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## Risk Management, Green Finance, CSR, and Digital Transformation Effects on Financial Sustainability in KBMI Banks

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### ABSTRACT

**Objectives:** This study investigates whether risk management, green finance, corporate social responsibility, and digital transformation explain financial sustainability among Indonesian commercial banks in core-capital bank groups 3–4 (KBMI 3–4).

**Methodology:** Using a balanced panel of 13 listed banks over 2022–2024 (39 bank-year observations), we estimate a panel regression under a random-effects specification selected via Chow, Hausman, and Lagrange Multiplier tests. Financial sustainability is proxied by the net interest margin ratio, while the explanatory variables are proxied by the non-performing loan ratio, green investment ratio, corporate social responsibility expenditure ratio, and a digital transformation index.

**Finding:** The findings demonstrate that green finance significantly enhances financial sustainability among KBMI 3 and 4 banks during 2022–2024. Meanwhile, risk management, corporate social responsibility, and digital transformation do not exhibit significant short-term effects on net interest margins. Therefore, banks should prioritize credible green financing portfolios while maintaining strict credit quality, and investors must evaluate sustainability signals beyond short-term margin impacts.

**Conclusion:** Research on SMEs in Indonesia increasingly emphasizes external shocks and digital transformation strategies. The evidence suggests that digital technology adoption combined with innovation, supported by training and enabling policies is essential to strengthen SMEs' competitiveness and long-term sustainability in Indonesia.

**Keywords:** Financial Sustainability; Risk Management; Green Finance; Corporate Social Responsibility; Digital Transformation.

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### INTRODUCTION

Indonesia's banking sector has remained relatively resilient amid global–domestic uncertainty, supported by positive intermediation performance, solid credit expansion, and strong capitalization (e.g., a high capital adequacy ratio) (BPS, 2025). Within this system,

core-capital bank groups 3–4 (KBMI 3–4) dominate assets, lending, and third-party funds, making them a key pillar of banking stability and economic activity (OJK, 2025).

During 2022–2024, KBMI 3–4 banks operated under a more demanding landscape: higher interest rates increased funding costs and potential credit risk, while regulators intensified sustainable-finance implementation (e.g., the sustainable finance regulation and green taxonomy), effectively requiring banks to reorient portfolios toward greener sectors. As systemically important banks, they are also subject to tighter supervision and higher expectations for integrated risk management and sustainability practices (Subrini et al., 2024).

In the banking context, financial sustainability is closely linked to a bank's ability to generate stable net interest income from productive assets over time (Amoa-Gyarteng et al., 2025). The net interest margin ratio is widely used to reflect intermediation efficiency how effectively a bank manages earning assets and transforms collected funds into consistent interest margins while also signaling funding cost discipline. Financial statement analysis provides a structured approach to evaluate performance, risk, and efficiency through key ratios and trend assessments (Sihombing, 2025c).

Prior findings are not always consistent across different performance proxies and sectors; for instance, some studies find profitability and liquidity to be insignificant for firm value while capital structure remains significant, and external conditions may further shape these relationships (Sihombing et al., 2023). Recent patterns suggest that margin indicators may appear stable, yet large banks can still experience profit compression, implying that margin-based signals do not always translate into broader profit resilience. This concern is reinforced by the credit-growth slowdown, which can pressure future interest income and increase earnings uncertainty, especially when margin volatility rises.

Conceptually, financial sustainability is no longer explained by interest margins alone; it is also associated with the effectiveness of risk management, sustainable financing orientation, corporate social responsibility commitment, and the strategic execution of digital transformation. However, prior empirical evidence is not fully consistent for example, some studies report a positive association of corporate social responsibility with sustainability outcomes, while others find non-significant direct effects; similarly, digital transformation is often linked to stronger intermediation functions, but results vary across contexts and models. Broader evidence in the Indonesian capital market also shows mixed effects of financial ratios on performance-related outcomes, indicating that the direction and significance of financial indicators may vary across contexts and dependent variables (Sihombing & Zakchona, 2024).

In addition, evidence that is specific to Indonesian listed KBMI 3–4 banks particularly for the recent post pandemic and tightening cycle period (2022–2024) remains limited, even though this segment is expected to have more mature capacity and stronger sustainability initiatives than smaller capital banks.

