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Financial Risk Mitigation Through Sustainability: Evidence from Construction Sector in Southeast Asia

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Abstract

Background: The construction sector is highly exposed to financial risk due to cost overruns, delayed payments, and market volatility. However, limited studies have examined how multidimensional financial risks affect firm value in Southeast Asia, particularly when ESG is positioned as a risk-mitigation mechanism.
Objective: This study examines the effects of bankruptcy risk, fundamental risk, and liquidity risk on firm value while testing the moderating role of ESG in construction firms across Southeast Asia from 2015 to 2024.
Methods: This study employed an explanatory quantitative design using unbalanced panel data, consisting of 1,831 observations for the direct risk model and 240 observations for the ESG moderation model. The data were analyzed using static panel estimation with Driscoll–Kraay standard errors and dynamic System GMM estimation.
Results: Bankruptcy risk, fundamental risk, and liquidity risk significantly affected firm value across different model specifications. ESG significantly moderated the relationship between bankruptcy risk and firm value, indicating that sustainability practices strengthen the market signal of financial stability. However, ESG did not significantly moderate the effects of fundamental risk or liquidity risk on firm value.
Conclusion: ESG practices selectively enhance firm resilience against bankruptcy risk, whereas operational and liquidity risks are assessed more independently by the market. This study contributes cross-country evidence on financial risk, firm value, and sustainability in Southeast Asia's construction sector.

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INTRODUCTION

Every company faces risks whose characteristics and intensity are influenced by the industry type and which directly impact the company's value. The construction sector is one of the industries with relatively higher risk levels compared to other sectors, primarily due to its project-based business model, which is inherently uncertain. These risks include intense competition for projects, potential delays in project completion, and the risk of cost overruns that can pressure the company's financial performance. Despite its high risk, the construction sector plays a strategic role in providing and maintaining infrastructure, making the financial stability of construction companies a crucial factor for sustainable economic development. Globally, the construction industry has experienced significant financial distress.

According to data from Deloitte, approximately 25% of construction firms worldwide faced insolvency risk between 2020 and 2023, while the sector consistently ranks among the top three industries in terms of bankruptcy filings across OECD countries. A report by McKinsey Global Institute noted that large construction projects typically take 20% longer and are up to 80% over budget, contributing to chronic financial instability in the sector. Public infrastructure built by construction companies encompasses physical, technical, institutional, and social facilities that serve as the foundation for economic activity and societal welfare (Torrisi, 2009). Adequate and sustainable infrastructure has been shown to enhance market efficiency, strengthen resource connectivity, promote long-term economic growth, stimulate investment, and create employment opportunities (Kumar et al., 2025; Pascha, 2020; Sarangi & Pradhan, 2020). Therefore, the construction sector, despite being high-risk, is highly relevant to study due to its fundamental role in economic development.

The urgency of studying the construction sector is increasingly high, especially in developing countries that are still undertaking massive infrastructure development, compared to developed countries that already have relatively established infrastructure. Southeast Asia is one of the developing regions with a high intensity of infrastructure development over the past two decades. In addition to significant growth in infrastructure investments, this region also exhibits a high degree of diversity in economic development levels, regulatory frameworks, and institutional governance across countries.

These conditions make the construction sector in Southeast Asia an important subject for analysis, as cross-country diversity allows research to capture structural and institutional variations more comprehensively, thereby enhancing the inferential power and empirical relevance of research findings. Data from the ASEAN Secretariat (2023) indicates that infrastructure investment in the region grew at an average annual rate of 7.2% between 2015 and 2023, with the construction sector contributing approximately 5.8% to the combined GDP of ASEAN member states. Meanwhile, financial data from S&P Capital IQ reveals that construction companies in ASEAN countries exhibited an average debt-to-equity ratio of 1.42 during the same period, significantly higher than the cross-sector average of 0.89, reflecting elevated financial risk exposure.

The high risk in the construction sector in Southeast Asia is reflected in the performance characteristics of construction companies' markets. Financial data analysis of the construction sector sourced from Investing.com shows that although the average Price-to-Book Value (PBV) of construction companies in the region during the 2015-2024 period was above one, there is substantial variation indicated by the high standard deviation and the wide range of PBV values. This finding indicates the presence of a subgroup of companies with PBV below one, reflecting the market's perception of high financial risk. This condition is generally associated with high leverage, weak profitability, and the risk of project payment delays, particularly in government projects (K. Kim, 2023).

