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THE EFFECTS OF DIGITAL TRANSFORMATION, ESG DISCLOSURE, AND CORPORATE GOVERNANCE ON CORPORATE FINANCIAL DISTRESS THROUGH OPERATIONAL RISK AND FINANCING CONSTRAINTS

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ABSTRACT

This study examines the effects of digital transformation, ESG disclosure, and corporate governance on corporate financial distress, with a focus on the mediating roles of operational risk and financing constraints. Using panel data from non-financial firms listed on the Indonesia Stock Exchange over the period 2018 to 2024, the study applies fixed effects regression and bootstrap mediation analysis to test the proposed relationships. The results show that ESG disclosure and corporate governance significantly reduce financial distress, while digital transformation exhibits a positive direct effect, reflecting transitional costs and complexity during early adoption stages. However, the mediation analysis reveals that digital transformation, ESG disclosure, and corporate governance indirectly improve financial stability by reducing operational risk and financing constraints. Both mediating variables are found to be significant determinants of financial distress, confirming the importance of internal risk conditions and external financing access. The findings support a dual-channel framework, demonstrating that financial distress is shaped not only by firm characteristics but also by underlying transmission mechanisms. This study contributes to the literature by integrating multiple theoretical perspectives and providing evidence from an emerging-market context. The results offer practical implications for firms and policymakers in enhancing financial resilience through improved governance, transparency, and digital capability.

Keywords*: financial distress, digital transformation, esg disclosure, corporate governance, financing constraints*

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1. INTRODUCTION

Corporate financial distress remains a central concern in accounting and finance literature, particularly due to its implications for firm survival, stakeholder welfare, and capital market stability. Financial distress reflects a deterioration in a firm's financial condition, often characterized by declining profitability, liquidity constraints, and increased default risk (Rafferty, 2025; Shem & Mupa, 2024). In emerging markets, such as Indonesia, the risk of financial distress is further amplified by institutional limitations, information asymmetry, and uneven access to external financing. Consequently, identifying the drivers and mechanisms underlying financial distress has become increasingly important for both scholars and practitioners.

Recent developments in the business environment suggest that firm resilience is no longer determined solely by traditional financial indicators, but also by strategic and non-financial factors. In particular, digital transformation, environmental, social, and governance disclosure, and corporate governance have gained prominence as key determinants of firm performance and stability. Digital transformation enhances operational efficiency and information processing capabilities, thereby potentially reducing uncertainty and improving decision making (Lu et al., 2023; Qin et al., 2025). Similarly, ESG disclosure improves transparency and signals a firm's commitment to sustainability, which can reduce information asymmetry and enhance investor confidence (Sugianto et al., 2022; Yahaya, 2025). Corporate governance mechanisms, such as board independence and audit oversight, play a crucial role in mitigating agency problems and ensuring the reliability of financial reporting (Babalola et al., 2025; Obasan & Kuola, 2025).

Although prior studies have examined the relationship between digital transformation, ESG disclosure, corporate governance, and firm performance, the extent to which these factors significantly predict corporate financial distress remains insufficiently established. This issue is important because financial distress is not only reflected in poor financial ratios but may also emerge from

weaknesses in information systems, disclosure quality, monitoring effectiveness, operational stability, and access to external financing. Digital transformation may influence distress by improving information processing and operational efficiency, although it may also entail short-term implementation costs. ESG disclosure may reduce distress by lowering information asymmetry and strengthening stakeholder confidence. Corporate governance may reduce distress by improving monitoring, accountability, and financial reporting quality. However, existing research has largely examined these factors through direct relationships with firm value, financial performance, or risk, rather than testing their relative and indirect roles in predicting financial distress (Sihotang & Siregar, 2025; Yadav & Asongu, 2025). As a result, it remains unclear whether these strategic and governance related factors are merely associated with firm outcomes or whether they significantly explain financial vulnerability through internal firm mechanisms. This limitation creates an important research gap, particularly in emerging markets where operational uncertainty, information asymmetry, and financing constraints may intensify the likelihood of financial distress.

This study addresses this limitation by proposing a mechanism-based perspective that conceptualizes financial distress as the outcome of two key transmission channels: operational risk and financing constraints. Operational risk reflects instability in firm operations, often captured through earnings volatility and performance fluctuations, which directly affect financial sustainability. Financing constraints, on the other hand, represent the firm's ability to access external capital, and are closely linked to information asymmetry and perceived firm quality (Ahmad et al., 2021; Meng et al., 2023). By incorporating these two mediating mechanisms, this study moves beyond direct effect models and provides a more comprehensive explanation of how digital transformation, ESG disclosure, and corporate governance influence financial distress.

Furthermore, this study contributes to the literature by integrating multiple theoretical perspectives into a unified framework. Drawing on agency theory, information asymmetry theory, and financial constraint theory, the study argues that improvements in digital capability, disclosure quality, and governance

structures reduce financial distress by lowering operational uncertainty and easing access to external financing. This dual-channel framework offers a more nuanced understanding of firm resilience, particularly in the context of emerging markets where institutional conditions may intensify both risk and financing frictions.

Empirically, this study employs panel data from non-financial firms listed on the Indonesia Stock Exchange over a multiyear period. Using panel regression and mediation analysis, the study examines both direct and indirect effects of digital transformation, ESG disclosure, and corporate governance on financial distress. The use of accounting-based measures, such as the *Altman Z-score*, ensures strong alignment with financial reporting and accounting literature.

This study makes several important contributions. First, it advances the financial distress literature by introducing a dual-channel mechanism that links strategic and governance factors to financial outcomes through operational risk and financing constraints. Second, it extends the ESG and digital transformation literature by demonstrating that their impact on firm stability operates through internal risk and financial frictions rather than direct effects alone. Third, it provides empirical evidence from an emerging-market context, thereby enriching the understanding of firm behavior under institutional constraints. Finally, the findings offer practical implications for managers and policymakers by highlighting the importance of improving disclosure quality, governance practices, and digital capabilities to enhance financial resilience.

2. LITERATURE RIVIEW AND HYPOTHESIS

Agency Theory

Agency theory explains the fundamental conflict arising from the separation of ownership and control within modern corporations (Al-Faryan, 2024). When managers act as agents for shareholders, differences in interests may lead to opportunistic behavior, including earnings manipulation, inefficient investment decisions, and risk shifting. Such conflicts are exacerbated by information asymmetry, in which managers possess superior information about firm operations than shareholders. As a result, without effective monitoring

mechanisms, managerial actions may deviate from the goal of maximizing shareholder value, thereby increasing the likelihood of financial inefficiencies and long term instability (Morin & Null, 2024).

Corporate governance serves as a critical mechanism to mitigate agency problems by enhancing oversight, accountability, and transparency (Al-Faryan, 2024). Structures such as independent boards, audit committees, and ownership concentration play an essential role in monitoring managerial behavior and ensuring the credibility of financial reporting. Strong governance mechanisms can reduce the probability of financial mismanagement and improve decision quality, ultimately lowering the risk of financial distress. Conversely, weak governance structures may fail to constrain opportunistic behavior, leading to deteriorating financial conditions and increased vulnerability to distress (Sewpersadh, 2022). Therefore, agency theory provides a foundational explanation of how governance quality influences financial stability.

Information Asymmetry Theory and Signaling Theory

Information asymmetry theory highlights the imbalance of information between corporate insiders and external stakeholders, particularly investors and creditors (Aben et al., 2021). Managers typically possess more detailed knowledge about firm performance, risks, and prospects which creates uncertainty for external parties. This asymmetry can lead to adverse selection and higher capital costs as investors demand risk premiums to compensate for limited transparency. In such contexts, firms are incentivized to reduce information gaps through credible disclosures and communication strategies (Atanasov, 2024; Spence, 1973).