This study is guided by four research questions: whether risk management influences financial sustainability in Indonesian KBMI 3–4 banks; whether green finance influences financial sustainability; whether corporate social responsibility influences financial sustainability; and whether digital transformation influences financial sustainability within the same bank group context.

Accordingly, the objective of this study is to empirically test the direct effects of risk management, green finance, corporate social responsibility, and digital transformation on the

financial sustainability of Indonesian KBMI 3–4 banks, emphasizing the role of these strategic factors in explaining sustainability beyond margin stability.

## LITERATURE REVIEW

### Resource-Based View

The Resource-Based View explains that a firm can achieve sustainable competitive advantage when it possesses resources and capabilities that are valuable, rare, difficult to imitate, and non-substitutable (VRIN), meaning performance differences are largely rooted in unique internal strengths rather than external positioning (Bhandari et al., 2022). In banking, this perspective is highly relevant because core capabilities such as an integrated risk management system covering credit, market, liquidity, and operational risk function as strategic assets that strengthen resilience during shocks and improve the bank's ability to maintain stable, long-term performance; likewise, digital transformation can be viewed as a capability that enhances efficiency and adaptability, supporting financial sustainability through more robust operations and decision-making quality (Gazi et al., 2024).

### Legitimacy Theory

Legitimacy Theory posits that organizations must align their actions with prevailing social norms, values, and expectations to secure continued acceptance from stakeholders, because legitimacy reflects the generalized perception that an entity's activities are desirable, proper, and appropriate within a socially constructed system (Martens et al., 2023). In the banking context, sustainability-oriented initiatives, such as green finance and CSR can be interpreted as legitimacy-seeking strategies that strengthen trust from regulators, investors, and the public by demonstrating responsibility and compliance with broader societal expectations; this alignment may reduce reputational risk and support long-term stability, which is closely connected to the concept of financial sustainability (Asyura et al., 2023). Investment decision-making can be strengthened by integrating fundamental analysis, technical analysis, and technology-based tools as complementary sources of information (Sihombing, 2025a).

### Signalling Theory

Signaling Theory describes how firms mitigate information asymmetry between insiders and external parties by conveying credible signals through disclosures or strategic actions that reflect quality, commitment, and future prospects, particularly when outsiders cannot fully observe true performance or risk conditions (Bimantara et al., 2025). Behavioral finance explains that decision-making may deviate from full rationality due to biases, heuristics, and contextual influences (Sihombing, 2025b). For banks, practices such as strong risk management, green finance programs, CSR engagement, and digital transformation can operate as observable signals of prudence, long-term orientation, and institutional capability, thereby influencing stakeholder confidence and potentially reinforcing financial sustainability; even though this journal model does not include Good Corporate Governance as a mediating variable, these strategic actions can still be framed as signals that shape market perceptions of the bank's sustainability trajectory (Farkhana et al., 2025). Findings from LQ45 companies show that dividend policy is positively associated with profitability and good governance, and negatively associated with leverage and free cash flow; moreover, good corporate governance acts as a moderator, strengthening the effect of free cash flow while weakening the effects of profitability and leverage on dividend policy (Kunawangsih & Sihombing, 2025).

**Financial Sustainability**

In banking, financial sustainability refers to an institution's capacity to maintain consistent long-term financial performance while remaining resilient to external shocks (e.g., economic crises), regulatory changes, and broader sustainability pressures. Beyond short-term profitability, it reflects a combination of stable growth, survivability, controlled income-risk exposure, and an attractive risk profile so that a bank can generate superior returns with lower volatility over time (Gleißner et al., 2022). In the banking context, financial sustainability can be viewed as the ability to maintain stable intermediation performance and profitability over time while managing risks. In this study, financial sustainability is operationalized using the Net Interest Margin Ratio (NIMR), which captures the bank's capacity to generate net interest income relative to earning assets and reflects the efficiency and resilience of core intermediation activities (Sihombing et al., 2025). Recent literature also positions financial sustainability within frameworks that emphasize embedding sustainability practices into financial strategy to strengthen long-run competitiveness (Tamara et al., 2024). In the banking context, the Net Interest Margin Ratio (NIMR) is commonly used as a core indicator because it captures intermediation efficiency and the ability to sustain net interest income from productive assets over time (Amoa-Gyarteng et al., 2025).