Previous studies emphasize that strong financial fundamentals enhance a company's market value, whereas a weak financial structure tends to worsen investor perceptions and depress the firm's value (Otero González et al., 2023; Tripathy & Pani, 2017). Therefore, financial risk management becomes a key strategy in maintaining and restoring market confidence in construction companies. Good financial stability in companies, including in the construction sector, is reflected through adequate levels of solvency, liquidity, and asset efficiency Altman, (1968), as well as sound fundamentals and liquidity conditions (Durán-Vázquez et al., 2014; Liang & Pathak, 2018).

In addition to risk mitigation through management of financial parameters, which tends to be conservative and challenging in highly competitive sectors, an alternative approach is to change investors' perspectives on risk and corporate value. In this context, sustainability is becoming increasingly relevant. The implementation of sustainability practices through Environmental, Social, and Governance (ESG) has been shown to reduce the risk of bankruptcy, lower the cost of capital, and improve access to funding, particularly in high-risk sectors (Nian & Said, 2024). Therefore, in addition to capital structure management, ESG adoption can serve as a complementary, strategic risk-mitigation mechanism for construction companies.

The research gap underlying this study lies in the limited empirical evidence examining financial risks in the construction sector in a partial manner, thereby failing to capture the multidimensional interactions among bankruptcy risk, fundamental risk, and liquidity risk on firm value (Farooq et al., 2024; Liang & Pathak, 2018). Furthermore, the role of sustainability (ESG) as a risk mitigation mechanism has rarely been empirically tested as a moderating variable, while most studies are still dominated by the use of static panel models that are less capable of capturing risk dynamics and the endogeneity issues inherent in the construction sector (Arellano & Bond, 1991; Baltagi, 2021; Soares & Pereira, 2022). The limited cross-country studies in Southeast Asia further highlight the need for comprehensive research to advance financial theory and to examine the practical implications of risk management and sustainability in high-risk yet strategic sectors for the region's economic development (Aplugi et al., 2024; Broadstock et al., 2021).

In response to this gap, this study adopts an integrative approach by analyzing the financial risks in the construction sector from a multidimensional perspective, covering bankruptcy risk, fundamental risk, and liquidity risk, while linking them to sustainability within a comprehensive conceptual framework. Theoretically, this study employs Signalling Theory as its main foundation, reinforced by the Triple Bottom Line Theory and bridged by Stakeholder Theory, to explain the mechanisms of corporate value creation. Empirically, the study extends the literature by simultaneously examining various dimensions of financial risk in the construction sector in Southeast Asia and analysing the role of ESG as a moderating variable. The use of a combination of static and dynamic panel models is expected to produce more comprehensive estimates that capture both temporal and long-term dynamics, thereby enhancing the inferential validity of the research findings.

The novelty of this study lies in several key contributions. First, this research integrates three dimensions of financial risk (bankruptcy risk, fundamental risk, and liquidity risk) simultaneously within a single analytical framework, whereas previous studies have predominantly examined these dimensions in isolation. Second, this study introduces ESG as a moderating variable in the relationship between financial risk and firm value in the construction sector, a perspective that has been largely absent from existing literature. Third, the combination of static and dynamic panel estimation techniques (Driscoll-Kraay standard errors and System GMM) provides a methodological advancement that addresses the econometric challenges inherent in cross-country panel data analysis. Fourth, the focus on the construction sector in Southeast Asia fills a significant regional gap, given that most previous studies have been conducted in developed economies.

This study offers three categories of research benefits. Theoretically, it contributes to the development of an integrated conceptual framework linking Signalling Theory, Stakeholder Theory, and Triple Bottom Line Theory in explaining the mechanisms of corporate value creation under conditions of financial risk. Practically, the findings provide actionable insights for construction company managers regarding the strategic importance of maintaining financial stability and adopting ESG practices to enhance firm value. From a policy perspective, the results offer evidence-based recommendations for regulators in ASEAN countries to standardize ESG disclosure requirements and develop incentive mechanisms for construction companies that demonstrate robust financial risk management and sustainability practices.

Based on this framework, this study aims to examine the impact of financial risk on firm value, as well as the role of sustainability in mitigating risk and enhancing the value of construction companies in Southeast Asia. These objectives are articulated through the following two research questions:

RQ1: Does internal financial risk affect the value of construction companies in Southeast Asia.