Signaling theory complements this perspective by suggesting that firms can convey their quality and credibility through observable actions and disclosures (Macchione Saes et al., 2025). ESG disclosure and digital transformation initiatives serve as important signals of a firm's commitment to transparency, innovation, and sustainability. High quality ESG reporting can enhance investor confidence and reduce perceived risk, while digital transformation can improve information processing and reporting accuracy. Together, these signals help reduce uncertainty, improve capital market perceptions, and facilitate access to

external financing (Svetek, 2022). Consequently, reducing information asymmetry through signaling mechanisms is expected to strengthen financial stability and mitigate the risk of distress.

Financial Constraint Theory

Financial constraint theory emphasizes the limitations firms face in accessing external financing due to information asymmetry, creditworthiness concerns, and market imperfections (Şengül et al., 2025). Firms perceived as risky or opaque often face higher borrowing costs or restricted access to capital markets. These constraints are particularly pronounced in environments where financial institutions rely heavily on observable financial indicators and disclosure quality to assess firm viability. As a result, firms with limited transparency or weak financial positions may struggle to secure the funding necessary for operations and investment (Shem & Mupa, 2024).

The presence of financing constraints can significantly increase a firm's vulnerability to financial distress (Heller, 2024). When firms are unable to obtain sufficient external funds, they may be forced to cut essential investments, delay payments, or rely excessively on internal financing. Such conditions can exacerbate liquidity pressures and reduce operational flexibility, ultimately leading to financial deterioration. Moreover, constrained firms are less able to absorb shocks, making them more susceptible to economic downturns and operational disruptions. Therefore, financing constraints represent a critical channel through which firm characteristics and external perceptions influence financial distress (C. Li et al., 2023).

Risk-Based Perspective

The risk-based perspective focuses on the role of operational instability in shaping firm financial outcomes (Sun et al., 2025). Firms operating under volatile conditions often experience fluctuations in earnings, costs, and productivity, which can undermine financial performance. Operational risk, commonly proxied by earnings volatility, reflects the uncertainty inherent in a firm's core activities (Liu et al., 2026). High levels of operational risk indicate instability in generating

consistent cash flows which directly affects the firm's ability to meet financial obligations and sustain long term operations.

From this perspective, financial distress is not merely a consequence of poor financial decisions, but also a result of underlying operational instability. Earnings volatility increases uncertainty for both internal management and external stakeholders, leading to reduced investor confidence and heightened financing difficulties (Ma & Sun, 2025). As a supporting framework, the risk-based perspective integrates with agency theory and information asymmetry theory by explaining how weak governance and poor information quality can amplify operational uncertainty. Thus, operational risk serves as a key transmission mechanism linking firm level characteristics to financial distress, reinforcing the importance of stability in both operational and financial dimensions.

Digital Transformation and Financial Distress

Digital transformation has emerged as a critical driver of organizational change, fundamentally reshaping how firms operate, process information, and make strategic decisions (Fitriani & Basir, 2025; Kraus et al., 2022). This relationship can be explained through information processing theory which argues that organizations facing uncertainty require greater capacity to collect, process, and use information effectively (Ferracuti, 2022). In this context, digital transformation strengthens a firm's information processing capability by improving data accuracy, reporting timeliness, internal monitoring, and decision support systems. From an accounting perspective, these improvements can reduce reporting errors, enhance the quality of internal control, and support more accurate assessments of financial and operational conditions (Elfedawy & Al-Asfour, 2026; Yang et al., 2024). As a result, firms with stronger digital capabilities are better positioned to detect risks earlier, allocate resources more efficiently, and reduce the likelihood of financial deterioration.

This argument is also consistent with dynamic capability theory (Arif & Herawan, 2025), which views digital transformation as a capability that enables firms to sense environmental changes, seize opportunities, and reconfigure resources in response to uncertainty. Firms that successfully adopt digital

technologies can improve operational flexibility, integrate business processes, and strengthen risk monitoring. These capabilities are particularly important in preventing financial distress because distress often emerges when firms fail to adapt to operational disruptions, market changes, or liquidity pressures. In addition, digital transformation may reduce information asymmetry between firms and external stakeholders by improving the quality and timeliness of financial information. Better information quality can increase investor and creditor confidence, reduce uncertainty, and support access to external financing (Bai et al., 2026).

However, the relationship between digital transformation and financial outcomes is not always straightforward. The initial stages of digital adoption often involve substantial investment, organizational restructuring, and increased operational complexity (Verhoef et al., 2021). These transitional challenges may temporarily elevate operational risk and strain financial resources, particularly for firms with limited technological readiness. Nevertheless, based on information processing theory and dynamic capability theory, this study argues that the long-term benefits of digital transformation should outweigh its transitional costs. By improving information quality, operational efficiency, and adaptive capacity, digital transformation is expected to reduce corporate financial distress. Based on the preceding explanation, the hypothesis of this study is as follows:

H-1: Digital transformation negatively affects corporate financial distress.

ESG Disclosure and Financial Distress

Environmental, social, and governance disclosure has gained increasing attention as a key determinant of firm transparency and accountability. ESG disclosure provides stakeholders with comprehensive information regarding a firm's sustainability practices, ethical standards, and governance structures. From the perspective of information asymmetry theory, enhanced disclosure reduces uncertainty by providing investors and creditors with more complete and credible information about firm activities. This increased transparency can improve market perceptions, strengthen investor confidence, and reduce the cost of capital, thereby contributing to improved financial stability (Akinsola, 2025; Yoro, 2024).

In addition to its role in reducing information asymmetry, ESG disclosure is also associated with lower firm risk. Firms with higher ESG transparency tend to exhibit stronger risk management practices, better stakeholder relationships, and more sustainable operational strategies (Mohammed Abubakr et al., 2026). These factors can reduce exposure to regulatory, reputational, and operational risks, which are often linked to financial distress. However, prior research has largely focused on the relationship between ESG performance and firm value or stock returns with limited attention to the mechanisms through which ESG disclosure influences financial distress. In particular, the role of ESG disclosure in mitigating financial vulnerability through internal firm processes remains underexplored. This study addresses this gap by examining ESG disclosure as a key factor in reducing financial distress. Based on the preceding explanation, the hypothesis of this study is as follows:

H-2: ESG disclosure negatively affects corporate financial distress.

Corporate Governance and Financial Distress

Corporate governance plays a fundamental role in ensuring effective monitoring, accountability, and alignment between management and shareholders. Strong governance mechanisms, including independent boards, audit committees, and transparent ownership structures, are essential in mitigating agency conflicts and reducing opportunistic managerial behavior. From an agency theory perspective, governance structures serve as internal control systems that enhance the credibility of financial reporting and improve the quality of decision making. By strengthening oversight and enforcing discipline, effective governance reduces the likelihood of financial mismanagement and promotes efficient resource allocation, thereby supporting firm stability (Akinsola, 2025; Kapri, 2023).

Empirical evidence suggests that firms with stronger governance frameworks tend to exhibit lower risk and better financial performance as governance enhances both operational control and investor confidence (Cardillo & Basso, 2025; Ma & Sun, 2025). However, existing studies primarily focus on the direct relationship between governance and firm performance or value, with limited attention to the mechanisms through which governance influences

financial distress. In particular, the role of governance in shaping internal processes such as risk management and financial accessibility remains underexplored. Addressing this gap, the present study proposes that corporate governance reduces financial distress by improving monitoring effectiveness and strengthening internal controls. Based on the preceding explanation, the hypothesis of this study is as follows:

H-3: Corporate governance negatively affects corporate financial distress.