**Risk Management**

Risk management is a systematic process of identifying, evaluating, monitoring, and controlling risks that may hinder an organization from achieving its objectives. In banking, it is fundamental because intermediation activities inherently expose banks to multiple risks especially credit risk, which can directly erode earnings stability and capital strength. Contemporary evidence suggests that a comprehensive risk management framework improves financial performance and reduces potential losses, thereby supporting long-term sustainability (Iqbal et al., 2024). Empirically, credit-risk quality is often captured through the Non-Performing Loan Ratio (NPLR), lower NPLR indicates stronger risk control, greater efficiency, and more stable interest margins, features that align closely with sustained financial resilience (Amoa-Gyarteng et al., 2025). Core corporate finance principles emphasize the trade-off between risk and return and the role of financial policies in sustaining long-term performance (Sihombing, 2023).

**Green Finance**

Green finance represents financial instruments and policies designed to support sustainable development and a transition to a low-carbon economy. It is not limited to instruments such as green bonds, but also includes lending, investment allocation, and capital-market mechanisms that incentivize environmentally responsible activities (Jing et al., 2024). In banking, green finance reflects how far a bank integrates environmental (and related social–governance) considerations into its financing and investment decisions. Theoretically, this aligns with stakeholder-oriented responsibility beyond shareholders (Espino & Mutuc, 2024) and is also shaped by institutional pressures from international norms and sustainability agendas that encourage banks to adopt green practices. A widely used operational proxy is the Green Investment Ratio (GIR) the proportion of a bank's environmentally oriented investment/financing relative to total investment assets because it offers a measurable way to compare commitment across banks and time.

### **Corporate Social Responsibility**

Corporate Social Responsibility (CSR) is the firm's responsibility to balance economic objectives with social and environmental concerns; in banking, CSR is frequently associated with reputation strengthening, legitimacy, and longer-run sustainability orientation. Prior studies argue that well-managed CSR can reinforce a positive corporate image and may contribute to improved financial performance. CSR is also commonly framed under the triple bottom line, where success is assessed not only by profit, but also by contributions to people and planet. Empirical evidence indicates that CSR can function as a risk-reducing mechanism in capital structure settings; CSR moderates the relationship between leverage (DER) and firm value, suggesting that stronger CSR engagement may dampen investors' concerns about financial risk (Asmaranti & Sihombing, 2025).

### **Digital Transformation**

Digital transformation is the integration of digital technology into the full scope of organizational operations; in banking, it aims to improve efficiency, service innovation, and competitive positioning. Importantly, digital transformation is not only about deploying technology, but also about redesigning business models and developing new organizational capabilities and culture that enable adaptation under changing environments and stakeholder expectations. Empirically, digitalization is often captured using structured indices; one approach adopts a Cisco Consulting-based framework that evaluates a bank's digital maturity across staged capabilities (from basic e-banking to advanced system-wide integration using big data/AI and cloud computing), operationalized via a multi-indicator digital banking index (Akbar et al., 2025).

### **Hypotheses Development**

An increase in NPLR reflects higher credit risk, which can lead banks to reprice loans and incorporate higher risk premiums into lending rates; if this pass-through is effective, the interest spread may widen and support a higher NIMR as a proxy of financial sustainability. Thus, the following hypothesis is proposed: H1: Risk management (NPLR) has a positive effect on financial sustainability (NIMR).

