just a symbolic but also a substantive. ESG implementation under effective Islamic governance tends to achieve more stakeholder trust and firms' resilience.

This research examines firms that are listed on the Jakarta Islamic Index (JII). Although not all firms are in the Sharia sector, firms on the JII represent businesses that are operated based on Islamic values of ethical investment, transparency, and social responsibility. Investors in JII tend to have more sensitivity to sustainability, governance, transparency, and ethical issues. In this case, AI implementation in JII is not only perceived as a technology innovation but also an ethical responsibility and sustainability tool. ESG implementation in JII is also not perceived as a regulatory obligation, but rather a concern about social and environmental values.

Previous studies examine technology, ESG, and governance separately. Also, most studies are limited in the context of Islamic governance and the stock market. Since the Islamic stock market has unique characteristics that emphasize Islamic moral obligation to ethical investment, sustainability, and accountability, this research focuses on AI and ESG implementation to improve firms' resilience under effective Islamic governance. This research aims to examine AI-based digital transformation and ESG implementation on firms' resilience with Islamic governance as a moderating variable. This research has a novelty in integrating AI-based digital transformation, ESG, Islamic governance, and firms' resilience that have not been fully examined. This research also promotes an Islamic governance mechanism that is not only a governance mechanism based on Islamic law but also a mechanism that reinforces digital transformation and ESG to improve firms' resilience in the digital era.

2. Literature Review

2.1. Theoretical Framework

This research uses three theoretical bases, including dynamic capability theory, stakeholder theory, and signaling theory. Dynamic capability theory suggests that firms' competitive advantages are shaped by the capability to integrate, establish, and reconfigure the available resources to respond to the external environment (C. Wang et al., 2026). Dynamic capability theory is suitable for firms that have uncertain business conditions, where firms need to respond rapidly to technology disruption, market turbulence, regulation change, and external shocks. In the case of firms' resilience, dynamic capability reflects firms' ability to survive, adapt, and recover from disturbance. Firms need to formulate a flexible strategy, innovation, organizational learning, and effective resource reconfiguration. Dynamic capability theory puts adaptive and transformational capability as a factor to establish firms' resilience.

Stakeholder theory suggests that firms must fulfill not only shareholder interests, but also the interests of wider stakeholders, such as employees, customers, community, regulator, supplier, investor, and nature (Phillips et al., 2026). In the context of stakeholder theory, firms' sustainability depends on

the ability to fulfil all stakeholder interests. In this case, stakeholders point out ESG implementation as a firm's response to fulfil stakeholders' demands of sustainability, transparency, and accountability.

Signaling theory explains how firms tend to reduce information asymmetry by giving signals to investors and other stakeholders (Handajani et al., 2026). In the stock market, investors tend to have less information than firms' managers, which makes signaling an important process to communicate information about firms' quality. A credible signal can increase investor trust, a firm's reputation, and risk mitigation. In this research, signaling theory explains how AI-based digital transformation, ESG implementation, and Islamic governance can be interpreted as signals of firms' adaptive capability, sustainability commitment, and governance quality.

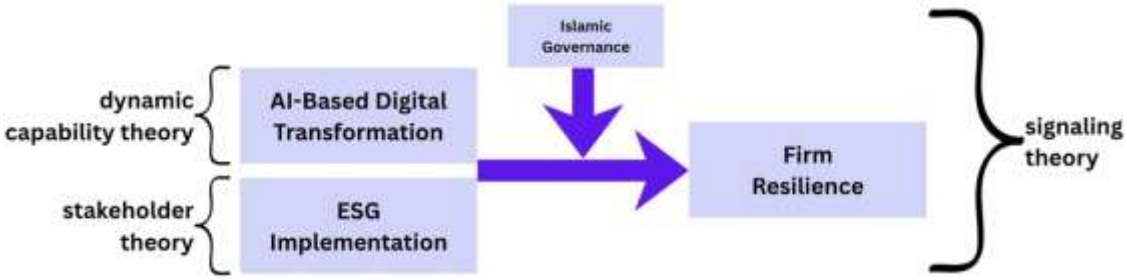

Figure 2. Theoretical Framework

Based on Figure 2, the relationship between dynamic capability theory and AI-based digital transformation comes from the firms' ability to use AI as a strategic advantage to face changes in business. AI-based digital transformation represents how firms can redesign business processes, improve efficiency, accelerate data-driven decision-making, manage risk, and innovate. In the context of dynamic capability, AI can reinforce firms to assess opportunities and threats, take strategic possibilities, and reconfigure organizational processes. In this case, AI-based digital transformation can be seen as a dynamic capability to support firms' resilience.

The relationship between stakeholder theory and ESG comes from the role of ESG implementation to fulfil stakeholders' interests. Environmental dimension refers to the firms' commitment to manage environmental conservation, energy saving, and climate risk. Social dimension refers to firms' concern for employees, customers, community, human rights, work safety, and social empowerment. Governance dimension refers to governance quality, transparency, accountability, monitoring, and business ethics. In the context of stakeholder theory, ESG allows firms to have stakeholder legitimacy, trust, and support that can improve stability, reputation, and restore external pressure.

Signaling theory captures AI-based digital transformation, ESG, and Islamic governance as an important signal. AI-based digital transformation is a signal of firms' readiness for technology, innovation, and adaptation in the digital era. ESG is a signal that firms have a commitment to sustainability, non-financial risk management, and stakeholder responsibility. Islamic governance is a signal that firms have values of ethics, trust, fairness, transparency, and accountability.

Integration of the three theories gives a strong basis for this research to examine the effects of AI-based digital transformation and ESG on firms' resilience, and how Islamic governance reinforces the effects. Dynamic capability theory explains how AI-based digital transformation can increase firms' resilience by improving adaptive capability. Stakeholder theory explains how ESG contributes to firms' resilience by improving stakeholders' legitimacy, trust, and support. Signaling theory explains how AI, ESG, and Islamic governance can communicate the signal of firms' resilience.

2.2. AI-Based Digital Transformation and Firm Resilience

In contemporary strategic management literature, firm resilience is no longer viewed as a passive, static trait of survival, but rather as an active, dynamic capability to anticipate potential disruptions, absorb exogenous shocks, and reconfigure organizational resources to achieve post-crisis growth (Dickson, 2025). Traditional digital transformation, which heavily relies on legacy IT systems and standard Enterprise Resource Planning (ERP) frameworks, primarily fosters operational efficiency by automating historic workflows. In contrast, an AI-based digital transformation, where technology is driven by machine learning algorithms, natural language processing, and deep learning architectures, functions as a higher-order capability. It introduces a systemic cognitive layer into the firm, radically altering how information is processed and how strategic assets are deployed during periods of extreme environmental turbulence (C. Wang et al., 2026).

The direct mechanism through which AI-based transformation builds firm resilience begins with the radical enhancement of an organization's sensing capabilities. In highly volatile markets, the initial impact of a crisis is often amplified by information asymmetry and delayed detection. Traditional organizations suffer from high latency between the occurrence of a disruptive event and its recognition by executive leadership. AI-driven enterprises mitigate this vulnerability by processing high-velocity, multi-structured big data streams, such as global supply chain anomalies, shifts in regulatory policies, and real-time consumer sentiment data, into actionable predictive insights. By utilizing predictive and prescriptive analytics, the firm transitions from a reactive firefighting posture to an anticipatory state. This advanced warning system allows the enterprise to identify structural vulnerabilities and market threats long before they manifest on the balance sheet, thereby reducing the initial velocity and destructive force of external shocks.