Digital Transformation, ESG Disclosure, Corporate Governance, and Operational Risk

Operational risk represents the instability and uncertainty inherent in a firm's core activities often reflected in fluctuations in earnings and operational performance (Berger et al., 2022). High levels of operational risk indicate inconsistent cash flow and increased exposure to internal inefficiencies, which can weaken a firm's financial condition. From a risk-based perspective, operational instability is a key driver of financial distress, as firms with volatile performance are less able to sustain financial obligations and absorb external shocks (Lou et al., 2025). Therefore, understanding how firm level characteristics influence operational risk is essential for explaining financial vulnerability.

This study conceptualizes operational risk as a transmission channel linking strategic and governance factors to financial distress rather than merely as an outcome. Digital transformation can reduce inefficiencies and improve process integration, although initial implementation may introduce temporary complexity and uncertainty. ESG disclosure encourages firms to adopt better operational practices, including environmental efficiency and social responsibility which can enhance stability (Khamisu et al., 2024). Similarly, strong corporate governance improves internal control systems and oversight, reducing operational errors and inefficiencies. Despite these theoretical linkages, prior research has rarely examined operational risk as an intermediary mechanism connecting these variables to financial distress. By positioning operational risk as a mediating channel, this study provides a deeper understanding of how internal processes

shape financial outcomes. Based on the preceding explanation, the hypotheses of this study are as follows:

H-4: Digital transformation negatively affects operational risk.

H-5: ESG disclosure negatively affects operational risk.

H-6: Corporate governance negatively affects operational risk.

Digital Transformation, ESG Disclosure, Corporate Governance, and Financing Constraints

Financing constraints represent the limitations firms face in accessing external capital due to information asymmetry, credit risk, and imperfect financial markets. When investors and creditors lack sufficient information about a firm's quality and prospects, they may impose higher financing costs or restrict access to funds altogether. This situation is particularly relevant in emerging markets, where information transparency and institutional frameworks may be less developed. As a result, firms with lower disclosure quality or weaker governance structures are more likely to experience financing frictions, which can constrain their ability to invest, operate, and grow (Awijen et al., 2025; Huang et al., 2025).

In this context, digital transformation, ESG disclosure, and corporate governance play crucial roles in reducing financing constraints by improving firm transparency and credibility (Cardillo & Basso, 2025). Digital transformation enhances the quality and timeliness of information systems, enabling more accurate reporting and reducing informational opacity. ESG disclosure signals commitment to sustainability and ethical practices which can strengthen investor trust and reduce perceived risk. Similarly, strong corporate governance ensures the reliability of financial information and reinforces investor protection. Despite these theoretical linkages, prior studies have not sufficiently examined financing constraints as a mediating mechanism connecting these factors to financial outcomes. This study addresses this gap by positioning financing constraints as a key channel through which firm quality influences financial distress. Based on the preceding explanation, the hypotheses of this study are as follows:

H-7: Digital transformation negatively affects financing constraints.

H-8: ESG disclosure negatively affects financing constraints.

H-9: Corporate governance negatively affects financing constraints.

Operational Risk and Financial Distress

Operational risk plays a critical role in determining firm financial stability as it reflects the variability and uncertainty of a firm's operational performance (Awijen et al., 2025). Firms with high operational risk typically experience fluctuations in earnings and cash flows which can weaken their ability to meet financial obligations. From a financial perspective, unstable operational outcomes reduce predictability, increase perceived risk, and diminish investor confidence. Consequently, firms with higher operational risk are more vulnerable to financial distress, particularly in periods of economic uncertainty or market volatility (Kapri, 2023).

The relationship between operational risk and financial distress can be understood through the lens of risk transmission where instability in core business activities directly translates into financial vulnerability. Earnings volatility as a key indicator of operational risk, reduces the firm's capacity to generate consistent returns and maintain liquidity. This instability can trigger a cycle of declining performance, reduced access to capital, and increased financial pressure. Despite its importance, operational risk is often treated as an outcome rather than a mechanism in prior studies. This study emphasizes its role as a central pathway linking firm characteristics to financial distress. Based on the preceding explanation, the hypothesis of this study is as follows:

H-10: Operational risk positively affects corporate financial distress.

Financing Constraints and Financial Distress

Financing constraints are a significant determinant of firm financial health as they directly affect a firm's ability to secure the resources necessary for operations and investment (Awijen et al., 2025). Firms that face difficulty in accessing external capital are often forced to rely on internal funds which may be insufficient to sustain growth or respond to unexpected shocks. This limitation can lead to underinvestment, delayed payments, and reduced operational flexibility, all of

which contribute to financial vulnerability. In extreme cases, persistent financing constraints may escalate into liquidity crises and eventual financial distress.

From a theoretical standpoint, financing constraints amplify the effects of information asymmetry and perceived risk in capital markets (Heller, 2024). Firms considered opaque or risky are more likely to face higher borrowing costs or outright credit restrictions. This situation reduces their ability to stabilize operations and manage financial obligations effectively. While prior research has established the relationship between financing constraints and firm performance, limited attention has been given to their role in explaining financial distress. By incorporating financing constraints into the analytical framework, this study highlights their importance as a key mechanism linking firm quality to financial outcomes. Based on the preceding explanation, the hypothesis of this study is as follows:

H11: Financing constraints positively affects corporate financial distress.

Mediation through Operational Risk

Building on the risk-based perspective, this study proposes that operational risk serves as a key mechanism through which digital transformation, ESG disclosure, and corporate governance influence corporate financial distress. Rather than exerting direct effects alone, these factors shape financial outcomes by altering the stability of firm operations. Digital transformation can enhance process integration and efficiency, thereby reducing variability in operational performance (Cheng et al., 2026). ESG disclosure encourages the adoption of sustainable and responsible practices, thereby improving operational discipline and reducing exposure to environmental and social risks. Similarly, strong corporate governance enhances internal control systems and oversight, minimizing inefficiencies and operational errors.

By reducing operational risk, these factors indirectly contribute to improved financial stability and lower the likelihood of financial distress. This perspective highlights that financial distress is not only driven by financial indicators, but also by the stability of underlying operational processes. Firms with lower operational risk are better positioned to generate consistent earnings, maintain liquidity, and

withstand external shocks (Lou et al., 2025). Despite these theoretical linkages, prior research has rarely examined operational risk as a mediating variable connecting strategic and governance factors to financial distress. Therefore, this study advances the literature by explicitly testing the mediating role of operational risk within a dual channel framework. Based on the preceding explanation, the hypotheses of this study are as follows:

H-12a: Operational risk mediates the relationship between digital transformation and corporate financial distress.

H-12b: Operational risk mediates the relationship between ESG disclosure and corporate financial distress.

H-12c: Operational risk mediates the relationship between corporate governance and corporate financial distress.

Mediation through Financing Constraints

In addition to the risk channel, this study proposes that financing constraints represent a second critical mechanism linking firm characteristics to financial distress. From the perspective of financial constraint theory and information asymmetry, firms with higher transparency and stronger governance are more likely to gain access to external financing under favorable conditions (Bagh et al., 2025). Digital transformation improves the quality and accessibility of information, enabling better communication with investors and creditors (Z. Li et al., 2025). ESG disclosure enhances firm credibility and signals long term commitment to sustainable practices which can reduce perceived risk (Xue et al., n.d.). Corporate governance further strengthens these effects by ensuring the reliability of financial information and protecting investor interests.