RQ2: How can financial risk mitigation be implemented to protect the value of construction companies in Southeast Asia.

Literature Review

The construction industry is characterized by cost uncertainty, complex project financing, and cash flow volatility. These characteristics play a crucial role in shaping perceptions of risk and company value in this sector. Table 8 provides a synthesis of key previous studies examining the relationship between financial risk, sustainability, and firm value, which serves as the empirical foundation for identifying the research gaps addressed in this study. This can be explained through the Signalling Theory Ross (1977), in which financial risk indicators serve as primary signals to the market. Ultimately, this affects investor perceptions in assessing the quality and prospects of companies, particularly in sectors sensitive to cash flow fluctuations (Vivel-Búa et al., 2024). High financial risk may also increase the potential for agency costs and worsen investor perceptions of company stability (Alshihri et al., 2022; Shibani et al., 2024).

The theoretical foundation of Signalling Theory directly underpins the first hypothesis by explaining how financial risk indicators function as market signals that shape investor perceptions. Specifically, higher levels of financial stability (lower bankruptcy risk), stronger internal fundamentals (lower fundamental risk), and more efficient cash flow management (lower liquidity risk) each send positive signals to the market, linking the three dimensions of financial risk to firm value. Empirically, bankruptcy risk, proxied by the Altman Z-Score, has been shown to have strong predictive validity in explaining variations in market value across countries and sectors (Awwad & Razia, 2021; Bargagli-Stoffi et al., 2024; Fung, 2023; Mavengere & Gumede, 2024).

Fundamental risk, as reflected in the Piotroski F-Score, indicates internal financial health and is associated with firms' long-term valuations Uzun (2024) and Walkshäusl (2020) though its impact is not always consistent across the service industry (Anderson et al., 2024). Finally, liquidity risk, as reflected in accounts receivable turnover, plays a role in maintaining cash flow stability and shaping investors' perceptions of the operational resilience of construction companies (Bintara, 2020; Wibowo et al., 2024; Wonkyoung et al., 2024). Based on the consistency of this theoretical framework and empirical evidence, the following hypothesis is formulated:

H1a: Bankruptcy risk negatively affects firm value (a decrease in bankruptcy risk, as indicated by a higher Altman Z Score, is associated with an increase in PBV).
H1b: Fundamental risk negatively affects firm value (a decrease in fundamental risk, as indicated by a higher Piotroski F Score, is associated with an increase in PBV).
H1c: Liquidity risk negatively affects firm value (a decrease in liquidity risk, as reflected by a higher receivables turnover ratio, corresponds to an increase in PBV).

In the construction industry, which has significant social and environmental impacts, Stakeholder Theory Freeman (1984) emphasizes that meeting stakeholder expectations is key to building legitimacy and reducing perceived risks, particularly in public infrastructure projects that are subject to strict regulatory oversight (Hörisch et al., 2014; Olander, 2007). Accordingly, the Triple Bottom Line Theory Elkington (1994) asserts that corporate value creation must simultaneously encompass economic, social, and environmental dimensions (Lima et al., 2021; Sridhar & Jones, 2013).

From a capital market perspective, Signalling Theory Ross (1977) and Arbitrage Pricing Theory Ross (1976) explain that ESG disclosure functions as a credibility signal that influences risk perception, cost of capital, and investors' expected returns, while also reducing exposure to systemic risk (Duque-Grisales & Aguilera-Caracuel, 2021). Empirical evidence shows that ESG can enhance corporate value resilience, lower the cost of capital, and moderate the impact of financial pressures and economic policy uncertainty (D. Kim & Yoon, 2024; Li et al., 2025; Loh et al., 2017; Yadav & Asongu, 2025).

Although findings indicate inconsistent results and potential increases in operational costs Khamis (2025) and Pérez (2025), ESG is still considered effective as a mechanism for mitigating strategic risks and strengthening a company's long-term fundamentals (Inamdar, 2024). Based on this theoretical foundation, the third hypothesis can be formulated as follows:

H2a: ESG weakens the negative effect of bankruptcy risk on firm value.
H2b: ESG weakens the negative effect of fundamental risk on firm value.
H2c: ESG weakens the negative effect of liquidity risk on firm value.