Beyond foresight, AI-based digital transformation directly augments the firm's seizing capability, which forms the core of its absorptive resilience during an ongoing crisis. When exogenous shocks disrupt standard operating procedures, organizational decision-makers are frequently paralyzed by cognitive overload, compressed time horizons, and bounded rationality. Under such high-pressure scenarios, human panic or reliance on outdated heuristics can lead to catastrophic strategic missteps. AI architectures counteract this institutional inertia by acting as augmented intelligence systems. By executing automated real-time scenario simulations and processing millions of variables simultaneously, AI provides management with optimized, data-backed strategic alternatives. This algorithmic support enables the rapid formulation of crisis responses, such as the instantaneous realignment of pricing models, dynamic credit risk adjustments for vulnerable clients, or the immediate rerouting of fractured logistics networks, thereby safeguarding the firm's operational continuity.

Furthermore, the long-term adaptive dimension of firm resilience relies heavily on the transforming or asset-reconfiguration capability, which AI-enabled structures optimize through unparalleled architectural elasticity. True resilience requires an organization to be structurally malleable rather than rigid. When an environmental crisis triggers localized resource scarcities, asset deficiencies, or sudden labor shortages, traditional firms often face structural collapse due to fixed operational designs. AI-driven transformation addresses this by embedding cognitive automation and self-correcting feedback loops directly into the firm's core infrastructure. Through intelligent automation, routine operational workflows can dynamically scale up or down or pivot entirely to alternative digital channels without requiring immediate, cost-prohibitive capital investments or lengthy human retraining. This fluid asset orchestration ensures that the enterprise can absorb severe operational friction while continuously executing business model innovations to adapt to the new normal.

Synthesizing these interconnected mechanisms, it is evident that AI-based digital transformation does not merely optimize isolated operational nodes but fundamentally fortifies the cognitive, operational, and behavioral pillars of holistic firm resilience. By deeply embedding algorithmic foresight, augmented decision-making, and structural elasticity into the organizational fabric, digitally transformed enterprises achieve the requisite capability to withstand severe external shocks, maintain structural equilibrium, and turn market volatility into a sustainable competitive advantage. Consequently, firms with advanced AI integration are structurally and strategically equipped to recover faster and bounce back stronger than their technologically lagging counterparts.

H1: AI-based digital transformation has a significant positive effect on firm resilience.

2.3. ESG and Firm Resilience

ESG practices should not be narrowly misconstrued as cost centers or superficial philanthropic gestures; instead, they represent strategic investments that generate critical intangible assets. By consistently committing to ESG indicators, an enterprise actively accumulates robust social capital, institutional legitimacy, and stakeholder goodwill (Chau et al., 2025). This repository of non-financial resources functions as a crucial absorptive buffer that shields the firm from catastrophic value destruction during periods of macroeconomic volatility, regulatory shifts, or systemic market crises.

The environmental dimension of ESG contributes directly to building operational and financial resilience by mitigating both transition risks and physical climate vulnerabilities (Naseer et al., 2024). Firms that proactively adopt eco-friendly protocols, such as carbon footprint reduction, energy efficiency optimizations, and circular waste management, exhibit lower dependencies on volatile and increasingly scarce natural resources. Consequently, when global energy crises or stringent environmental regulations (such as carbon taxation mechanisms) occur, ecologically transformed enterprises experience significantly less structural vulnerability. Furthermore, embedding climate-risk assessments into the core corporate strategy enhances the firm's absorptive capacity against physical disruptions, minimizes asset vulnerability, and prevents costly litigation, thereby safeguarding operational continuity amidst shifting ecological paradigms.

On the social dimension, ESG implementation fortifies relationships with both internal and external stakeholders, laying the groundwork for behavioral resilience. Internally, a demonstrated commitment to employee welfare, workplace safety, and diversity and inclusion cultivates a highly secure and equitable corporate culture. This directly drives employee morale, organizational identification, and productivity while drastically mitigating turnover intentions. When an unexpected crisis destabilizes the firm, this embedded social capital induces collective flexibility, enabling cross-functional collaboration and organic problem-solving among a loyal workforce. Externally, maintaining transparent and ethical relationships with local communities, suppliers, and customers engenders deep-seated trust. This public trust acts as a "reputational insurance policy" that protects corporate brand equity from immediate market boycotts or loss of social license to operate if operational anomalies happen during a crisis.

The governance dimension serves as the regulatory nervous system that directs the firm's cognitive resilience through stringent risk oversight and ethical decision-making structures. Robust corporate governance ensures effective checks and balances. This structural discipline minimizes agency problems, thwarts internal fraudulent vulnerabilities, and decreases information asymmetry with external capital markets. When confronted with abrupt economic shocks, a competent and diversified board is structurally better equipped to detect weak early-warning distress signals, neutralize cognitive biases, and execute rational resource reallocations. This governance premium preserves investor confidence, granting ESG-compliant firms superior access to external financing at a lower cost of capital, even during contractionary phases of market liquidity.

Synthesizing these dimensions, ESG implementation holistically transforms an enterprise into a highly elastic, adaptive, and institutionally validated entity. By systematically aligning financial targets with stakeholder-oriented accountability, ESG-driven firms do not merely reduce their exposure to idiosyncratic risks; they cultivate a multidimensional resilience architecture encompassing cognitive, operational, and behavioral safeguards. As a result, when exposed to severe macro-level perturbations, organizations with mature ESG integration display significantly accelerated recovery trajectories and a superior capability to convert external disruptions into renewal opportunities.

H2: ESG has a significant positive effect on firm resilience.

2.4. Islamic Governance, AI-Based Digital Transformation, and Firm Resilience

While AI-based digital transformation provides the raw technical capabilities necessary to foster firm resilience, the magnitude of this effect is contingent upon the internal governance structures that guide technology deployment. Islamic governance extends beyond conventional governance by anchoring corporate oversight in the principles of Islamic law, Maqasid al-Shariah, and core ethical pillars such as trustworthiness, justice, and the absolute avoidance of excessive uncertainty or deception and speculation. In an era of rapid technological shift, the intersection between Islamic governance and AI-based digital transformation is profound. AI architectures inherently introduce complex ethical dilemmas, ranging from algorithmic bias and data privacy violations to the risk of over-relying on probabilistic machine learning models that can inadvertently simulate deception and speculation if left unchecked. Islamic governance provides the ethical blueprint and structural oversight to audit, filter, and align AI deployments with broader societal welfare and strict ethical compliance.

Islamic governance moderates the relationship between AI-based digital transformation and firm resilience by acting as a strategic stabilizer and risk-mitigation mechanism. AI-driven transformation, if driven purely by unconstrained profit maximization, can lead to systemic vulnerabilities, such as aggressive automated trading, exploitative dynamic pricing, or reckless workforce displacement, which expose the firm to severe reputational shocks and regulatory backlashes during a crisis. When Islamic Governance is high, it tames these volatile dimensions of AI. By enforcing the principle of Amanah, management views AI not merely as a tool for cost-cutting but as a resource to be managed responsibly. This ensures that algorithmic decision-making under AI frameworks is designed to be transparent, fair, and risk-averse. For instance, predictive AI models under an Islamic governance framework are restricted from engaging in hyper-speculative market ventures, steering the firm's AI capabilities toward stable, real-economy investments. Consequently, the combination of AI's predictive precision and Islamic governance's ethical boundaries prevents the firm from experiencing catastrophic, self-inflicted operational failures, thereby reinforcing its absorptive resilience.

Furthermore, the interaction between Islamic governance and AI integration significantly enhances a firm's cognitive and behavioral resilience during macro-level shocks. In times of crisis, an AI system might recommend severe, cold-calculated resource retrenchment that damages long-term organizational health. Islamic governance counteracts this through the mandate of justice and benevolence, ensuring that AI-driven operational adjustments do not compromise fair treatment of employees, suppliers, and customers. This ethical commitment deepens institutional trust and builds

substantial social capital. When external shocks occur, stakeholders are much more likely to exhibit loyalty and collaborative flexibility toward an organization that pairs advanced technological agility with unyielding moral integrity. Conversely, in environments with weak Islamic Governance, AI implementation may be perceived by stakeholders as an oppressive or untrustworthy mechanism of surveillance and exploitation, eroding the social fabric of the firm and diminishing its capacity to bounce back collectively from crises.