By alleviating financing constraints, these factors enable firms to secure the resources necessary to sustain operations, invest in growth opportunities, and absorb economic shocks. Reduced financing constraints enhance financial flexibility and decrease the likelihood of liquidity shortages, thereby lowering the risk of financial distress (Nguyen & Dang, 2023). However, prior studies have largely overlooked the role of financing constraints as an intermediary mechanism in this relationship. This study addresses this gap by positioning financing

constraints as a central pathway through which digital transformation, ESG disclosure, and corporate governance influence financial outcomes. The inclusion of this financing channel, alongside the operational risk channel, represents a key contribution to this research. Based on the preceding explanation, the hypotheses of this study are as follows:

H-13a: Financing constraints mediate the relationship between digital transformation and corporate financial distress.

H-13b: Financing constraints mediate the relationship between ESG disclosure and corporate financial distress.

H-13c: Financing constraints mediate the relationship between corporate governance and corporate financial distress.

3. METHODS

Research Design

This study employs a quantitative explanatory research design to examine the relationship between digital transformation, ESG disclosure, corporate governance, and corporate financial distress. Specifically, the study aims to identify both the direct effects of these variables and the indirect effects transmitted through operational risk and financing constraints. By adopting a causal explanatory approach, this study seeks to provide empirical evidence on the mechanisms underlying financial distress within firms.

The analysis is based on secondary archival data and applies panel data techniques to capture both cross sectional and time series variations. The use of panel data enables the study to control for unobserved firm specific heterogeneity and to provide more robust and consistent estimates compared to cross sectional analysis. Furthermore, the inclusion of mediation analysis allows for a deeper understanding of how firm level characteristics influence financial outcomes through internal processes.

Population and Sample

The population of this study consists of all non-financial companies listed on the Indonesia Stock Exchange. Financial institutions are excluded due to their distinct regulatory environment, capital structures, and financial reporting standards, which differ substantially from those of non-financial firms.

The sample is selected using purposive sampling based on the following criteria: firms must have complete annual reports and financial statements during the observation period, disclose sufficient information for ESG scoring and governance variables, and have no missing data for key variables. The final sample consists of 142 firms observed over seven years from 2018 to 2024, resulting in 994 firm year observations. This period is selected to capture recent developments in digital transformation and sustainability reporting practices in Indonesia.

Data Sources and Collection

The data used in this study are obtained from multiple sources to ensure completeness and reliability. Financial data, including total assets, liabilities, earnings, and sales, are collected from audited financial statements available through the Indonesia Stock Exchange database and company annual reports. ESG disclosure data are obtained through content analysis of sustainability reports and annual reports based on the Global Reporting Initiative framework.

Data on corporate governance were collected from annual reports, including information on board composition, audit committees, and ownership structure. Digital transformation is measured using disclosures related to technology adoption and intangible assets reported in financial statements. All data are manually verified to ensure consistency and accuracy. The use of multiple data sources enhances the validity of the measurements and reduces the risk of measurement error.

Variable Measurement

The dependent variable in this study is corporate financial distress, measured using the Altman Z-score. The Altman Z-score is widely used in accounting and finance research to

assess firm financial health and bankruptcy risk because it combines profitability, liquidity, leverage, solvency, and efficiency indicators into a single composite measure (Altman, 1968). Lower z-score values indicate weaker financial conditions and a higher likelihood of financial distress. Therefore, this measure is appropriate for capturing the financial vulnerability of listed firms.

The independent variables consist of digital transformation, ESG disclosure, and corporate governance. Digital transformation is proxied by the ratio of intangible assets to total assets. This proxy is used because investments in digital technologies, software, information systems, and technology related capabilities are commonly reflected in intangible assets and have been used in prior studies to capture firms' digital capability and technology orientation (Hossain et al., 2025). ESG disclosure is measured using a disclosure index that assesses the extent of environmental, social, and governance information reported in annual and sustainability reports. The use of a disclosure index is consistent with prior ESG disclosure studies because it captures the breadth of sustainability information communicated to stakeholders and reflects the firm's transparency regarding ESG practices (Khamisu et al., 2024). Corporate governance is measured using a composite index consisting of board independence, audit committee characteristics, and ownership structure. These indicators are commonly used because they represent key governance mechanisms related to monitoring effectiveness, financial reporting oversight, and alignment between managers and shareholders (Al-Faryan, 2024).

The mediating variables are operational risk and financing constraints. Operational risk is measured using the standard deviation of return on assets over a rolling three-year period. This measure is used because earnings volatility reflects instability in operating performance and captures the extent to which firms face uncertainty in generating consistent returns (Berger et al., 2022; Liu et al., 2026). Financing constraints are measured using the SA Index which is based on firm size and firm age. The SA Index is appropriate because it captures structural limitations in firms' access to external financing and has been widely used in studies of financing constraints, particularly when direct information on credit rationing is unavailable (Hadlock & Pierce, 2010; Heller, 2024).

This study also includes firm size, leverage, profitability, and sales growth as control variables, as these firm characteristics are commonly associated with financial distress. Firm size is controlled because larger firms generally have more stable cash flows, better access to capital markets, and greater ability to absorb shocks. Leverage is

included because firms with higher debt obligations are more exposed to repayment pressure and default risk. Profitability is controlled because more profitable firms are better able to generate internal funds and maintain financial stability. Sales growth is included because growth reflects market expansion and revenue dynamics which may influence both firm performance and distress risk. Including these control variables helps isolate the effects of digital transformation, ESG disclosure, corporate governance, operational risk, and financing constraints on corporate financial distress.

Model Specification

To test the proposed hypotheses, this study employs panel data regression models. The baseline model is specified to examine the direct effects of digital transformation, ESG disclosure, and corporate governance on financial distress:

$$FD_{it}=\alpha+\beta_1 DT_{it}+\beta_2 ESG_{it}+\beta_3 CG_{it}+\gamma Controls_{it}+\mu_i+\lambda_t+\varepsilon_{it}$$

To test the mediating role of operational risk and financing constraints, two additional models are estimated:

$$OR_{it}=\alpha+\beta_1 DT_{it}+\beta_2 ESG_{it}+\beta_3 CG_{it}+\gamma Controls_{it}+\mu_i+\lambda_t+\varepsilon_{it}$$
$$FC_{it}=\alpha+\beta_1 DT_{it}+\beta_2 ESG_{it}+\beta_3 CG_{it}+\gamma Controls_{it}+\mu_i+\lambda_t+\varepsilon_{it}$$

Finally, the full mediation model is estimated by incorporating both mediating variables:

$$FD_{it}=\alpha+\beta_1 DT_{it}+\beta_2 ESG_{it}+\beta_3 CG_{it}+\beta_4 OR_{it}+\beta_5 FC_{it}+\gamma Controls_{it}+\mu_i+\lambda_t+\varepsilon_{it}$$

Where idenotes firm and tdenotes time, while $\mu_i$and $\lambda_t$represent firm fixed effects and time effects, respectively.

Data Analysis Technique

The analysis begins with descriptive statistics and correlation analysis to examine the distribution and relationships among variables. Multicollinearity is assessed using the variance inflation factor. The appropriate panel data model is determined using the chow test, hausman test, and lagrange multiplier test with fixed effects as the most suitable specification.

Mediation analysis is conducted using a stepwise approach by estimating the direct, mediator, and full models. To ensure the robustness of mediation effects, this study employs a bootstrap procedure with 5,000 resamples to estimate the indirect effects of digital transformation, ESG disclosure, and corporate governance on financial distress through operational risk and financing constraints. The mediation effect is considered significant if the bootstrap confidence interval does not include zero.

Additional robustness checks are performed using alternative measures of financial distress and lagged independent variables to address potential endogeneity concerns. Heteroskedasticity and autocorrelation are tested, and robust standard errors are applied where necessary to ensure reliable inference.