METHOD

This study employed an explanatory quantitative design to examine the influence of financial risk and sustainability on the value of construction companies in Southeast Asia. This approach was deemed appropriate for testing causal relationships using multidimensional, cross-country secondary data, in line with the methodological guidelines for international panel research (Baltagi, 2021). The study population includes all publicly listed construction companies in Southeast Asian countries during the period 2015–2024. Sample selection was carried out using purposive sampling, following common practices in construction sector research, which generally employs an unbalanced panel data structure. Financial and non-financial data were obtained from Investing.com, Refinitiv Eikon, and Trading Economics to support the two main empirical models in this study.

Financial risk is operationalized through three main dimensions: bankruptcy risk (BCR), measured using the Altman Z-Score (Altman, 1968); fundamental risk (FDR), measured with the Piotroski F-Score (Piotroski, 2000); and liquidity risk (LQR), proxied by accounts receivable turnover (Durán-Vázquez et al., 2014). The dependent variable, firm value (FVL), is proxied by Price-to-Book Value (PBV). Sustainability (SUS), proxied through the combined Environmental, Social, and Governance (ESG) score, is included as a moderating variable to assess its role in risk mitigation, consistent with contemporary empirical findings (Zheng et al., 2022).

Since the research was conducted across countries and over time, in order to reduce estimation bias and enhance reliability (robustness), this study employed control variables (Hünermund et al., 2025). The three internal and external control variables used are profitability (PFT), firm size (FSZ), and construction market size (CMS), which have been empirically proven to affect the value of companies in the construction sector (Akhmadi & Januarsi, 2021; Alaloul et al., 2022; Rachmat et al., 2019).

Profitability is proxied by Gross Profit Margin (GPM), reflecting project cost efficiency and aligning with project-based revenue characteristics, whereas firm size is measured by the natural logarithm of total assets to represent funding capacity and the management of large-scale projects (Almashhadani & Almashhadani, 2022; Jahan et al., 2022). Meanwhile, the construction market size, as an external control variable, is proxied by the logarithm of the construction sector's contribution to GDP, reflecting the scale of infrastructure development and its impact on the market value of cross-country construction companies (Brueckner, 2021; Sobieraj & Metelski, 2024).

For the static estimation, this study employed the Common Effect Model, Fixed Effect Model, and Random Effect Model, with model selection conducted through the Chow Test, Hausman Test, and Breusch–Pagan Lagrange Multiplier Test (Wooldridge, 2010). Given the potential presence of heteroskedasticity, autocorrelation, and cross-sectional dependence in the cross-country panel data, this study uses the Driscoll–Kraay Standard Error to obtain robust inferences that are unaffected by major violations of classical assumptions (Driscoll & Kraay, 1998). This approach enhances the reliability of statistical conclusions in panels exhibiting significant temporal and spatial dependence.

As part of the novelty, this study employs dynamic analysis, in addition to static analysis, to capture the dynamic behaviour of firm value and address potential endogeneity in risk and leverage variables. For this purpose, the study uses the System Generalized Method of Moments (System GMM) estimator (Arellano & Bover, 1995; Blundell & Bond, 1998). This estimator is suitable for panel data with a large number of entities and a relatively short time span, and it enables effective use of internal instruments. Model validity is tested using the Arellano–Bond AR(1) and AR(2) tests to detect higher-order autocorrelation, as well as the Hansen and Sargan tests to ensure instrument exogeneity (Roodman, 2009). The combination of static and dynamic modeling provides a robust analytical foundation for identifying short-term causal effects and the long-term persistence of firm value in the construction industry.

RESULTS AND DISCUSSION

Results

Descriptive Analysis

Descriptive statistical analysis for Model 1 (Table 1.) includes 1,831 observations and involves the variables firm value (FVL), bankruptcy risk (BCR), fundamental risk (FDR), liquidity risk (LQR), and three control variables. Firm value (FVL), measured using price-to-book value (PBV), shows a mean value of 1.4713 with a standard deviation of 1.7634, and a range from 0.2000 to 12.4000. Bankruptcy risk (BCR), proxied by the Altman Z-Score, has a mean value of 6.6877 and a standard deviation of 3.6738, with a range from -5.1000 to 20.1000. Fundamental risk (FDR), measured using the Piotroski F-Score, exhibits a mean of 4.5456 with a standard deviation of 1.9194, and a range from 1 to 9. Liquidity risk (LQR), measured by accounts receivable turnover, has an annual mean of 3.0466, a standard deviation of 3.0834, and a range of 0 to 22.9000.