Synthesizing these arguments, Islamic Governance does not impede the efficacy of digital transformation; rather, it amplifies its positive outcomes by channeling algorithmic power into sustainable, ethically sound, and resilient organizational behaviors. By filtering AI's data-driven capabilities through a dual-layer oversight mechanism of commercial prudence and Shariah compliance, firms can navigate turbulent environments without exposing themselves to structural or moral collapse. Therefore, the positive impact of AI-based digital transformation on firm resilience becomes significantly more pronounced in the presence of robust Islamic Governance frameworks.

H3: Islamic governance moderates the relationship between AI-based digital transformation and firm resilience.

2.5. Islamic Governance, ESG, and Firm Resilience

While the implementation of ESG principles provides a strategic framework for building firm resilience, the actualization of these benefits depends heavily on the authenticity and depth of the internal oversight structures. Islamic governance acts as a profound moderating force that determines how effectively ESG strategies translate into resilient organizational outcomes. The conceptual intersection between Islamic Governance and ESG is deeply rooted in the philosophy of Maqasid al-Shariah (the objectives of Islamic law), which mandates the preservation of life, intellect, posterity, and wealth. Under an Islamic governance framework, environmental protection and social equity are not viewed as discretionary corporate social responsibility (CSR) goals, but as divine spiritual obligations. Consequently, Islamic governance provides a rigorous, dual-layered oversight mechanism that naturally reinforces, codifies, and authenticates the multi-dimensional facets of ESG implementation.

Islamic governance significantly moderates the ESG–resilience relationship by mitigating the pervasive risks of greenwashing or symbolic decoupling. In conventional corporate settings, ESG initiatives can occasionally degenerate into superficial public relationship exercises, driven purely by external institutional pressures. Such superficial adoption fails to build genuine operational or cognitive resilience, leaving the firm vulnerable when a severe crisis exposes its underlying structural weaknesses. When a firm operates under robust Islamic governance, the principle of trustworthiness and accountability ensures that ESG commitments are deeply embedded in the corporate. Because managers are held accountable not only to secular stakeholders but also to transcendental ethical standards, ESG policies become structurally authentic. This governance premium guarantees that the reputational insurance, supply chain integrity, and resource efficiencies derived from ESG practices are real and substantive, thereby amplifying the firm's capacity to absorb external macroeconomic shocks.

Furthermore, the interaction between Islamic governance and ESG implementation fortifies a firm's behavioral and financial stability during times of crisis. When an exogenous shock threatens corporate survival, conventional firms are often tempted to abandon their long-term sustainability and social commitments in favor of short-term, aggressive cost-cutting. Islamic Governance prevents this moral hazard by enforcing the principles of distributive justice and public interest. Under strict Islamic oversight, the firm cannot unilaterally compromise employee welfare or supplier fair treatment to protect immediate margins. This unyielding ethical consistency during turbulent periods cements stakeholder loyalty and supercharges the firm's social capital. Simultaneously, the strict prohibition of excessive risk and speculation inherent in Islamic governance ensures that the financial resources conserved through green or social initiatives are never deployed into highly volatile, speculative markets. This fiscal discipline preserves corporate liquidity, ensuring that the firm maintains a stable capital buffer to execute rapid, post-crisis adaptive reconfigurations.

Synthesizing these theoretical arguments, Islamic Governance acts as an institutional catalyst that unlocks and maximizes the resilience-building potential of ESG implementation. By transforming voluntary corporate sustainability targets into an unyielding ethical covenant, Islamic Governance ensures that environmental stewardship, social justice, and transparent administration function as a cohesive, impregnable shield against market turbulence. Therefore, the positive effect of ESG performance on holistic firm resilience becomes exponentially more pronounced in organizations characterized by high levels of Shariah-compliant corporate governance.

H4: Islamic governance moderates the relationship between ESG implementation and firm resilience.

3. Research Methods

3.1. Population and Sample

The population comprised companies listed on the Indonesian Stock Exchange, considering ease of data access. The sample was selected using purposive sampling with specific criteria. First, the companies were listed on the JII70. The JII considered that the JII represents businesses that operate based on Islamic values of ethical investment, transparency, and social responsibility. Second, the companies were registered between 2022 and 2024. The 2022-2024 period was considered to be regulated by Act (*UU*) No. 27 of 2022 concerning Personal Data Protection, which facilitates cyber risk mitigation related to personal data in the digital world. Third, the companies had complete data. The net sample size was 210 observations, as shown in Table 1.

Table 1. Research Sample

Year	Firms in JII70
2022	70
2023	70
2024	70
Total	210

Sources: www.idx.co.id

3.2. Research Variables

Independent variables are AI-based digital transformation and ESG implementation. AI-based digital transformation refers to the extent to which a firm adopts, develops, and discloses the use of AI digital technologies in its strategy, business processes, decision-making, risk management, innovation, and operational efficiency. This variable not only reflects the technical use of AI but also represents a firm's capability to utilize digital technologies to strengthen adaptability, responsiveness, and competitiveness in the digital era. In relation to firm resilience, AI-based digital transformation is viewed as a strategic capability that can help firms identify risks more quickly, improve business process efficiency, enhance data-driven decision-making, and respond more effectively to changes in the business environment. AI-based digital transformation is measured by the disclosure level of AI in the annual report. This measurement approach is used because data on AI investment, the number of AI systems, or the technical level of AI implementation are generally not disclosed consistently by public firms in Indonesia. Therefore, a disclosure-based measurement is considered more suitable for this research since it captures the extent to which firms communicate information regarding digital strategy, AI use, automation, data analytics, and digital innovation in corporate reports. This research calculates the number of words that relate to AI, including artificial intelligence (AI), machine learning, deep learning, big data analytics, natural language processing (NLP), robotic process automation (RPA), automation, predictive analytics, data mining, intelligent systems, cloud-based analytics, and other relevant terms to measure the AI score as in equation 1 (Y. Liu et al., 2025).

$$AI\ Score = Ln\ (1 + number\ of\ words\ that\ relate\ to\ AI) \quad (1)$$

ESG implementation refers to the extent to which a firm applies environmental, social, and governance practices in its business activities. ESG implementation is measured using an ESG disclosure index constructed through content analysis of annual reports and sustainability reports (Khamisu & Paluri, 2024). This approach is used because not all firms listed in the JII have ESG risk scores or ESG ratings from international rating agencies. ESG implementation is measured using the sustainability disclosure index based on Financial Service Authority Circular Letter (*SEOJK*) No. 16/SEOJK.04/2021. The index consists of 52 disclosure items covering sustainability strategy, sustainability performance highlights, company profile, board of directors' explanation, sustainability governance, sustainability performance, and other supporting disclosures. Each item is scored 1 if disclosed and 0 otherwise. The ESG disclosure index is calculated by dividing the total disclosed items by the maximum number of disclosure items, namely 52 items. ESG implementation is calculated as in equation 2.

$$ESG\ Disclosure\ Index = \frac{Number\ of\ ESG\ items\ disclosed}{52} \quad (2)$$