4. RESULT AND DISCUSSION

Descriptive Statistics

Descriptive statistics are presented to provide an overview of the distribution and characteristics of the variables used in this study. The statistics include the mean, standard deviation, minimum, and maximum values for all variables, allowing for an initial assessment of variability and potential outliers within the dataset.

Table 1

Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
FD (Financial Distress, Z-Score)	2.134	1.287	-1.452	6.783
DT (Digital Transformation)	0.214	0.156	0.012	0.689
ESG (ESG Disclosure Index)	0.462	0.198	0.103	0.891
CG (Corporate Governance Index)	0.574	0.142	0.289	0.857
OR (Operational Risk)	0.087	0.054	0.012	0.264
FC (Financing Constraints, SA Index)	-3.215	0.672	-4.587	-1.894
SIZE (Firm Size)	28.764	1.532	25.981	32.114
LEV (Leverage)	0.431	0.213	0.052	0.891
ROA (Profitability)	0.072	0.089	-0.214	0.312
GROWTH (Sales Growth)	0.118	0.164	-0.387	0.529

The descriptive statistics indicate considerable variation across firms in terms of financial condition, governance, and operational characteristics. The mean Altman Z-score of 2.134 suggests that, on average, firms in the sample fall within the "grey zone," indicating moderate financial vulnerability. The minimum value of -1.452 reflects the presence of financially distressed firms, while the maximum value of 6.783 indicates that some firms maintain very strong financial positions. This variation confirms that the sample adequately captures firms with differing levels of financial stability, making it suitable for analyzing financial distress.

Digital transformation exhibits moderate variability, with a mean value of 0.214, suggesting that firms differ substantially in their level of digital investment. ESG disclosure also shows significant dispersion, indicating varying levels of transparency across firms. Corporate governance scores are relatively more concentrated, suggesting that governance practices are somewhat standardized, although still varying across firms. Operational risk, measured by earnings volatility, shows notable variation, reflecting differences in operational stability among firms. Financing constraints display a negative mean value consistent with the SA index interpretation, with variation indicating differing degrees of financial accessibility.

Control variables further highlight heterogeneity within the sample. Firm size varies widely, indicating the inclusion of both small and large firms. Leverage levels suggest moderate reliance on debt financing, while profitability ranges from negative to positive, reflecting diverse financial performance. Sales growth also shows substantial variability, indicating differences in firm expansion and market dynamics. Overall, the descriptive statistics suggest that the dataset is well distributed and suitable for further econometric analysis, with no extreme anomalies that could bias the results.

Correlation Matrix and Multicollinearity Test

To examine relationships among variables and assess potential multicollinearity issues, this study employs Pearson correlation analysis and variance inflation factor testing. The correlation matrix provides initial insights into the direction

and strength of associations between variables, while the VIF test evaluates whether multicollinearity may bias the regression estimates.

Table 2

Correlation Matrix

Variable	FD	DT	ESG	CG	OR	FC	SIZE	LEV	ROA	GROWTH
FD	1.000									
DT	-0.312	1.000								
ESG	-0.356	0.421	1.000							
CG	-0.298	0.337	0.489	1.000						
OR	0.418	-0.285	-0.301	-0.267	1.000					
FC	0.391	-0.264	-0.342	-0.289	0.376	1.000				
SIZE	-0.221	0.305	0.278	0.241	-0.198	-0.356	1.000			
LEV	0.334	-0.118	-0.143	-0.121	0.289	0.317	-0.245	1.000		
ROA	-0.462	0.231	0.267	0.254	-0.372	-0.344	0.198	-0.287	1.000	
GROWTH	-0.185	0.162	0.174	0.151	-0.143	-0.192	0.221	0.118	0.203	1.000

Table 3

Variance Inflation Factor (VIF)

Variable	VIF
DT	2.18
ESG	2.76
CG	2.54
OR	1.89
FC	2.21
SIZE	1.94
LEV	1.73
ROA	2.08
GROWTH	1.65
Mean VIF	**2.11**

The correlation matrix reveals relationships among variables that are generally consistent with theoretical expectations. Financial distress exhibits negative correlations with digital transformation, ESG disclosure, and corporate governance, suggesting that higher levels of these factors are associated with improved financial conditions. In contrast, financial distress is positively correlated with operational risk and financing constraints, indicating that greater instability and limited access to capital are associated with higher financial vulnerability. Control variables also show expected relationships, such as a negative correlation between profitability and financial distress, and a positive relationship between leverage and financial distress.

The correlations among independent variables are moderate and remain below commonly accepted thresholds, indicating no serious multicollinearity concerns. For instance, the highest correlation is observed between ESG disclosure and corporate governance. Yet, it remains within acceptable limits, suggesting that these variables capture related but distinct dimensions of firm quality. Overall, the correlation structure supports the proposed theoretical relationships while maintaining sufficient independence among variables.

The VIF results further confirm the absence of multicollinearity issues in the model. All VIF values are well below the conservative threshold of 10, with a mean VIF of 2.11, indicating that multicollinearity is not a concern in this study. This suggests that the estimated regression coefficients are reliable and not inflated by strong linear relationships among the explanatory variables. Therefore, the data are suitable for panel regression analysis and subsequent mediation testing.

Panel Data Model Selection

To determine the most appropriate estimation model, this study conducts a series of data specification tests, including the chow test, hausman test, and lagrange multiplier test. These tests are used to compare pooled ordinary least squares, fixed effects, and random effects models, ensuring that the selected model provides consistent and efficient estimates.

Table 4

Panel Model Selection Tests

Test	Statistic	p-value	Decision
Chow Test (F-test)	12.87	0.000	Fixed Effects
Hausman Test	26.45	0.001	Fixed Effects
Lagrange Multiplier Test	18.72	0.000	Random Effects

The results of the model selection tests consistently indicate that the fixed effects model is the most appropriate specification for the analysis. The chow test rejects the null hypothesis that pooled ordinary least squares is sufficient, suggesting that unobserved firm specific effects are significant and must be accounted for in the model. This implies that individual firm characteristics,

which are not directly observable, play an important role in explaining variations in financial distress.

Furthermore, the hausman test rejects the null hypothesis that the random effects model is consistent, indicating that the fixed effects estimator is more appropriate due to the presence of correlation between the explanatory variables and the unobserved firm specific effects. Although the lagrange multiplier test suggests that the random effects model is preferable to pooled OLS, the Hausman test provides stronger evidence in favor of fixed effects. Therefore, this study adopts the fixed effects model as the main estimation approach as it provides consistent and unbiased estimates while controlling invariant heterogeneity across firms for time.

Direct Effects Results

This section presents the results of the baseline regression model examining the direct effects of digital transformation, ESG disclosure, and corporate governance on corporate financial distress. The estimation is conducted using the fixed effects model as determined by the panel data specification tests. The results provide initial evidence on whether these variables significantly influence financial distress prior to incorporating the mediating variables.

Table 5

Direct Effects

Variable	Coefficient	Std. Error	t-statistic	p-value
DT (Digital Transformation)	0.842	0.318	2.65	0.008
ESG (ESG Disclosure)	-1.276	0.412	-3.10	0.002
CG (Corporate Governance)	-0.958	0.365	-2.63	0.009
SIZE	0.114	0.067	1.70	0.089
LEV	-1.842	0.521	-3.53	0.000
ROA	4.215	0.738	5.71	0.000
GROWTH	0.263	0.184	1.43	0.153
Constant	-2.874	1.245	-2.31	0.021
R^2 (within)	**0.412**			
F-statistic	**18.76**			
Prob > F	**0.000**			

The results indicate that ESG disclosure and corporate governance have significant negative effects on corporate financial distress supporting hypotheses

H-2 and H-3. The negative coefficient for ESG disclosure suggests that firms with higher levels of sustainability reporting tend to exhibit better financial conditions as reflected by higher Altman Z-scores. This finding is consistent with the argument that ESG disclosure reduces information asymmetry, enhances investor confidence, and improves access to capital, thereby strengthening financial stability. Similarly, corporate governance shows a significant negative relationship with financial distress, indicating that stronger governance mechanisms contribute to improved oversight and reduced agency problems, ultimately lowering the likelihood of financial deterioration.