The control variables exhibit different patterns; profitability (PFT), measured by gross profit margin, has a mean of 0.1713 and a standard deviation of 0.1488. Firm size (FSZ), expressed in the natural logarithm of total assets, records a mean value of 18.8642 with a standard deviation of 1.5473. Meanwhile, the size of the construction market (CMS), measured as the natural logarithm of the construction sector's contribution to GDP, has a mean of 23.5333 and a standard deviation of 0.6153. These findings are consistent with the characteristics of the construction sector reported in various previous regional studies (Anderson et al., 2024; Arisandi, 2025; Tsivtsivadze, 2025).

Table 1. Descriptive Statistic of Model 1

Variable	Observation	Mean	Std. dev.	Min.	Max.
FVL	1,831	1.4713	1.7634	0.2000	12.4000
BCR	1,831	6.6877	3.6738	-5.1000	20.1000
FDR	1,831	4.5456	1.9194	1.0000	9.0000
LQR	1,831	3.0466	3.0834	0.0000	22.9000
PFT	1,831	0.1713	0.1488	-0.2790	0.7890
FSZ	1,831	18.8642	1.5473	14.6278	22.4161
CMS	1,831	23.5333	0.6153	22.7339	25.0990

Descriptive statistical analysis for Model 2 (Table 2.) includes 240 unbalanced panel observations and incorporates the sustainability variable (SUS), proxied through the combined ESG score. Firm value (FVL) records a mean of 1.9046 with a standard deviation of 3.0335 and a range from 0.2000 to 23.2000. Bankruptcy risk (BCR) has a mean of 6.9450, fundamental risk (FDR) has a mean of 4.9625, and liquidity risk (LQR) has a mean of 4.3651. The ESG score averages 40.0349 with a standard deviation of 16.4313, indicating a relatively low and heterogeneous level of ESG disclosure in emerging markets (Broadstock et al., 2021). Control variables indicate that profitability (PFT) has a mean of 0.1924, firm size (FSZ) is 19.9427, and construction market size (CMS) is 23.5201. This pattern of variation is consistent with cross-country industry characteristics reported in studies on market structure and firm size (Anderson et al., 2024; Arisandi, 2025; Tsivtsivadze, 2025).

Table 2. Descriptive Statistic of Model 2

Variable	Observation	Mean	Std. dev.	Min.	Max.
FVL	240	1.9046	3.0335	0.2000	23.2000
BCR	240	6.9450	3.2256	-1.4000	16.0000
FDR	240	4.9625	1.9733	1.0000	9.0000
LQR	240	4.3651	8.2708	0.1000	63.9000
SUS	240	40.0349	16.4313	6.3300	75.6800
PFT	240	0.1924	0.1225	-0.0630	0.6350
FSZ	240	19.9427	1.6777	15.8528	22.7058
CMS	240	23.5201	0.6718	22.8671	25.0990

Panel Data Analysis

Static panel data analysis of Model 1 (Table 3.) shows that the Fixed Effect Model (FEM) is the best model based on the Chow, BP–LM, and Hausman tests (all p-values = 0.000), thus capable of capturing unobserved heterogeneity across companies. Classical assumption testing indicates the presence of heteroskedasticity (p-value = 0.000) and cross-sectional dependence (CSD), while no autocorrelation is found (p-value = 0.0848) and multicollinearity is low (VIF 1.09–1.18). Due to the limitations in meeting these assumptions, the estimation is corrected using the Driscoll–Kraay standard errors estimator to obtain robust results. From an estimation perspective, only the LQR variable with the accounts receivable turnover proxy has a positive and significant effect on firm value (β = 0.0541 with p-value = 0.008), whereas bankruptcy risk, fundamental risk, profitability, company size, and market size are not individually significant. Nevertheless, simultaneously the model remains significant (F = 20.36; p = 0.0001), confirming that variations in firm value are influenced by the collective interaction between financial risk, internal characteristics, and market conditions.