The dependent variable is firm resilience. Firm resilience in this study refers to a firm's ability to maintain stability, adapt to external pressures, and recover from disruptions that may affect its financial and operational performance. This study measures firm resilience using a PCA-based firm resilience index. Principal component analysis (PCA) is used because firm resilience is a multidimensional

construct and cannot be fully represented by one indicator. This approach is appropriate because resilience reflects a combination of financial strength, operational capability, and distress avoidance (Capoani et al., 2025). A higher firm resilience index indicates that the firm has a stronger ability to withstand, adapt to, and recover from business pressures. The firm resilience index is constructed using five indicators, including return on assets (ROA), current ratio (CR), debt to asset ratio (DAR), sales growth (SG), and Altman Z-score (ZSCORE) (X. Li et al., 2025). ROA represents profitability resilience because it reflects the firm's ability to generate profit from its assets. The current ratio represents liquidity resilience because it reflects the firm's ability to meet short-term obligations. The debt-to-asset ratio represents solvency resilience because it indicates the extent to which a firm's assets are financed by debt. Sales growth represents operational resilience because it reflects the firm's ability to maintain or increase business activity. Altman Z-score represents financial distress avoidance because it captures the firm's overall financial health and likelihood of avoiding financial distress. Before conducting PCA, all indicators are standardized to ensure comparability because each indicator has a different measurement scale. After standardization, PCA is performed to extract the main component that represents firm resilience. The component score generated from the first principal component is then used as the firm's resilience index. If more than one component has an eigenvalue greater than one, the retained components can be combined using their explained variance as weights. The PCA-based firm resilience index can be expressed in equation 3.

$$FRI = w1\ ZROA + w2\ ZCR + w3\ ZDAR + w4\ ZSG + w5ZALTMANT \quad (3)$$

FRI is the firm resilience index. ZROA, ZCR, ZDAR, ZSG, and ZALMANT are standardized values of ROA, current ratio, reverse-coded debt to asset ratio, sales growth, and Altman Z-score; and w1-w5 are the component loadings or weights obtained from PCA. A higher FRI value indicates stronger firm resilience.

Islamic governance in this study refers to the extent to which a firm discloses governance practices that reflect Islamic ethical values, including accountability, transparency, fairness, trustworthiness, stakeholder orientation, sustainability, and ethical conduct. In this case, , Islamic governance is not measured through formal sharia governance mechanisms such as the existence of a sharia supervisory board because not all JII firms are Islamic financial institutions. Therefore, this study measures Islamic governance using an Islamic ethical governance disclosure index, which captures how far firms communicate Islamic-oriented ethical governance principles through annual reports, sustainability reports, and other official corporate disclosures. The use of a disclosure-based index is considered appropriate because Islamic governance in non-financial Islamic-listed firms is more observable through ethical, social, sustainability, and governance disclosures rather than through formal sharia institutional structures. The index is developed by integrating several relevant frameworks, including the governance principles of the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI), Islamic Social Reporting (ISR), good corporate governance (GCG), ESG disclosure, GRI-based sustainability reporting, and digital governance literature. This integrated approach is used because there is no single universally accepted standard for measuring Islamic governance disclosure in non-financial firms listed in Islamic equity markets. The Islamic ethical governance disclosure index consists of 25 disclosure items, as in equation 4 and Table 2.

$$Islamic\ Ethical\ Governance\ Disclosure\ Index = \frac{Number\ of\ Islamic\ ethical\ governance\ items\ disclosed}{25} \quad (4)$$

Table 2. Islamic Ethical Governance Disclosure

Dimension	Disclosure Item	Source
Ethical governance	Code of ethics disclosure	AAOIFI, GCG
Ethical governance	Anti-corruption policy	GCG, ESG
Ethical governance	Whistleblowing system	GCG
Ethical governance	Business integrity commitment	AAOIFI, ISR
Transparency and accountability	Governance structure disclosure	GCG
Transparency and accountability	Audit committee disclosure	GCG
Transparency and accountability	Risk management disclosure	GCG, ESG
Transparency and accountability	Stakeholder communication	Stakeholder theory, ISR
Transparency and accountability	Internal control disclosure	GCG
Sustainability responsibility	Sustainability reporting	ESG, GRI
Sustainability responsibility	Environmental responsibility	ESG, ISR
Sustainability responsibility	Social responsibility program	ISR
Sustainability responsibility	SDGs commitment	ESG

Sustainability responsibility	Employee welfare disclosure	ISR
Islamic ethical values	Halal commitment disclosure	ISR
Islamic ethical values	Sharia compliance statement	AAOIFI
Islamic ethical values	Ethical investment or financing	AAOIFI
Islamic ethical values	Islamic value statement	ISR
Stakeholder orientation	Community empowerment	ISR
Stakeholder orientation	Customer protection disclosure	ESG
Stakeholder orientation	Employee development program	ISR
Stakeholder orientation	Social inclusion commitment	ESG
Digital ethical governance	AI ethical disclosure	AI governance literature
Digital ethical governance	Data privacy and cybersecurity	ESG, digital governance
Digital ethical governance	Digital transparency	Digital governance literature

Source: as in the table

This study includes firm size, firm age, industry type, operating cash flow, and growth opportunity as control variables because these firm-specific characteristics may influence firm resilience. Firm size, measured by the natural logarithm of total assets, is controlled because larger firms generally have greater resources, stronger organizational capacity, and better access to technology and capital, which may help them withstand external pressures (Yáñez-Araque et al., 2026). Firm age, measured by the natural logarithm of the number of years since establishment, is included because older firms may have accumulated experience, organizational learning, and established routines that support crisis response and recovery (Yáñez-Araque et al., 2026). Industry type, measured using industry dummy variables, is controlled because firms in different sectors face different levels of environmental exposure, stakeholder pressure, digital transformation intensity, and business risk (Safón et al., 2024). Operating cash flow, measured by operating cash flow divided by total assets, is included because stronger internal cash flow reflects financial flexibility and the ability to sustain operations during disruptions (Huang et al., 2026). Growth opportunity, measured by the market-to-book ratio, is controlled because firms with higher growth prospects may have stronger investor confidence, better access to resources, and greater capacity to invest in resilience-enhancing strategies (Z. Wang et al., 2023). These control variables are included to ensure that the effects of AI-based digital transformation, ESG implementation, and Islamic governance on firm resilience are not driven by differences in basic firm characteristics.

3.3. Data Analysis

This research uses fixed-effect regression to test hypotheses. Fixed effects aim to control for the fact that different firms have different resilience strategies. The regression model is as in equation 5.

$$FRI = a + b1AI + b2ESG + b3AI\ x\ IG + b4ESG\ x\ IG + b5IG + b6SIZE + b7AGE + b8CASH + b9MTB + b10INDUSTRY + e \quad (5)$$

In this model, FRI represents the firm resilience index. AI refers to AI-based digital transformation. ESG represents ESG implementation. IG refers to Islamic governance. SIZE denotes firm size. AGE represents firm age. CASH refers to operating cash flow. MTB represents the market-to-book ratio. INDUSTRY refers to industry dummy variables. Hypotheses are accepted if the coefficient values of b1-b4 are positive and significant.

4. Results and Discussion

4.1. Descriptive Statistics

Table 3. Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
FRI	120	-1.842	2.315	0.000	1.000
AI	120	0.120	0.760	0.418	0.156
ESG	120	0.365	0.904	0.642	0.128
IG	120	0.280	0.840	0.573	0.137
SIZE	120	28.214	33.687	30.912	1.384
AGE	120	2.398	4.605	3.714	0.526
CASH	120	-0.082	0.241	0.073	0.061
MTB	120	0.681	5.942	2.187	1.126

Source: statistical output

Based on Table 3, the firm resilience index (FRI) has a minimum value of -1.842 and a maximum value of 2.315. The mean value of 0.000 and the standard deviation of 1.000 indicate that the index has

been standardized through principal component analysis. A higher FRI value indicates stronger firm resilience, reflecting a firm's ability to maintain profitability, liquidity, solvency, operational growth, and financial stability.

The AI-based digital transformation (AI) variable has a mean value of 0.418, indicating that the disclosure of AI-based digital transformation among JII firms is at a moderate level. The minimum value of 0.120 shows that some firms disclose only limited information related to AI, data analytics, automation, cybersecurity, and digital innovation. Meanwhile, the maximum value of 0.760 indicates that some firms have disclosed AI-based digital transformation practices more extensively.