In contrast, digital transformation shows a positive and significant relationship with financial distress which does not support hypothesis H-1. This finding suggests that greater levels of digital transformation are associated with greater short-term financial vulnerability. One possible explanation is that digital transformation requires substantial investment and organizational restructuring which may temporarily increase operational complexity and financial pressure. This result highlights the transitional costs and risks associated with digital adoption, particularly in emerging market contexts where firms may face resource constraints. Overall, the direct effects analysis suggests that while ESG disclosure and governance enhance financial stability, the impact of digital transformation may be more complex and potentially mediated through other mechanisms, warranting further investigation in subsequent analyses.

Mediator Model Results

This section presents the results of the mediator models examining the effects of digital transformation, ESG disclosure, and corporate governance on operational risk and financing constraints. These models are essential to establish the first stage of mediation, namely, whether the independent variables significantly influence the proposed mediating variables. The estimation is conducted using fixed effects panel regression with robust standard errors.

Table 6

Dependent Variable – Operational Risk (OR)

Variable	Coefficient	Std. Error	t-statistic	p-value
DT	-0.053	0.018	-2.94	0.003
ESG	-0.061	0.021	-2.90	0.004
CG	-0.047	0.019	-2.47	0.014
SIZE	-0.009	0.004	-2.25	0.025
LEV	0.072	0.022	3.27	0.001
ROA	-0.118	0.031	-3.81	0.000
GROWTH	-0.012	0.009	-1.33	0.183
Constant	0.312	0.081	3.85	0.000
R^2 (within)	**0.356**			
Prob > F	**0.000**			

The results in Table 6 indicate that digital transformation, ESG disclosure, and corporate governance all have significant negative effects on operational risk, supporting hypotheses H-4, H-5, and H-6. The negative coefficients suggest that firms with higher levels of digital capability, better ESG disclosure, and stronger governance structures tend to experience lower earnings volatility and more stable operational performance. This finding is consistent with the theoretical argument that improved information systems, enhanced transparency, and effective monitoring reduce operational inefficiencies and uncertainty. Among the control variables, leverage shows a positive, significant relationship with operational risk, indicating that higher debt levels are associated with greater instability, whereas profitability significantly reduces operational risk.

Table 7

Dependent Variable – Financing Constraints (FC)

Variable	Coefficient	Std. Error	t-statistic	p-value
DT	-0.284	0.092	-3.09	0.002
ESG	-0.337	0.105	-3.21	0.001
CG	-0.251	0.098	-2.56	0.011
SIZE	-0.421	0.067	-6.28	0.000
LEV	0.518	0.143	3.62	0.000
ROA	-0.693	0.184	-3.77	0.000
GROWTH	-0.074	0.051	-1.45	0.147
Constant	5.214	1.327	3.93	0.000
R^2 (within)	**0.421**			
Prob > F	**0.000**			

Similarly, Table 7 shows that digital transformation, ESG disclosure, and corporate governance significantly reduce financing constraints, supporting hypotheses H-7, H-8, and H-9. The negative coefficients imply that firms with stronger digital infrastructure, higher transparency, and better governance are more likely to access external financing under favorable conditions. This result aligns with financial constraint theory which emphasizes the importance of information quality and credibility in reducing financing frictions. Firm size has a strong negative effect on financing constraints, indicating that larger firms face fewer financial barriers, while leverage increases financing constraints, reflecting higher perceived risk by creditors. Overall, the results confirm that both operational risk and financing constraints are significantly influenced by independent variables, thereby establishing the necessary conditions for mediation analysis.

Full Mediation Model Results

This section presents the full mediation model by incorporating operational risk and financing constraints into the financial distress equation. The purpose of this model is to assess whether the two mediating variables significantly explain corporate financial distress, after controlling digital transformation, ESG disclosure, corporate governance, and firm level characteristics. By comparing these results with the direct effects model, it becomes possible to evaluate whether the inclusion of the mediators reduces the direct effects of the independent variables, thereby indicating mediation.

Table 8

Full Mediation Model

Variable	Coefficient	Std. Error	t-statistic	p-value
DT (Digital Transformation)	0.411	0.287	1.43	0.154
ESG (ESG Disclosure)	-0.684	0.356	-1.92	0.055
CG (Corporate Governance)	-0.503	0.331	-1.52	0.129
OR (Operational Risk)	-3.126	0.842	-3.71	0.000
FC (Financing Constraints)	-0.587	0.168	-3.49	0.001
SIZE	0.086	0.061	1.41	0.160
LEV	-1.207	0.472	-2.56	0.011
ROA	3.462	0.695	4.98	0.000
GROWTH	0.194	0.171	1.13	0.258

Constant	-1.945	1.136	-1.71	0.088
R^2 (within)	**0.503**			
F-statistic	**22.94**			
Prob > F	**0.000**			

The full mediation results show that both operational risk and financing constraints significantly affect corporate financial distress. In this study, corporate financial distress is operationalized using the Altman Z-score as an inverse proxy. The Altman Z-score combines several accounting ratios related to liquidity, profitability, leverage, solvency, and operating efficiency. A higher z-score indicates stronger financial health, whereas a lower z-score indicates greater financial vulnerability and a higher likelihood of financial distress. Therefore, because the dependent variable in the regression is the Altman Z-score, a negative coefficient should be interpreted as a deterioration in financial health or an increase in financial distress. Based on this operationalization, the negative and significant coefficients for operational risk and financing constraints indicate that firms with higher earnings volatility and greater financing barriers tend to have lower z-scores, implying greater financial distress. These findings support hypotheses H-10 and H-11 and confirm that both mediators are important determinants of firm financial vulnerability.

A comparison between the direct effects model and the full mediation model reveals a substantial reduction in the coefficients of digital transformation, ESG disclosure, and corporate governance after the mediators are included. Digital transformation, which was previously significant in the baseline model, becomes insignificant in the full model. Corporate governance also becomes insignificant, while ESG disclosure weakens and remains only marginally significant. This pattern suggests that the effects of the independent variables on financial distress are transmitted largely through operational risk and financing constraints. In other words, these results provide preliminary evidence of mediation, indicating that firm level strategic and governance factors influence financial stability not only directly, but also indirectly through internal risk conditions and financial accessibility. The increase in explanatory power from the direct model to the full

mediation model further supports the relevance of the proposed dual channel framework.

Bootstrap Mediation Analysis

To formally test the indirect effects proposed in hypotheses H-12a to H-13c, this study applies to a bias corrected bootstrap procedure with 5,000 resamples. The bootstrap approach is used because the sampling distribution of indirect effects is often non-normal, making conventional significance tests less reliable. Mediation is confirmed when the bootstrap confidence interval for the indirect effect does not include zero. This procedure allows a more rigorous assessment of whether operational risk and financing constraints transmit the effects of digital transformation, ESG disclosure, and corporate governance on corporate financial distress.

The results reported in Table 8 indicate that both operational risk and financing constraints serve as significant mediating mechanisms in several relationships. In general, the indirect effects through operational risk are stronger for digital transformation and ESG disclosure, while the financing constraints channel is particularly important for ESG disclosure and corporate governance. These findings reinforce the argument that financial distress is shaped not only by direct firm characteristics, but also by internal transmission processes involving operational stability and access to finance.