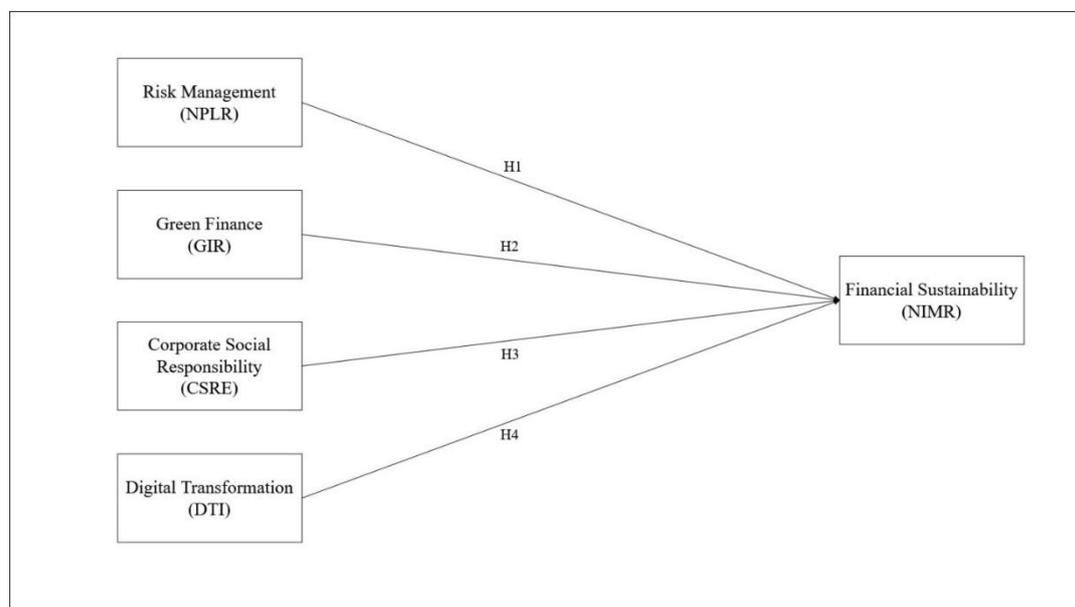
Green finance, proxied by the green investment ratio (GIR), may strengthen long-term financial sustainability by aligning bank financing with sustainability-oriented demand and regulatory direction, improving stakeholder confidence, and reducing longer-horizon environmental and transition risks that can disrupt performance. Thus, the following hypothesis is proposed: H2: Green finance (GIR) has a positive effect on financial sustainability (NIMR).

Higher CSR expenditures can enhance stakeholder trust and reputation critical in banking, thereby reducing non-financial risk and supporting more stable intermediation outcomes, which may improve NIMR over time. Thus, the following hypothesis is proposed: H3: CSR (CSR expenditures) has a positive effect on financial sustainability (NIMR).

Digital transformation can improve efficiency, service reach, and data-driven risk processes; these enhancements may strengthen intermediation performance and support a more stable NIMR as a measure of financial sustainability. Thus, the following hypothesis is proposed: H4: Digital transformation has a positive effect on financial sustainability (NIMR).

## Conceptual Framework

Figure 1. Conceptual Framework



## METHOD

This study adopts a quantitative, explanatory design and employs panel-data analysis to examine whether risk management, green finance, corporate social responsibility, and digital transformation explain financial sustainability among Indonesian listed banks. The study focuses on banks classified under KBMI 3–4 (core-capital bank groups) as defined in the Indonesian banking classification framework (POJK No. 12/POJK.03/2021).

The population comprises commercial banks in KBMI 3 and KBMI 4 that are listed on the Indonesia Stock Exchange (IDX/BEI) during the observation window, yielding an initial population of 14 banks. To ensure comparability and data completeness, the study applies a purposive sampling approach with clear inclusion and exclusion criteria namely, banks must be IDX-listed and belong to KBMI 3–4, while banks that do not consistently publish a Sustainability Report and banks undergoing merger/acquisition during the study period are excluded.

Based on these criteria, the final sample consists of 13 KBMI 3–4 listed banks. The research period covers 2022–2024 (three consecutive years), producing a balanced panel of 39 bank-year observations (13 banks × 3 years).