The ESG implementation (ESG) variable has a mean value of 0.642. This suggests that ESG disclosure among JII firms is relatively higher than AI-based digital transformation disclosure. This condition may reflect the growing regulatory pressure and stakeholder demand for sustainability reporting in Indonesia. The maximum value of 0.904 indicates that some firms disclose most ESG-related items, while the minimum value of 0.365 shows that ESG disclosure remains limited in some firms.

The Islamic governance (IG) variable has a mean value of 0.573, indicating a moderate level of Islamic governance disclosure among firms in the sample. This is reasonable because firms listed in the JII are not necessarily Islamic financial institutions. Therefore, Islamic governance is mainly reflected through ethical governance, transparency, accountability, stakeholder orientation, sustainability responsibility, Islamic ethical values, and digital ethical governance, rather than formal sharia governance mechanisms such as sharia supervisory boards.

4.2. Classical Assumption

Table 4. Classical Assumption

Test	Result	Cut-off Criteria	Conclusion
Jarque-Bera test	Prob. = 0.087	Prob. > 0.05	Normally distributed
Variance Inflation Factor	Highest VIF = 2.684	VIF < 10	No multicollinearity
Breusch-Pagan test	Prob. = 0.142	Prob. > 0.05	No heteroscedasticity
Wooldridge test	Prob. = 0.219	Prob. > 0.05	No autocorrelation

Source: statistical output

Based on Table 4, the classical assumption tests were conducted to ensure that the regression model satisfies the basic requirements for reliable estimation. The normality test using the Jarque-Bera test shows a probability value of 0.087, which is higher than 0.050. This indicates that the residuals are normally distributed. The multicollinearity test shows that the highest variance inflation factor is 2.684, which is below the threshold of 10.000. Therefore, the model does not indicate multicollinearity among the independent variables.

The heteroscedasticity test using the Breusch-Pagan test produces a probability value of 0.142, which is greater than 0.050. This result indicates that the model does not suffer from heteroscedasticity. Furthermore, the autocorrelation test using the Wooldridge test shows a probability value of 0.219, which is also greater than 0.050. This means that there is no autocorrelation problem in the regression model. Overall, the results suggest that the regression model satisfies the classical assumptions and is appropriate for further hypothesis testing.

4.3. Regression

Table 5. Regression

Variables	Model 1: Without Moderating	Model 2: With Moderating
	Coefficient t-statistic p-value	
AI	0.286** 2.314 0.023	0.214* 1.892 0.061
ESG	0.341*** 3.127 0.002	0.276** 2.421 0.017
IG	0.248** 2.204 0.03	0.219** 2.038 0.044
AI × IG		0.187** 2.176

		0.032
ESG × IG		0.231**
		2.458
		0.016
SIZE	0.153*	0.141*
	1.814	1.762
	0.072	0.081
AGE	0.096	0.087
	1.213	1.105
	0.228	0.272
CASH	0.312***	0.289***
	3.412	3.106
	0.001	0.003
MTB	0.118*	0.107*
	1.891	1.743
	0.061	0.084
INDUSTRY	0.074	0.069
	0.936	0.884
	0.351	0.379
Constant	-1.274	-1.186
Adjusted R-squared	0.376	0.446
F-statistic	9.328***	10.214***

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Source: statistical output

Based on Table 5, the regression results show the relationship between AI-based digital transformation, ESG implementation, Islamic governance, and firm resilience. Model 1 presents the baseline regression without moderation, while Model 2 includes the moderating effects of Islamic governance through the interaction terms. Overall, the results indicate that the explanatory power of the model improves after adding the moderation variables, as shown by the increase in Adjusted R-squared from 0.376 in Model 1 to 0.446 in Model 2.

In Model 1, AI-based digital transformation has a positive and significant coefficient of 0.286 with a p-value of 0.023. This result indicates that firms with higher AI-based digital transformation tend to have stronger firm resilience. This finding supports the argument that the use of AI and related digital technologies can enhance organizational adaptability, improve decision-making, strengthen operational efficiency, and help firms respond more effectively to external pressures.

ESG implementation also shows a positive and significant effect on firm resilience in Model 1, with a coefficient of 0.341 and a p-value of 0.002. This suggests that firms with stronger ESG implementation are more likely to achieve higher resilience. ESG practices can strengthen firm resilience by improving risk management, building stakeholder trust, enhancing transparency, and supporting long-term sustainability. This finding indicates that ESG is not only a disclosure mechanism but also a strategic factor that contributes to corporate stability and adaptability.

In Model 2, after adding the moderation variables, the interaction between AI-based digital transformation and Islamic governance has a positive and significant coefficient of 0.187 with a p-value of 0.032. This result indicates that Islamic governance strengthens the relationship between AI-based digital transformation and firm resilience. In other words, AI-based digital transformation has a stronger positive effect on firm resilience when firms have stronger Islamic governance. This suggests that Islamic governance can enhance the effectiveness of digital transformation by ensuring that the use of AI and digital technology is supported by ethical monitoring, accountability, transparency, and responsible risk management.

The interaction term between ESG implementation and Islamic governance also has a positive and significant coefficient of 0.231 with a p-value of 0.016. This finding indicates that Islamic governance strengthens the effect of ESG implementation on firm resilience. ESG practices appear to contribute more strongly to resilience when they are supported by Islamic governance values such as trustworthiness, fairness, social responsibility, and stakeholder welfare. This result suggests that Islamic governance can improve the credibility and substance of ESG implementation, reducing the possibility that ESG is merely symbolic and increasing its contribution to firm resilience.

4.4. Robustness Test: Alternative Measurement of Firm Resilience

The first robustness test is conducted by replacing the PCA-based firm resilience index with the Altman Z-score. In the main analysis, firm resilience is measured using a composite index constructed through principal component analysis. This index captures several dimensions of resilience, including profitability, liquidity, solvency, operational growth, and distress avoidance. However, because the PCA-based index is a constructed measure, it is necessary to examine whether the results remain consistent when firm resilience is measured using a more established financial distress indicator. Altman Z-score is appropriate for this purpose because it reflects a firm's financial health and its ability to avoid financial distress (X. Liu et al., 2026). A higher Altman Z-score indicates stronger financial resilience and lower financial distress risk. Therefore, this test helps confirm whether the main findings are robust to an alternative measurement of the dependent variable. The result for alternative measurement of firm resilience can be seen in Table 6.

Table 6. Robustness Test: Alternative Measurement of Firm Resilience

Variables	Coefficient t-statistic p-value
AI	0.238** 2.112 0.037
ESG	0.294*** 2.876 0.005
IG	0.201** 2.041 0.044
AI × IG	0.164** 2.008 0.047
ESG × IG	0.205** 2.214 0.029
SIZE	0.126* 1.731 0.086
AGE	0.074 0.984 0.327
CASH	0.267*** 2.942 0.004
MTB	0.096* 1.702 0.091
INDUSTRY	0.058 0.782 0.436
Constant	-1.042*
Adjusted R-squared	0.411
F-statistic	9.804***

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Source: statistical output

Based on Table 6, the results of the first robustness test show that the main findings remain consistent when firm resilience is measured using Altman Z-score. AI-based digital transformation has a positive and significant coefficient of 0.238 with a p-value of 0.037. This indicates that firms with stronger AI-based digital transformation tend to have better financial resilience. This result supports the argument that digital transformation based on AI can strengthen a firm's ability to respond to uncertainty, improve operational efficiency, and reduce exposure to financial distress.

ESG implementation also shows a positive and significant coefficient of 0.294 with a p-value of 0.005. This finding suggests that firms with stronger ESG implementation are more likely to have stronger financial health and lower financial distress risk. ESG practices may support financial resilience by improving risk management, strengthening stakeholder trust, enhancing transparency, and supporting long-term sustainability. Islamic governance also remains positive and significant, with a coefficient of 0.201 and a p-value of 0.044. This indicates that ethical governance based on Islamic values contributes to the financial resilience of JII firms.