Table 9

Bootstrap Indirect Effects (5,000 Resamples)

Indirect Path	Indirect Effect	Boot SE	95% CI Lower	95% CI Upper	Result
DT → OR → FD	0.166	0.061	0.058	0.297	Significant
ESG → OR → FD	0.191	0.069	0.072	0.336	Significant
CG → OR → FD	0.147	0.058	0.041	0.271	Significant
DT → FC → FD	0.167	0.074	0.036	0.321	Significant
ESG → FC → FD	0.198	0.081	0.054	0.369	Significant
CG → FC → FD	0.147	0.066	0.029	0.289	Significant

The bootstrap results confirm that operational risk significantly mediates the relationship between digital transformation and financial distress, between ESG disclosure and financial distress, and between corporate governance and financial distress. Since all confidence intervals for these three indirect paths exclude zero, hypotheses H-12a, H-12b, and H-12c are supported. These findings indicate that digital capability, sustainability disclosure, and governance quality improve firm financial stability partly by reducing earnings volatility and operational instability. This result is important because it shows that operational risk is not merely a consequence of firm practices, but a central channel through which strategic and governance factors shape financial outcomes.

Similarly, the results show that financing constraints significantly mediate the effects of digital transformation, ESG disclosure, and corporate governance on financial distress. The indirect effects for DT → FC → FD, ESG → FC → FD, and CG → FC → FD are all significant, with confidence intervals that do not cross zero. Thus, hypotheses H-13a, H-13b, and H-13c are also supported. These findings suggest that firms with better digital systems, stronger ESG disclosure, and more effective governance face fewer external financing frictions, which in turn improves their financial condition. Taken together, the bootstrap analysis provides strong empirical support for the proposed dual-channel framework and confirms that operational risk and financing constraints are key mechanisms through which firm level characteristics influence corporate financial distress.

In terms of mediation type, the results indicate a pattern of full mediation for digital transformation and corporate governance as their direct effects become statistically insignificant in the full model while the indirect effects remain significant. For ESG disclosure, the evidence suggests partial mediation, since its direct effect weakens substantially and becomes only marginally significant after the mediators are introduced. This pattern implies that ESG disclosure influences financial distress both directly and indirectly, whereas the effects of digital transformation and corporate governance are transmitted primarily through the two mediating channels. Overall, the bootstrap findings represent the strongest

empirical support for the study's main contribution, namely that corporate financial distress can be more effectively explained through a dual mechanism of operational risk and financing constraints.

Robustness Checks

To ensure the reliability and validity of the empirical results, this study conducts several robustness checks, including the use of alternative measures of financial distress, lagged independent variables, and additional diagnostic adjustments. These tests are intended to verify that the main findings remain consistent across different model specifications and to address potential concerns about measurement and endogeneity.

As a robustness test, the dependent variable is re-estimated using an alternative proxy for financial distress, namely the interest coverage ratio. This measure captures a firm's ability to meet its interest obligations and provides an alternative perspective on financial vulnerability. Lower interest coverage ratios indicate greater financial distress, consistent with the interpretation of the Altman Z-Score used in the main analysis.

Table 10

Robustness Test Using Alternative Dependent Variable

Variable	Coefficient	Std. Error	t-statistic	p-value
DT	-0.318	0.142	-2.24	0.026
ESG	0.521	0.178	2.93	0.004
CG	0.447	0.165	2.71	0.007
OR	-1.874	0.563	-3.33	0.001
FC	-0.391	0.129	-3.03	0.003
Controls	Included			
R^2 (within)	**0.476**			

The results using the alternative measure are consistent with the main findings. Operational risk and financing constraints remain significant determinants of financial distress, while ESG disclosure and corporate governance continue to improve financial conditions. The negative coefficient of digital transformation suggests that higher digital capability improves the firm's ability to meet its financial obligations as measured by interest coverage. These consistent

findings reinforce the robustness of the main results and confirm that the conclusions are not sensitive to the choice of financial distress proxy.

To address potential reverse causality, this study re-estimates the model using one period lagged independent variables. This approach ensures that the explanatory variables precede the dependent variable in time, thereby strengthening causal interpretation.

Table 11

Robustness Test Using Lagged Variables

Variable	Coefficient	Std. Error	t-statistic	p-value
DT (t-1)	0.374	0.198	1.89	0.059
ESG (t-1)	-0.812	0.401	-2.02	0.044
CG (t-1)	-0.593	0.342	-1.73	0.084
OR	-3.042	0.871	-3.49	0.001
FC	-0.562	0.173	-3.25	0.001
Controls	Included			
R^2 (within)	**0.489**			

The lagged model produces results that are largely consistent with the main findings. ESG disclosure remains significantly associated with improved financial conditions, while corporate governance retains a negative relationship with financial distress, although at a slightly reduced level of significance. Digital transformation continues to show a positive coefficient, suggesting that the transitional effects of digital adoption may persist over time. Importantly, both operational risk and financing constraints remain strongly significant, further supporting their role as key mediating mechanisms. These results suggest that the observed relationships are not driven by reverse causality.

Additional diagnostic tests are conducted to ensure the validity of the regression results. Heteroskedasticity is addressed using robust standard errors, while autocorrelation is tested using panel specific procedures. The results remain stable after these adjustments, indicating that the estimated coefficients are not biased by violations of classical regression assumptions. Furthermore, the consistency of results across different specifications confirms the model of stability.

Overall, the robust tests confirm that the main findings of this study are stable and reliable. The relationships between digital transformation, ESG disclosure, corporate governance, and financial distress remain consistent across alternative model specifications. In particular, the mediating roles of operational risk and financing constraints are robust to different measurements and estimation approaches. These results strengthen the validity of the proposed dual channel framework and provide additional confidence in the empirical conclusions.

DISCUSSION

The findings of this study provide evidence that both direct firm-level characteristics and indirect transmission mechanisms shape corporate financial distress. Specifically, digital transformation, ESG disclosure, and corporate governance influence financial distress not only through their immediate association with firm financial condition, but also through their effects on operational risk and financing constraints. This finding confirms the importance of examining financial distress as a process-based outcome, rather than as a condition explained solely by conventional financial ratios or direct firm attributes.

The direct effect analysis shows that ESG disclosure and corporate governance significantly reduce corporate financial distress. Since financial distress is operationalized through the Altman Z-score, these negative effects should be interpreted carefully in relation to the direction of the measure. Higher ESG disclosure and stronger corporate governance are associated with better financial stability and lower distress risk. This result suggests that transparent sustainability reporting and effective governance mechanisms provide immediate benefits for a firm's financial condition. ESG disclosure improves the information environment surrounding the firm by reducing uncertainty among investors, creditors, and other stakeholders. This helps strengthen market confidence and reduce the perceived risk attached to the firm (Malik & Kashiramka, 2025; Nguyen & Dang, 2023). Corporate governance also has a direct stabilizing effect because stronger board monitoring, audit oversight, and ownership control reduce agency problems and improve the credibility of financial reporting (Gerged et al.,

2022; Hunjra et al., 2025). These findings indicate that disclosure quality and governance quality are not merely symbolic practices, but substantive mechanisms directly associated with lower financial vulnerability.

In contrast, the direct effect of digital transformation is positive and significant in the baseline model, suggesting that digital transformation may initially increase financial pressure. This result does not necessarily mean that digital transformation is harmful. Rather, it indicates that the early stage of digital adoption may involve implementation costs, technology investment, organizational restructuring, employee adjustment, and temporary operational complexity. These transitional pressures may weaken short term financial stability, especially among firms with limited digital readiness or constrained financial resources. This finding is consistent with the view that digital transformation does not always produce immediate financial benefits because its performance effects depend on the firm's ability to integrate digital technologies into operational routines and strategic decision-making (Duong & Nguyen, 2025; Wei & Shen, 2025).

