EXAMINING THE IMPACT OF BOARD OF DIRECTORS, CHIEF RISK OFFICERS, AND INTELLECTUAL CAPITAL ON ENTERPRISE RISK MANAGEMENT EFFECTIVENESS IN THE MINING SECTOR

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Abstract

The mining sector in Southeast Asia is particularly susceptible to external disturbances, including fluctuations in commodity prices and rigorous regulatory constraints. These factors have the potential to significantly influence operational resilience and profitability. However, the implementation of effective governance and risk management strategies can assist companies in mitigating these risks and attaining optimal performance (Pangestuti et al., 2024). This study examines the roles of the board of directors (BOD) and the chief risk officer (CRO) in enhancing enterprise risk management (ERM) and improving firm performance (FP) in the mining sector of Southeast Asia. The study employs quantitative methods, including regression analysis and moderated regression analysis (MRA), to examine data from 205 mining companies over a seven-year period. The findings indicate a positive correlation between active BOD involvement and ERM effectiveness, with the presence of a CRO significantly enhancing risk management processes. The concept of intellectual capital (IC) is identified as a moderating factor that enhances the relationship between ERM and FP, thereby leading to superior outcomes. These findings underscore the necessity for robust governance structures and strategic risk management roles, offering practical insights for mining companies in Southeast Asia to enhance stability and growth.

Keywords: Board of Directors, Chief Risk Officer, Enterprise Risk Management, Intellectual Capital, Firm Performance

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1. INTRODUCTION

The mining industry in Southeast Asia has been a principal contributor to the region's economic development, with a notable impact on the gross domestic product (GDP) of countries such as Indonesia, Malaysia, Thailand, and the Philippines (Cu et al., 2017). This sector is indispensable for attaining the objectives of the Association of Southeast Asian Nations (ASEAN) Economic Community 2025, which prioritizes regional sustainability and furnishes indispensable resources for industrial growth (Basri & Hill, 2020). However, the industry is confronted with significant risks, including fluctuations in commodity prices, regulatory challenges, and stakeholder pressures. In order to ensure stability and growth, it is therefore essential to implement robust risk management strategies.

Enterprise risk management (ERM) has emerged as a pivotal framework for navigating the intricate risks inherent to the mining sector. ERM is a methodology that integrates risk management practices across an organization, offering a comprehensive approach to identifying, assessing, and mitigating risks (Oydag & Senvar, 2020). Prior research has demonstrated that the effective implementation of ERM can result in notable performance enhancements, particularly in high-risk sectors such as mining (Khan et al., 2016). However, the implementation of ERM in Southeast Asia is frequently impeded by a lack of comprehension and the distinctive business milieu of the region (Onu & Mbohwa, 2019).

To address this issue, the study proposes the integration of ERM with corporate governance mechanisms, with a particular focus on the roles of the board of directors (BOD) and chief risk officer (CRO). The involvement of the BOD in risk oversight and strategic decision-making is of paramount importance for the establishment of a risk-aware culture and the alignment of risk management with organizational goals (Al-Farsi, 2020; Bailey, 2022). Similarly, the CRO plays a pivotal role in the implementation and monitoring of ERM practices, ensuring the effective integration of risk management processes across all levels of the organization (Bailey, 2022).

The extant literature on ERM and firm performance (FP) presents a complex and nuanced picture. While numerous studies have indicated that ERM has a positive impact on firm value and return on assets, influenced by innovation intensity and knowledge-oriented industry structures (Jurdi & AlGhnaimat, 2021), others have reported mixed or even negative effects. For example, Alawattegama (2018) observed that ERM functions, such as risk assessment and control activities, may have a detrimental impact on FP due to increased costs.

Furthermore, the relationship between ERM and FP appears to be contingent on various factors, including the degree of ERM implementation and the specific organizational context (Farrell & Gallagher, 2019). These findings indicate that a universal approach may be inadequate and that further research is necessary to ascertain the circumstances under which ERM is most effective (Gordon et al., 2009). Furthermore, the integration of intellectual capital (IC) with ERM has been proposed as a promising avenue for enhancing FP. However, empirical evidence on this interaction remains limited (Khan & Ali, 2017; Saeidi et al., 2020).

The objective of this study is to examine the impact of ERM, the roles of the BOD and the CRO, and the moderating effect of IC on the performance of mining companies in Southeast Asia. This research aims to provide a comprehensive understanding of the manner in which these factors interact to influence FP, with particular reference to the distinctive challenges encountered by the mining industry in this region.

This study is distinctive in its integrated approach, which combines ERM with corporate governance and IC to examine their combined effects on FP. By addressing the mixed findings in the literature and focusing on the Southeast Asian mining sector, this research provides contextually relevant insights that can inform both academic discourse and practical applications. The study encompasses a quantitative analysis of 205 mining companies in Southeast Asia over a seven-year period, employing regression analysis and moderated regression analysis (MRA) tests to examine the relationships between the variables.

It is anticipated that the findings of this research will contribute to the existing literature on risk management, corporate governance, and strategic management by offering a more nuanced understanding of the moderating role of IC in the ERM performance nexus. Furthermore, the study offers practical guidance for managers on formulating IC strategies that are aligned with ERM practices, with the aim of enhancing FP and competitiveness in the global market.

The rest of this study is structured as follows. Section 2 reviews the literature forming the basis of the research framework and hypotheses. Section 3 outlines the research methodology, including data observation and the model. Section 4 presents the results with descriptive and inferential statistics. Section 5 discusses and analyzes the findings. Section 6 summarizes the paper, addresses study limitations, and suggests directions for future research.