Dynamic panel data analysis of Model 1 using System GMM (Table 4.) indicates that the model is feasible and provides consistent estimates. This is evidenced by the absence of second-order autocorrelation (AR(2) with a p-value = 0.277), the fulfilment of instrument validity through the Hansen test (p-value = 0.219), the Sargan test (with a p-value = 0.129), as well as the Difference-in-Hansen test (with a p-value > 0.05), and a controlled number of instruments (47 < number of groups). In terms of estimation, firm value is strongly persistent with a lagged FVL coefficient of 0.7488 (with a p-value < 0.001), while the FDR variable, proxied by the Piotroski F-Score, has a positive and significant effect on firm value (β = 0.1313 with a p-value = 0.0260), and firm size has a significantly negative effect (β = −0.0740 with a p-value = 0.0050). The simultaneous test indicates that the model is significant overall (F = 335.72, p < 0.001). This underscores that a dynamic approach can capture the delayed effects of corporate value adjustments, as well as the selective roles of risk factors and internal characteristics in determining the value of construction companies.

Table 3. Static Panel Regression using FEM with Driscoll-Kraay S.E. of Model 1

Variable	Coefficient	Drisc-Kraay S.E.	p-value
BCR	-0.0137	0.0219	0.5460
FDR	-0.0164	0.0176	0.3780
LQR	0.0541	0.0161	0.0080
PFT	0.5056	0.5084	0.3460
FSZ	-0.1422	0.2096	0.5150
CMS	-0.3885	0.3349	0.2760
Cons	13.2114	10.0479	0.2210

Table 4. Dynamic Panel Regression Using System GMM of Model 1

Variable	Coefficient	Corrected S.E.	p-value
L.FVL	0.7488	0.0672	0.0000
BCR	-0.0415	0.0287	0.1490
FDR	0.1313	0.0587	0.0260
LQR	-0.0176	0.0354	0.6200
PFT	0.2241	0.9472	0.8130
FSZ	-0.0740	0.0258	0.0050
CMS	-0.0338	0.0466	0.4690
Cons	2.1180	1.1321	0.0630

The static panel data analysis of Model 2 (Table 5.) designated the Fixed Effect Model (FEM) as the best model based on the Chow, BP–LM, and Hausman tests (all p-values = 0.0000). However, assumption testing indicated heteroscedasticity and cross-sectional dependence (CSD), while no autocorrelation was detected (VIF 1.05–1.70). Based on these results, the estimation was corrected using Driscoll–Kraay standard errors, yielding a robust model. Simultaneously, all independent and control variables significantly affected firm value (F = 1177.95, p-value < 0.001; R^2 = 0.1276), although not all individual coefficients were significant.

Key findings indicate that the BCR variable, proxied by the Altman Z-Score, has a positive and significant effect on firm value (β = 0.0646 with a p-value = 0.0490), and sustainability positively moderates this relationship (SUS*BCR: β = 0.0021 with a p-value = 0.0350), while the interaction of ESG with fundamental risk and liquidity is not significant. In addition, profitability (β = 1.5493, p-value = 0.0010) and the size of the construction market (β = 0.9707, p-value = 0.0180) enhance firm value. Meanwhile, firm size has a significant negative effect (β = −0.5909, p = 0.0020), confirming that firm value is shaped by a combination of bankruptcy risk, operational performance, market context, and the selective role of ESG as a risk-mitigation mechanism.

The dynamic panel data estimation of Model 2 using System GMM (Table 6.) indicates that the model is econometrically sound, although no individual explanatory variables are significant. The model's validity is confirmed by a controlled number of instruments (17 < 66 groups), the absence of second-order autocorrelation (AR(2) p-value = 0.946), as well as instrument validity based on the Sargan test (p-value = 0.7290), Hansen test (p-value = 0.6250), and Difference-in-Hansen test, all of which are not significant. Although the AR(1) test is not significant (p-value =

0.391), this condition does not violate the main assumptions of System GMM, as the critical requirement is that AR(2) is not significant.

Simultaneously, the overall model is significant at the 1% level ($F(11,65) = 10.98$, $p < 0.001$). This indicates that the combination of lagged firm value, financial risk (BCR, FDR, LQR), sustainability, and their interactions, along with control variables (PFT, FSZ, CMS), can systematically explain the dynamics of firm value. However, there is an absence of individual significance, including the lagged FVL ($\beta = -0.5853$ with a p-value = 0.505). This suggests that firm value is more influenced by the structure of long-term collective relationships than by short-term partial effects, reflecting the complexity and volatility of firm value dynamics in the construction sector.