The interaction terms are also positive and significant. The coefficient of interaction between AI-based digital transformation and Islamic governance is 0.164 with a p-value of 0.047, indicating that Islamic governance strengthens the effect of AI-based digital transformation on financial resilience. Similarly, the coefficient of interaction between AI-based digital transformation and Islamic governance is 0.205 with a p-value of 0.029, suggesting that Islamic governance enhances the positive effect of ESG implementation on firm resilience. These findings confirm that the moderating role of Islamic governance remains stable even when firm resilience is measured using Altman Z-score. Therefore, the main results are not driven solely by the PCA-based firm resilience index.

4.5. Robustness Test: ESG Sub-Dimensions

The second robustness test is conducted by decomposing ESG implementation into three sub-dimensions, including environmental disclosure, social disclosure, and governance disclosure. This test is important because ESG is a multidimensional construct, and each dimension may contribute differently to firm resilience. Environmental disclosure reflects the firm's commitment to managing environmental risks, energy efficiency, emissions, waste, and climate-related issues. Social disclosure reflects the firm's responsibility toward employees, customers, communities, occupational health and safety, and social welfare. Governance disclosure reflects the firm's transparency, accountability, risk management, anti-corruption practices, and oversight mechanisms. By testing these ESG sub-dimensions separately, this study examines whether the positive effect of ESG on firm resilience is driven by one specific component or remains consistent across ESG dimensions. The result for ESG sub-dimensions can be seen in Table 7.

Table 7. Robustness Test: ESG Sub-Dimensions

Variables	Environmental Model	Social Model	Governance Model
		Coefficient t-statistic p-value	
AI	0.219* 1.874 0.064	0.224* 1.902 0.060	0.231** 2.034 0.044
ESG (Environmental)	0.247** 2.283 0.024		
ESG (Social)		0.265** 2.407 0.018	
ESG (Governance)			0.298*** 2.816 0.006
IG	0.205** 2.031 0.045	0.211** 2.104 0.038	0.216** 2.178 0.032
AI× IG	0.151* 1.782 0.078	0.158* 1.841 0.069	0.166** 2.006 0.047
ESG (Environmental) × IG	0.184** 2.086 0.039		
ESG (Social) × IG		0.196** 2.193 0.031	
ESG (Governance) × IG			0.218** 2.384 0.019

SIZE	0.133*	0.137*	0.142*
	1.721	1.754	1.809
	0.088	0.083	0.073
AGE	0.078	0.081	0.085
	1.002	1.047	1.103
	0.319	0.298	0.273
CASH	0.276***	0.281***	0.286***
	2.987	3.031	3.094
	0.004	0.003	0.003
MTB	0.101*	0.104*	0.109*
	1.711	1.743	1.806
	0.09	0.084	0.074
INDUDTRY	0.061	0.064	0.067
	0.791	0.824	0.862
	0.431	0.412	0.391
Constant	-1.086*	-1.112*	-1.147**
Adjusted R-squared	0.417	0.426	0.442
F-statistic	9.118***	9.426***	9.941***

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Source: statistical output

Based on Table 7, the results of the second robustness test show that all ESG sub-dimensions are positively associated with firm resilience. Environmental disclosure has a positive and significant coefficient of 0.247 with a p-value of 0.024. This result indicates that firms with stronger environmental disclosure tend to have higher firm resilience. Environmental practices may help firms reduce exposure to environmental risk, regulatory pressure, resource inefficiency, and climate-related uncertainty. Therefore, environmental disclosure can support firm resilience by showing the firm's ability to manage long-term environmental challenges.

Social disclosure also has a positive and significant coefficient of 0.265 with a p-value of 0.018. This indicates that firms with stronger social disclosure tend to have higher firm resilience. Social practices may strengthen resilience by improving employee welfare, maintaining customer trust, building community support, and reducing social conflict. Firms that maintain stronger relationships with employees, customers, and communities are generally better positioned to sustain operations and recover from external pressures.

Governance disclosure has the strongest coefficient among the three ESG sub-dimensions, with a coefficient of 0.298 and a p-value of 0.006. This suggests that governance-related ESG practices play a particularly important role in strengthening firm resilience. Strong governance disclosure reflects transparency, accountability, risk management, oversight, and ethical conduct. These elements are important because resilient firms require effective monitoring and decision-making mechanisms to respond to uncertainty and business disruptions.

The interaction terms between ESG sub-dimensions and Islamic governance are also positive and significant. These findings indicate that Islamic governance strengthens the effect of each ESG dimension on firm resilience. The strongest moderating effect is found in the governance dimension, suggesting that Islamic governance is particularly effective in reinforcing governance-related sustainability practices. This is reasonable because Islamic governance emphasizes ethical accountability, transparency, fairness, and stakeholder responsibility, which are closely related to the governance dimension of ESG. Therefore, the positive relationship between ESG and firm resilience is not driven by only one ESG component, but remains consistent across environmental, social, and governance dimensions.

4.6. Robustness Test: Two-Stage Least Squares

This study also conducts an endogeneity check using two-stage least squares to address the possibility of reverse causality and omitted variable bias. Endogeneity may occur because firms with stronger resilience may have more resources to invest in AI-based digital transformation, ESG implementation, and governance practices. In other words, the relationship may not only run from AI and ESG to firm resilience, but also from firm resilience to AI and ESG. Resilient firms may be more capable of financing digital transformation, preparing sustainability reports, and strengthening governance disclosure. Therefore, an endogeneity check is needed to ensure that the main findings are not driven by reverse causality.

To address this concern, this study uses peer-industry averages as instrumental variables. Specifically, the peer-industry average of AI-based digital transformation is used as an instrument for firm-level AI-based digital transformation, while the peer-industry average of ESG implementation is used as an instrument for firm-level ESG implementation. These peer-industry averages are calculated by excluding the focal firm to avoid mechanical correlation. The logic behind this approach is that firms tend to respond to industry-level digitalization and sustainability pressures. Firms operating in industries where peer firms disclose higher AI-based digital transformation or ESG implementation are more likely to adopt similar practices due to competitive pressure, institutional pressure, and industry norms. At the same time, peer-industry averages are expected to affect firm resilience mainly through the firm's own AI-based digital transformation and ESG implementation rather than directly affecting firm resilience.

In the first stage, AI-based digital transformation and ESG implementation are regressed on their respective peer-industry instruments and control variables. In the second stage, the predicted values of AI-based digital transformation and ESG implementation are used to estimate their effects on firm resilience. The second-stage model also includes Islamic governance, interaction terms, and control variables. This procedure allows the study to examine whether the effect of AI-based digital transformation and ESG implementation on firm resilience remains consistent after addressing possible endogeneity concerns. The result of two-stage least squares can be seen in Table 8.

Table 8. Robustness Test: Two-Stage Least Squares

Variables	Coefficient t-statistic p-value
Predicted AI	0.251** 2.087 0.039
Predicted ESG	0.318** 2.516 0.013
IG	0.223** 2.163 0.033
Predicted AI × IG	0.176** 2.021 0.046
Predicted ESG × IG	0.228** 2.339 0.021
SIZE	0.132* 1.742 0.084
AGE	0.079 1.012 0.314
CASH	0.276*** 2.987 0.004
MTB	0.103* 1.731 0.086
INDUSTRY	0.061 0.794 0.429
Constant	-1.128*
Adjusted R-squared	0.415
F-statistic	8.936***

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Source: statistical output

Based on Table 8, the results of the two-stage least squares estimation indicate that the main findings remain consistent after addressing potential endogeneity. Predicted AI-based digital transformation has a positive and significant coefficient of 0.251 with a p-value of 0.039. This suggests that AI-based digital transformation continues to improve firm resilience even after accounting for possible reverse causality. The result supports the argument that AI-based digital capability helps firms strengthen adaptability, improve decision-making, enhance operational efficiency, and respond more effectively to external pressures.