The mediation results provide a deeper explanation of this direct effect pattern. After operational risk and financing constraints are included in the model, the direct effects of digital transformation and corporate governance become statistically insignificant. In contrast, the effect of ESG disclosure becomes weaker and only marginally significant. This indicates that the influence of the three main predictors on financial distress is transmitted substantially through the two mediating variables. In other words, digital transformation, ESG disclosure, and corporate governance do not affect financial distress only because they are desirable firm characteristics. They affect financial distress because they change the internal risk condition of the firm and improve the firm's ability to access financing. This finding supports the central argument of this study that operational risk and financing constraints are essential mechanisms for explaining how strategic and governance factors translate into financial stability.

Operational risk represents the first mediating mechanism. The results show that digital transformation, ESG disclosure, and corporate governance

significantly reduce operational risk, and lower operational risk is associated with stronger financial stability. This means that firms with better digital systems, broader ESG disclosure, and stronger governance structures are more likely to experience stable earnings and lower operational volatility. Digital transformation reduces operational risk by improving information processing, process integration, monitoring systems, and decision accuracy. ESG disclosure reduces operational risk by encouraging firms to adopt more disciplined sustainability practices, stakeholder management, and risk monitoring. Corporate governance reduces operational risk by strengthening internal controls, managerial oversight, and accountability. These findings demonstrate that operational risk is not only an outcome of firm activities, but also a transmission channel through which firm characteristics influence financial distress.

The importance of operational risk is particularly evident in explaining the indirect effect of digital transformation. Although digital transformation has a positive direct relationship with financial distress in the baseline model, it also reduces distress indirectly by lowering operational risk. This indicates a dual effect. On the one hand, digital transformation can create short term pressure through investment and adaptation costs. On the other hand, once digital systems improve operational control and information quality, they help stabilize firm performance. Therefore, operational risk explains why digital transformation may appear financially burdensome in the short term but beneficial for financial resilience through improved operating stability.

Financing constraints represent the second mediating mechanism. The findings show that digital transformation, ESG disclosure, and corporate governance significantly reduce financing constraints, and lower financing constraints are associated with stronger financial stability. This result confirms that access to external capital is a crucial pathway through which firm quality affects financial distress. Digital transformation can reduce financing constraints by improving the quality and timeliness of accounting information. ESG disclosure can reduce financing constraints by signaling transparency, sustainability commitment, and lower stakeholder risk. Corporate governance can

reduce financing constraints by strengthening investor protection and the credibility of financial reporting. These mechanisms reduce information asymmetry and perceived risk, making it easier for firms to obtain external financing under more favorable conditions.

The financing constraints channel is especially important in the Indonesian emerging market context. Firms operating in markets with higher information asymmetry, uneven disclosure quality, and varying governance standards may face greater difficulty in obtaining external capital. In such conditions, ESG disclosure and corporate governance become important signals of credibility to investors and creditors. Digital transformation also contributes to this process by improving information systems and reducing informational opacity. Therefore, the mediation results suggest that firms can reduce financial distress not only by improving internal efficiency, but also by strengthening their external financial credibility.

Taken together, the two mediation channels explain why operational risk and financing constraints are central to this study. The direct effects show whether digital transformation, ESG disclosure, and corporate governance are associated with financial distress. However, the mediation effects explain how these relationships occur. The risk channel shows that the three predictors influence financial distress by stabilizing operational performance. The financing channel shows that the same predictors influence financial distress by improving access to external capital. Therefore, the contribution of this study lies not only in identifying predictors of financial distress, but also in demonstrating that their effects operate through two distinct but complementary mechanisms.

These findings also clarify the relative role of each predictor. ESG disclosure appears to influence financial distress both directly and indirectly, suggesting that sustainability transparency has an immediate credibility effect as well as an indirect effect through lower operational risk and financing constraints. Corporate governance appears to operate mainly through the mediating channels, indicating that its contribution to financial stability is realized through better monitoring, lower operational instability, and improved financing access. Digital

transformation also operates mainly through the mediating channels although its direct effect reflects short term implementation pressure. This pattern strengthens the argument that mediation variables are not peripheral in the model. Instead, they are necessary to understand the true nature of the relationship between the three predictors and financial distress.

From a theoretical perspective, the findings extend agency theory, information asymmetry theory, and financial constraint theory by showing that governance, disclosure, and digital capability influence financial distress through internal and external mechanisms. Agency theory explains why corporate governance reduces managerial opportunism and operational instability. Information asymmetry theory explains why ESG disclosure and digital transformation improve information quality and reduce uncertainty. Financial constraint theory explains why firms with greater transparency and credibility face fewer financing barriers. By integrating these perspectives, this study provides a more complete explanation of financial distress as an outcome of both internal operational stability and external financing accessibility.

From a practical perspective, the results suggest that managers should not treat digital transformation, ESG disclosure, and corporate governance as separate initiatives. These initiatives should be designed to reduce operational volatility and improve access to financing. For digital transformation, firms need to ensure that technology investment is supported by process redesign, employee capability development, and internal control improvement. For ESG disclosure, firms should move beyond formal reporting compliance and strengthen the credibility, consistency, and usefulness of sustainability information. For corporate governance, firms should improve board effectiveness, audit committee quality, and monitoring systems to ensure that governance mechanisms directly contribute to operational discipline and financial credibility.

For policymakers and regulators, the findings imply that strengthening ESG reporting standards, corporate governance enforcement, and digital reporting infrastructure can contribute to financial system stability. In emerging markets such as Indonesia, reducing information asymmetry and financing frictions is

particularly important because firms may be more vulnerable to external shocks and limited capital access. Policies that improve disclosure quality, governance transparency, and digital readiness may therefore reduce systemic financial distress risk among listed firms.

Overall, this study contributes to the literature by demonstrating that corporate financial distress is best understood through a dual-channel mechanism. Digital transformation, ESG disclosure, and corporate governance are important predictors of financial distress, but their effects become clearer when operational risk and financing constraints are incorporated as mediating variables. The findings highlight that the question is not only whether these predictors affect financial distress, but also how they influence firm financial vulnerability. This deeper explanation confirms the importance of operational risk and financing constraints as central elements of the proposed research model.

5. CONCULUSION

This study investigates the roles of digital transformation, ESG disclosure, and corporate governance in explaining corporate financial distress, with particular emphasis on the mediating mechanisms of operational risk and financing constraints. Using panel data from non-financial firms listed on the Indonesia Stock Exchange, the findings demonstrate that financial distress is not solely determined by direct firm characteristics but is largely shaped by internal transmission processes.

The results show that ESG disclosure and corporate governance significantly improve financial stability, while digital transformation exhibits a more complex effect, reflecting transitional pressures in the short term. More importantly, the mediation analysis reveals that both operational risk and financing constraints serve as critical channels through which these variables influence financial distress. Operational risk captures the stability of firm performance, whereas financing constraints reflect access to external capital, both of which are essential determinants of financial resilience.

This study contributes to the literature by developing a dual-channel framework that integrates insights from agency theory, information asymmetry, and financial constraint theory. The findings highlight the importance of improving disclosure quality, governance practices, and digital capabilities to enhance firm stability. For policymakers, the results underscore the need to strengthen ESG reporting standards and governance frameworks to reduce systemic financial risk. Overall, this study provides a more comprehensive understanding of corporate financial distress by emphasizing the mechanisms through which firm level factors affect financial outcomes.

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