Table 1. Variables Operationalization Table

Variable	Indicator/Proxy	Scale	Data Source
Financial Sustainability	$\text{NIMR} = \frac{\text{Interest Income} - \text{Interest Expense}}{\text{Average Earning Assets}} \times 100\%$	Ratio	Financial Reports
Risk management	$\text{NPLR} = \frac{\text{Non Performing Loan}}{\text{Total Loans}} \times 100\%$	Ratio	Financial Reports
Green Finance	$\text{GIR} = \frac{\text{Green Financing}}{\text{Total Financing}} \times 100\%$	Ratio	Sustainability Reports

Variable	Indicator/Proxy	Scale	Data Source
Corporate Social Responsibility	CSRE = $\frac{\text{Total CSR Expenditures}}{\text{Total Assets}} \times 100\%$	Ratio	Sustainability Reports
Digital Transformation	DTI = digital banking index score based on a checklist from bank publications.	Quantitative Index	Annual Reports

Source: Processed by author (2026)

## RESULTS AND DISCUSSION

### Descriptives Statistics

Table 2. Descriptive Statistics Analysis Table

	NIMR	NPLR	GIR	CSRE	DTI
Mean	0.0776	0.0238	0.2281	0.0842	19.8205
Median	0.0785	0.0242	0.2286	0.0798	21.0000
Maximum	0.0850	0.0277	0.2935	0.1334	21.0000
Minimum	0.0684	0.0202	0.1601	0.0428	13.0000
Std. Dev.	0.0042	0.0022	0.0355	0.0217	2.0631
Observations	39	39	39	39	39

Source: Processed data with Eviews 13

The descriptive statistics are based on a balanced panel of 39 observations (13 banks × 3 years). Overall, the dependent variable Financial Sustainability (FS) (proxied by NIM ratio) shows a relatively stable profile, with a mean of 0.07769 and a narrow range between 0.06840 and 0.08500, indicating that the sample banks maintain fairly consistent interest margin performance over the study period. The dispersion is also low (Std. Dev. 0.004297), suggesting limited volatility in FS across banks and years.

For the explanatory variables, Risk Management (RM) (proxied by NPL ratio) has a mean of 0.023841 with values ranging from 0.020200 to 0.027700, implying that credit risk levels are generally moderate and do not fluctuate widely within the sample (Std. Dev. 0.002269). Green Finance (GIR) records a mean of 0.228136 (min 0.160100, max 0.293500) with a higher dispersion (Std. Dev. 0.035540), indicating more variation in the intensity/implementation of green-finance-related activities across banks. CSR (CSRE) has a mean of 0.084279 and ranges from 0.042800 to 0.133400, showing moderate variability (Std. Dev. 0.021796) across observations. Meanwhile, the Digital Transformation variable (DTI, index-based) has a mean of 19.82051 with a range from 13.00000 to 21.00000 (Std. Dev. 2.063107), suggesting that while many banks are clustered near the upper end, there remains a noticeable gap between less digitally advanced and more digitally mature banks.

### Panel Data Model Selection

Table 3. Panel Data Model Selection Table

Model Selection Test	Coefficient	Test Results	Explanation
Chow Test	7.0927	0.0000 > 0.05	Fixed Effect Model (FEM)
Hausman Test	1.5924	0.8101 < 0.05	Random Effect Model (REM)
Lagrange Multiplier Test	16.6776	0.0000 > 0.05	Random Effect Model (REM)

Source: Processed data with Eviews 13

To determine the most appropriate estimator for the balanced panel (13 banks, 2022–2024), the study applies three standard panel-model selection procedures: the Chow test (CEM vs FEM), the Hausman test (FEM vs REM), and the Lagrange Multiplier (LM) test (CEM vs REM).

The Chow (Redundant Fixed Effects) results show a cross-section F-statistic of 7.092793 with Prob. = 0.0000, indicating that the pooled/common model is rejected and that cross-sectional effects are present, so the model should proceed from CEM to an effects model.

Next, the Hausman test compares FEM and REM. The output reports a Chi-square statistic of 1.592477 with Prob. = 0.8101, implying that the difference in coefficients is not systematic; therefore, Random Effect Model (REM) is preferred because the individual (bank) effects are treated as uncorrelated with the regressors.

This conclusion is reinforced by the LM (Breusch–Pagan) test, where the cross-section effect is significant ( $p = 0.0001$ ) and the joint “Both” statistic is also significant ( $p = 0.0000$ ), supporting the presence of random effects and indicating that REM is more appropriate than CEM.