Table 5. Static Panel Regression using FEM with Driscoll-Kraay S.E. of Model 2

Variable	Coefficient	Drisc-Kraay S.E.	p-value
BCR	0.0646	0.0283	0.0490
FDR	-0.0253	0.0203	0.2430
LQR	0.0051	0.0078	0.5260
SUS	-0.0189	0.0089	0.0640
SUS*BCR	0.0021	0.0008	0.0350
SUS*FDR	-0.0009	0.0008	0.2940
SUS*LQR	-0.0010	0.0011	0.4200
PFT	1.5493	0.3436	0.0010
FSZ	-0.5909	0.1372	0.0020
CMS	0.9707	0.3346	0.0180
Cons	-9.2828	8.8699	0.3230

Table 6. Dynamic Panel Regression Using System GMM of Model 2

Variable	Coefficient	Corrected S.E.	p-value
L.FVL	-0.5853	0.8739	0.5050
BCR	0.1095	0.8706	0.9000
FDR	-0.0617	0.5492	0.9110
LQR	0.4899	0.6924	0.4820
SUS	-0.0230	0.0828	0.7820
SUS*BCR	0.0020	0.0192	0.9170
SUS*FDR	-0.0013	0.0116	0.9090
SUS*LQR	-0.0026	0.0084	0.7570
PFT	8.1709	7.3926	0.2730
FSZ	0.0868	2.7110	0.9750
CMS	0.2437	2.2544	0.9140
Cons	-7.8213	21.1085	0.7120

Hypotheses Result

Overall, out of the six hypotheses proposed, four hypotheses (H1a, H1b, H1c, and H2a) are empirically supported, while two hypotheses (H2b and H2c) do not receive empirical support based on the results of static and dynamic panel estimations. Overall, the estimation results indicate that risk characteristics affecting firm value (Model 1) exhibit different patterns of influence when sustainability aspects are considered versus when they are not (Model 2).

The results of hypothesis testing indicate that the three main hypotheses related to financial risk dimensions, namely H1a, H1b, and H1c, are supported by the estimation results in the corresponding models. Hypothesis H1a is validated in Model 2 using the Driscoll–Kraay static panel approach, as evidenced by the positive and statistically significant impact of decreased bankruptcy risk (BCR), proxied by increased Altman Z-Score, on firm value measured by the price-to-book ratio. Hypothesis H1b is supported through Model 1 using the dynamic panel estimator System GMM, where a reduction in fundamental risk (FDR), proxied by an increase in the Piotroski F-Score, shows a positive and significant coefficient. Furthermore, hypothesis H1c is also supported in Model 1 under the static panel specification, where a decrease in liquidity risk (LQR), measured by an increase in accounts receivable turnover, has a positive and significant effect on firm value.

In the moderation test on Model 2, only hypothesis H2a received empirical support, as indicated by the statistically significant interaction between sustainability (SUS) and bankruptcy risk (BCR). Conversely, hypothesis H2b was not supported because the interaction between sustainability and fundamental risk (FDR) was not statistically significant. Similarly, hypothesis H2c was not supported because the interaction between sustainability and liquidity risk (LQR) did not show a significant effect.

Overall, of the six hypotheses proposed in this study, four hypotheses (H1a, H1b, H1c, and H2a) are empirically supported, whereas the other two hypotheses (H2b and H2c) do not receive empirical support based on the results of static and dynamic panel estimations in Model 2.

Table 7. Hypotheses Decisions Result

Hypothesis	Model & Estimation	Decision
H1a	Model 2 (Static)	Accepted
H1b	Model 1 (Dynamic)	Accepted
H1c	Model 1 (Static)	Accepted
H2a	Model 2 (Static)	Accepted
H2b	Model 2	Rejected
H2c	Model 2	Rejected

Discussion

The research results indicate that the three main dimensions of risk possess different predictive powers in explaining firm value. A reduction in bankruptcy risk, reflected in an increase in the Altman Z-Score (which indicates greater financial stability rather than higher risk per se), has a positive, statistically significant effect in Model 2 (supporting H1a), consistent with established empirical evidence on the predictive validity of financial stability indicators (Altman, 1968; Grice & Ingram, 2001). A reduction in fundamental risk, indicated by an increase in the Piotroski F-Score, has a positive and significant impact on the dynamic panel System GMM estimation (supporting H1b), thereby reinforcing the view that strong financial fundamentals are a key determinant in the long-term value creation of firms (Mohanram, 2005; Piotroski, 2000). Furthermore, the reduction in liquidity risk, reflected in the increased receivables turnover, also shows a positive and statistically significant effect in the static Model 1 (supporting H1c), consistent with previous findings emphasizing the role of liquidity efficiency in shaping market valuation (Baños-Caballero et al., 2014; Enqvist et al., 2014).