Predicted ESG implementation also has a positive and significant coefficient of 0.318 with a p-value of 0.013. This indicates that ESG implementation remains an important determinant of firm resilience after controlling for potential endogeneity. ESG practices may help firms build stakeholder trust, improve risk management, strengthen transparency, and maintain long-term sustainability. Islamic governance remains positive and significant, with a coefficient of 0.223 and a p-value of 0.033, confirming its role as an ethical governance mechanism that contributes to firm resilience.

The interaction terms in the 2SLS model also support the main regression results. This indicates that Islamic governance strengthens the effect of AI-based digital transformation on firm resilience even after potential endogeneity is addressed. This also suggests that ESG implementation contributes more strongly to firm resilience when supported by stronger Islamic governance. Therefore, the endogeneity check strengthens the conclusion that AI-based digital transformation, ESG implementation, and Islamic governance play important roles in enhancing firm resilience among JII firms.

4.7. Discussion

Analyze The findings of this study provide evidence that AI-based digital transformation has a positive effect on firm resilience among firms listed in the JII. This result indicates that firms with stronger disclosure and implementation of AI-related digital transformation tend to have better ability to maintain stability, adapt to external pressures, and recover from disruption. AI-based digital transformation may improve firm resilience by strengthening data-driven decision-making, improving operational efficiency, enhancing risk identification, and accelerating organizational response to environmental changes. This finding is consistent with dynamic capability theory, which argues that firms need to build, integrate, and reconfigure strategic resources to respond to a rapidly changing business environment. In this context, AI-based digital transformation can be understood as a dynamic capability that enables firms to sense risks and opportunities, seize strategic responses, and reconfigure business processes in a more adaptive manner.

The positive effect of AI-based digital transformation on firm resilience is particularly relevant in the context of the post-pandemic business environment. During the 2022–2024 period, firms faced increasing pressure to improve digital readiness, operational flexibility, and technological adaptability. Firms that disclosed stronger AI-based digital transformation were likely to have better digital infrastructure, stronger innovation orientation, and greater ability to use technology for business continuity. Therefore, AI-based digital transformation does not only reflect technological adoption, but also indicates a firm's strategic readiness to deal with uncertainty. For JII firms, this finding is important because Islamic equity market firms are expected to maintain not only financial performance, but also ethical responsibility, transparency, and long-term business sustainability.

The results also show that ESG implementation positively affects firm resilience. This finding suggests that firms with stronger ESG implementation are more resilient because ESG practices help firms manage environmental, social, governance, reputational, and regulatory risks. Environmental practices may help firms reduce exposure to climate-related risks, resource inefficiency, and environmental compliance costs. Social practices may strengthen employee commitment, customer trust, community support, and stakeholder relationships. Governance practices may improve transparency, accountability, internal control, risk management, and decision-making quality. These mechanisms enable firms to maintain operational stability and stakeholder trust during periods of uncertainty.

This finding supports stakeholder theory, which emphasizes that firms can achieve long-term sustainability by balancing the interests of multiple stakeholders. ESG implementation reflects a firm's response to stakeholder expectations regarding environmental protection, social responsibility, and responsible governance. Firms that respond effectively to stakeholder demands are more likely to gain legitimacy, trust, and support, which are important resources for resilience. In the context of JII firms, ESG implementation is even more relevant because Islamic business principles are closely aligned with social responsibility, fairness, environmental stewardship, and ethical accountability. Therefore, ESG can be viewed not only as a sustainability reporting mechanism, but also as a strategic mechanism for strengthening firm resilience.

The moderation results show that Islamic governance strengthens the relationship between AI-based digital transformation and firm resilience. This finding suggests that AI-based digital

transformation becomes more effective in enhancing firm resilience when supported by strong Islamic governance. Digital transformation may create new opportunities for efficiency and innovation, but it can also generate risks such as data misuse, cyber risk, information asymmetry, and irresponsible technology adoption. Islamic governance can reduce these risks by promoting ethical monitoring, transparency, accountability, and responsible technology use. Therefore, AI-based digital transformation is more likely to support firm resilience when it is embedded within an ethical governance framework.

This moderating effect highlights the importance of governance quality in converting digital capability into resilience. Firms may adopt AI and digital technologies, but the benefits of such technologies depend on how they are governed and aligned with organizational values. In the JII context, Islamic governance provides an ethical foundation that guides the use of digital technology toward responsible and sustainable outcomes. This means that AI-based digital transformation should not be treated merely as a technological initiative, but as a governance-related capability that requires ethical oversight. The finding supports the argument that Islamic governance can act as an ethical control mechanism that enhances the resilience impact of digital transformation.

The study also finds that Islamic governance strengthens the relationship between ESG implementation and firm resilience. This result indicates that ESG practices contribute more strongly to resilience when supported by Islamic governance. ESG implementation may be symbolic if it is not supported by strong ethical values and accountability mechanisms. Islamic governance can improve the credibility and substance of ESG practices by reinforcing trustworthiness, fairness, social responsibility, and stakeholder orientation. Therefore, firms with stronger Islamic governance are more likely to implement ESG in a meaningful way rather than merely using ESG as a symbolic disclosure strategy.

This finding is important because prior studies have shown inconsistent evidence regarding the effect of ESG on firm resilience. Some studies argue that ESG improves resilience, while others suggest that ESG may be symbolic or may not generate significant financial benefits. The findings of this study help explain this inconsistency by showing that the effectiveness of ESG depends on the governance context. ESG implementation is more likely to strengthen firm resilience when firms have stronger Islamic governance because Islamic governance enhances the credibility, ethical orientation, and stakeholder relevance of ESG practices. Therefore, Islamic governance plays a critical role in transforming ESG from a reporting practice into a resilience-enhancing mechanism.

The robustness tests further strengthen the empirical findings. When firm resilience is measured using Altman Z-score, the results remain consistent. This indicates that the positive effects of AI-based digital transformation, ESG implementation, and Islamic governance are not dependent solely on the PCA-based firm resilience index. The ESG sub-dimension test also shows that environmental, social, and governance disclosures each have positive effects on firm resilience. Among the three ESG dimensions, governance disclosure shows the strongest coefficient, suggesting that governance-related sustainability practices may be particularly important in strengthening resilience. This finding is consistent with the argument that transparency, accountability, risk management, and oversight are central to corporate resilience.

The endogeneity check using two-stage least squares also supports the main findings. The results show that predicted AI-based digital transformation and predicted ESG implementation remain positively associated with firm resilience. This indicates that the main results are not merely driven by reverse causality, where more resilient firms have greater resources to adopt AI or implement ESG. Instead, the findings suggest that AI-based digital transformation and ESG implementation genuinely contribute to strengthening firm resilience. The interaction terms remain significant in the 2SLS model, confirming that Islamic governance continues to strengthen the effects of AI-based digital transformation and ESG implementation after addressing potential endogeneity concerns.

Overall, the findings suggest that firm resilience in JII firms is shaped by the interaction between digital capability, sustainability practices, and ethical governance. AI-based digital transformation provides adaptive capability, ESG implementation provides sustainability and stakeholder trust, while Islamic governance provides ethical monitoring and credibility. The integration of these three elements creates a stronger foundation for firm resilience. This study, therefore, extends the literature by showing that resilience is not only a financial outcome, but also the result of technological readiness, sustainability commitment, and ethical governance quality.