## Results

Table 4. Results

Hypotheses	Independent Variables	Coefficient	P Values	Explanation
H1	Risk Management (NPLR)	0.3809	0.1107	Not Significant
H2	Green Finance (GIR)	0.0706	0.0000	Positive Significant
H3	Corporate Social Responsibility (CSRE)	-0.0030	0.8950	Not Significant
H4	Digital Transformation (DTI)	0.0000	0.9821	Not Significant

Source: Processed data with Eviews 13

## Discussion

Based on the Random Effect Model (Panel EGLS) output in Table 4, the hypothesis testing yields the following empirical decisions. H1, risk management proxied by NPLR shows a positive coefficient ( $\beta = 0.380973$ ), indicating that higher NPLR is associated with higher NIMR. However, this effect is not statistically significant at the 5% level ( $p = 0.1107$ ). Thus, Hypothesis 1 is rejected. Substantively, the direction is consistent with the hypothesis (positive), which can be interpreted through a risk-pricing mechanism (banks may reprice loans and widen spreads when credit risk rises), but the insignificance implies that this pass-through is not consistent/strong enough across KBMI 3–4 banks in 2022–2024 to be concluded as a systematic determinant of financial sustainability in this sample.

The result of H2, the green finance variable (GF) has a positive and statistically significant impact on financial sustainability, with  $\beta = 0.070647$  and  $p = 0.0000$  ( $< 0.05$ ). Thus, Hypothesis 2 is accepted. This result suggests that banks with a higher share of green

financing tend to achieve stronger net interest margin sustainability, potentially because green-oriented portfolios may improve stakeholder confidence, strengthen funding stability, and align with regulatory direction supporting more resilient intermediation performance. In practical terms (since GIR is a ratio), a 1 percentage-point increase in GIR (0.01) corresponds to an increase in NIMR of about 0.000706, or roughly 0.07 percentage points in NIMR if expressed in percent, reinforcing that green finance is the only predictor in this model that consistently explains FS.

H3 (Corporate Social Responsibility), For CSR (CSRE), the model reports a negative coefficient ( $\beta = -0.003081$ ) with a very large p-value ( $p = 0.8950$ ), indicating no statistically significant relationship between CSR spending and NIMR. Thus, Hypothesis 3 is rejected. This finding implies that CSR expenditures at least as measured in this study period and sample, do not translate into improved margin sustainability. A plausible interpretation is that CSR benefits may be more indirect and longer-term (e.g., reputation and legitimacy), while NIMR is a relatively “core intermediation” metric that can be dominated by pricing competition, funding structure, and credit cycle dynamics, making the immediate marginal effect of CSR spending difficult to detect in a short three-year panel.

H4, The digital transformation index (DTI) shows an almost zero coefficient ( $\beta = 5.52E-06$ ) and is not significant ( $p = 0.9821 > 0.05$ ). Thus, Hypothesis 4 is rejected (Not Significant), This indicates that differences in digital maturity across the sampled banks do not explain variations in NIMR during 2022–2024. One interpretation is that digital initiatives may primarily affect cost efficiency and non-interest income channels (fee-based services) rather than the net interest spread directly; additionally, if most KBMI 3–4 banks are already clustered at relatively high digital scores, the limited variation can reduce statistical power to identify an effect on margin sustainability.

## CONCLUSION

Based on the Random Effect Model results for 13 KBMI 3 and 4 listed banks during 2022–2024, green finance (GIR) is the only variable that shows a positive and significant effect on financial sustainability (NIMR). In contrast, risk management (NPLR) is positive but not significant, implying that margin sustainability should be supported by stronger credit screening, monitoring, and recovery efforts rather than relying on repricing alone. CSR expenditure (CSRE) is negative and not significant, suggesting that CSR spending does not directly improve short-term NIMR and should be targeted toward measurable, risk-relevant outcomes. Digital transformation (DTI) is also not significant, indicating that digitalization may influence performance more through efficiency, risk controls, and non-interest income than through interest margins. Overall, the findings suggest that strengthening the quality and credibility of green financing is the most consistent lever for improving margin-based sustainability, while credit-risk discipline and outcome-based CSR and digital KPIs remain essential supporting priorities.

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