The control variables used are profitability, company size, and market size. The estimation results of the control variables individually show moderate variation but do not alter the direction or significance of the main variables. This indicates the stability of the core relationships across all model specifications.

The moderating role of sustainability, proxied by the ESG Combined Score in Model 2, indicates that sustainability strengthens the relationship between financial stability and firm value (supporting H2a). This finding is consistent with the literature, which suggests that sustainability disclosure enhances the market's perception of long-term risk and firm resilience (Broadstock et al., 2021). The significance of the SUS×BCR interaction indicates that the market places greater weight on financial stability when accompanied by strong ESG signalling quality.

Conversely, no moderating effect of ESG was found on the relationship between fundamental risk and firm value (H2b rejected), nor between liquidity risk and firm value (H2c rejected). The absence of such effects aligns with previous studies indicating that internally performance-based indicators, such as fundamental scores reflecting profitability, efficiency, and capital structure Piotroski (2000), as well as accounts receivable turnover reflecting short-term operational effectiveness Enqvist (2014), are assessed directly by the market without requiring external reputational reinforcement. Thus, the moderating influence of ESG appears limited to risk dimensions that have reputational or long-term financial stability implications, rather than to risks arising from internal operational efficiency.

CONCLUSION

This study demonstrates that bankruptcy risk, fundamental risk, and liquidity risk significantly influence firm value. A reduction in bankruptcy risk (an increase in the Altman Z-Score, reflecting greater financial stability), a decrease in fundamental risk (strengthening of the Piotroski F-Score), and a decrease in liquidity risk (faster accounts receivable turnover) provide positive signals to investors. The dynamic panel specification also indicates the persistence of firm value, underscoring the importance of a strong financial foundation for maintaining firm value sustainability. Therefore, the management of internal risks is a key pillar in enhancing the value of construction companies.

Sustainability, as proxied by ESG scores, significantly moderates the relationship between bankruptcy risk and firm value, serving as an additional non-financial mechanism in risk mitigation. However, the moderating effect of ESG is not significant for fundamental risk and liquidity risk, supporting the argument that ESG is more effective in responding to long-term strategic risks than short-term operational exposures. The integration of internal financial stability and optimal leverage strengthens the sustainable financial framework, where firm value increases when financial resilience, capital structure effectiveness, and sustainability practices operate synergistically.

These findings have several strategic implications. For managers, integrating ESG into risk management is a key step in enhancing corporate value. For investors, the simultaneous evaluation of financial risk indicators and ESG scores becomes relevant in assessing the long-term resilience of construction companies. Meanwhile, for regulators, standardizing ESG disclosures and incentivizing companies with healthy capital structures and consistent sustainability practices will yield significant benefits.

Although it has significant benefits for the construction sector, this study is not without its shortcomings. The lack of macroeconomic variables as control variables in cross-country research can increase estimation bias. Meanwhile, the use of a combined ESG score is less able to capture the individual effects of each component, which should be able to enhance the effectiveness and focus of sustainability implementation. Future research is recommended to include external macroeconomic variables and disaggregate ESG dimensions to more precisely identify each dimension's contribution to risk mitigation.

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AUTHOR CONTRIBUTION STATEMENT

Rustandi conceived the research idea, designed the study, collected and analyzed the data, and prepared the initial manuscript. Tri Gunarsih contributed to the research framework, methodology development, data interpretation, and critical revision of the manuscript. Nuryasman assisted in validating the empirical findings, strengthening the theoretical discussion, and reviewing the manuscript. Faizul Mubarok supervised the overall research process, refined the analysis, and finalized the manuscript for publication. All authors read, approved, and agreed to the final version of the manuscript and accept responsibility for its academic integrity.

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