The findings have several practical implications. For managers, the results suggest that AI-based digital transformation should be integrated with ESG and governance strategies rather than implemented as a separate technological initiative. Firms should ensure that AI adoption supports responsible decision-making, risk management, transparency, and sustainability reporting. For investors, the findings indicate that AI-based digital transformation, ESG implementation, and Islamic governance can be used as important signals in assessing the resilience of firms in Islamic equity markets. For regulators and market

authorities, the results highlight the importance of encouraging digital transparency, ESG reporting, and Islamic ethical governance to strengthen the resilience of listed firms. For JII firms, the findings emphasize that resilience can be strengthened when digital transformation is guided by sustainability values and Islamic governance principles.

5. Conclusion

This study examines the effect of AI-based digital transformation and ESG implementation on firm resilience, as well as the moderating role of Islamic governance among firms listed in the JII during the 2022–2024 period. The findings show that AI-based digital transformation has a positive effect on firm resilience. This indicates that firms with stronger AI-based digital transformation are more capable of improving adaptability, operational efficiency, data-driven decision-making, and responsiveness to external pressures. The results also show that ESG implementation positively affects firm resilience. This finding suggests that ESG practices help firms manage environmental, social, governance, reputational, and regulatory risks. Firms with stronger ESG implementation are more likely to maintain stakeholder trust, improve transparency, and support long-term business sustainability. In addition, Islamic governance has a positive effect on firm resilience, indicating that ethical governance based on Islamic values can strengthen accountability, fairness, transparency, stakeholder orientation, and sustainability. Furthermore, the study finds that Islamic governance strengthens the relationship between AI-based digital transformation and firm resilience. This means that AI-based digital transformation becomes more effective when supported by ethical monitoring, responsible technology use, and accountability mechanisms. Islamic governance also strengthens the relationship between ESG implementation and firm resilience. This indicates that ESG practices contribute more strongly to resilience when they are supported by Islamic ethical values, stakeholder responsibility, and governance credibility. Overall, this study concludes that firm resilience in JII firms is shaped by the integration of digital capability, sustainability practices, and Islamic ethical governance. AI-based digital transformation provides adaptive capability, ESG implementation provides sustainability orientation and stakeholder trust, while Islamic governance strengthens ethical accountability and credibility. Therefore, firm resilience in the Islamic capital market context is not only a financial outcome, but also the result of responsible digital transformation, substantive ESG implementation, and value-based governance.

5.1. Implication

The findings provide several theoretical, practical, and regulatory implications. Theoretically, this study contributes to the literature on firm resilience by integrating AI-based digital transformation, ESG implementation, and Islamic governance in one empirical model. The results support dynamic capability theory by showing that AI-based digital transformation functions as an adaptive capability that helps firms respond to environmental uncertainty. The findings also support stakeholder theory by showing that ESG implementation strengthens firm resilience through stakeholder trust, legitimacy, and sustainability orientation. In addition, the results support signaling theory by showing that AI-based digital transformation, ESG implementation, and Islamic governance can serve as positive signals of firm quality, sustainability commitment, and governance credibility.

Practically, the findings suggest that firms should not treat AI-based digital transformation as a purely technological initiative. Instead, AI-based digital transformation should be integrated with ESG and governance strategies to strengthen resilience. Firms need to ensure that the use of AI and digital technologies supports transparency, risk management, operational efficiency, responsible decision-making, and sustainability reporting. The findings also imply that ESG implementation should be substantive rather than symbolic. ESG practices will contribute more strongly to firm resilience when they are supported by strong governance, ethical accountability, and stakeholder orientation.

For JII firms, the study emphasizes that Islamic governance can become a strategic mechanism for strengthening resilience in the digital era. Islamic governance should not only be understood as a compliance-oriented concept, but also as an ethical governance framework that supports transparency, fairness, accountability, stakeholder welfare, and sustainability. Firms listed in the JII need to strengthen Islamic ethical governance disclosure to enhance investor confidence and demonstrate that digital transformation and ESG practices are implemented responsibly.

For investors, the findings suggest that AI-based digital transformation, ESG implementation, and Islamic governance can be considered important indicators in assessing the resilience of firms in the Islamic capital market. Investors should evaluate not only financial performance, but also whether firms have adaptive digital capabilities, sustainability practices, and ethical governance mechanisms. For regulators and market authorities, the findings highlight the importance of encouraging stronger ESG reporting, digital transparency, and Islamic governance disclosure among sharia-compliant firms.

Strengthening these areas may support the development of a more resilient, transparent, and sustainable Islamic capital market.

5.2. Limitation

This study has several limitations. First, the observation period is limited to 2022–2024. Although this period is relevant because it reflects the post-pandemic recovery phase and the growing importance of digital transformation and ESG reporting, the relatively short period may limit the ability to capture long-term resilience dynamics. Future studies may extend the observation period to obtain more comprehensive evidence.

Second, this study focuses only on firms listed in the JII. While this context is relevant for examining Islamic equity market firms, the findings may not be fully generalizable to all listed firms in Indonesia or to Islamic capital markets in other countries. Future studies may compare JII firms with non-JII firms or conduct cross-country comparisons across Islamic equity markets.

Third, AI-based digital transformation, ESG implementation, and Islamic governance are measured using disclosure-based indices. Although this approach is suitable due to data availability, disclosure may not always fully reflect actual implementation. Firms may disclose certain practices without implementing them substantively. Therefore, future studies may combine disclosure data with other indicators, such as digital investment, technology adoption metrics, ESG ratings, or survey-based measures.

Fourth, the Islamic governance index is developed by integrating several frameworks, including AAOIFI, ISR, GCG, ESG, and digital governance literature. Although this approach is relevant for JII firms, the index may still require further validation. Future research may refine the Islamic governance measurement by involving expert validation, inter-coder reliability testing, or alternative weighting methods.

Fifth, firm resilience is measured using a PCA-based composite index. While this approach captures multiple dimensions of resilience, the construction of the index depends on selected financial indicators and statistical weighting. Future research may use alternative measures, such as operational resilience, market-based resilience, stock price recovery, or crisis-period performance.

5.3. Recommendation

Based on the findings and limitations, several recommendations can be proposed. Future research should extend the study period to capture broader economic cycles and examine whether the relationship between AI-based digital transformation, ESG implementation, Islamic governance, and firm resilience remains stable over time. Future studies may also compare Islamic and non-Islamic firms to determine whether Islamic governance provides a distinctive advantage in strengthening resilience.

Future research is also encouraged to improve the measurement of AI-based digital transformation by using more objective indicators, such as digital investment, technology-related assets, IT expenditure, digital patents, or actual AI adoption data. Similarly, ESG implementation can be measured using ESG ratings, IDX ESG reporting data, sustainability assurance, or separate environmental, social, and governance scores.

For Islamic governance, future studies may further develop and validate the Islamic Ethical Governance Disclosure Index. This can be done by involving Islamic accounting experts, governance scholars, and sustainability practitioners to ensure that the index is conceptually valid and contextually relevant. Future studies may also examine whether specific dimensions of Islamic governance, such as ethical accountability, stakeholder orientation, or digital ethical governance, have different effects on firm resilience.

Methodologically, future research may use longer panel data, dynamic panel models, or more advanced endogeneity techniques when sufficient data are available. This would help provide stronger causal evidence regarding the effect of AI-based digital transformation and ESG implementation on firm resilience. Future studies may also examine mediation mechanisms, such as whether ESG mediates the relationship between AI-based digital transformation and firm resilience.

In practical terms, firms are encouraged to integrate AI-based digital transformation with sustainability and governance strategies. AI adoption should be directed not only toward efficiency, but also toward improving risk management, transparency, stakeholder engagement, and sustainability performance. JII firms should also strengthen Islamic governance disclosure to demonstrate ethical accountability and responsible business conduct. Regulators and market authorities may support this process by providing clearer guidelines for digital governance, ESG disclosure, and Islamic governance reporting in the Islamic capital market.

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