2. LITERATURE REVIEW

The effectiveness of risk management is contingent upon the presence of an engaged BOD comprising individuals with diverse expertise Gordon et al. (2009). Such a BOD can facilitate the enhancement of ERM practices through proactive involvement. The role of the BOD in risk oversight and policy setting is underscored in Securities and Exchange Commission (SEC) 33-9089, which underscores its responsibility for policymaking, compliance, and governance. The impact of the BOD on ERM has been mixed, with studies indicating a range of influences, including positive, negative, and minimal. In accordance with agency theory, the BOD is responsible for safeguarding the interests of shareholders and improving efficiency by supervising management to mitigate opportunistic behaviors (Merendino & Melville, 2019). The BOD is actively engaged in the identification, measurement, and management of risks, with the objective of ensuring organizational success. The studies conducted by Bhat et al. (2020) and Khaireddine et al. (2020) illustrate that the presence of diverse boards is conducive to the effective implementation of ERM. In light of the theoretical and empirical evidence presented, a hypothesis is put forth for further investigation into the influence of the BOD on ERM.

H1: The board of directors has a positive influence on enterprise risk management.

The evolution of risk management has elevated the role of the CRO, which was initially relevant to the financial and banking sectors but is now expanding across various industries due to the increasing prevalence of business risks and regulations (Beasley et al., 2013). The role of the CRO is of particular importance in enabling the independent navigation of risks, which sets it apart from other executive functions. The extant literature indicates that firms with a CRO implement more effective risk management, which in turn leads to superior financial outcomes and a strong commitment to ERM (Al-Farsi, 2020). Furthermore, Bailey (2022) underscores the beneficial influence of the CRO on ERM implementation, emphasizing their responsibility for recruiting and motivating specialized risk personnel. This leads to the formulation of the following hypothesis:

H2: The chief risk officer has a positive impact on enterprise risk management.

ERM is a vital strategic instrument for enhancing organizational performance through comprehensive risk identification, assessment, and mitigation. It is founded upon strategic management, organizational theory, and corporate governance (Gordon et al., 2009). An effective ERM system is aligned with strategic goals, facilitates improved decision-making, optimizes the use of resources, fosters stakeholder trust, ensures compliance with regulations, and encourages innovation. Empirical evidence demonstrates that ERM not only mitigates operational risks but also enhances investor confidence, influencing market perception (Anton & Nucu, 2020; Chairani & Siregar, 2021; Phan et al., 2020). The extant literature indicates that ERM has a positive impact on FP, including the stabilization of stock prices, a reduction in the cost of capital, and an enhancement of capital efficiency (Lechner & Gatzert, 2017). Furthermore, the effectiveness of ERM has been demonstrated to increase stakeholder satisfaction and adaptability, thereby enhancing financial outcomes and competitive advantages for firms. In light of the aforementioned evidence, the following hypothesis is proposed:

H3: Effective implementation of enterprise risk management positively impacts firm performance.

The BOD is of critical importance in the context of corporate governance, serving to align managerial actions with the goals of shareholders. An effective BOD, comprising members who are suitably qualified and experienced, is able to protect the interests of shareholders and contribute to the formulation of corporate strategy. They serve to mitigate risks, capitalize on opportunities, and ensure stability through rigorous monitoring. A diverse BOD enhances transparency, accountability, and informed decision-making, thereby promoting innovative solutions. Their extensive networks facilitate access to resources and strategic collaborations, thereby contributing to long-term organizational success. The effective governance of corporations by their BOD fosters trust with stakeholders and drives the performance of the firm (Merendino & Melville, 2019). The studies conducted by Pucheta-Martínez and Gallego-Álvarez (2020) and Merendino and Melville (2019) have demonstrated a positive correlation between the characteristics of the board and the performance of the firm. Further research by Assenga et al. (2018) lends further support to this positive influence, suggesting that effective board oversight can enhance FP by optimizing operational efficiency. The following hypothesis is proposed:

H4: The board of directors positively influences firm performance.

The CRO exerts a profound impact on organizational performance by integrating risk management into strategic decision-making processes, ensuring compliance with regulatory standards, and enhancing resilience to adverse conditions. The CRO's role in mitigating uncertainty, improving efficiency, and fostering stakeholder trust contributes to enhanced performance and the establishment of long-term relationships (Li et al., 2022). Bailey (2022) and Li et al. (2022) have demonstrated that an effective CRO has the capacity to enhance perceptions of quality and operational efficiency, thereby improving overall FP. However, Beasley et al. (2008) posit that the impact of the CRO is contingent upon factors such as company size, leverage, reporting structure, expertise, and compensation (Li et al., 2022). In light of the aforementioned findings, the following hypothesis is put forth for consideration:

H5: The chief risk officer has a positive influence on firm performance.

IC plays a pivotal role in bolstering organizational performance through the efficacious implementation of effective ERM, which is firmly rooted in strategic management, organizational theory, and corporate governance (Khan et al., 2019). IC is comprised of three key elements: human, structural, and relational capital. Each of these elements serves to reinforce ERM practices and enhance performance. The integration of IC into risk management facilitates the proactive identification of opportunities and the development of innovative strategies, thereby enhancing long-term performance. In accordance with the resource-based theory, distinctive resources bestow competitive advantages upon firms (Subaida et al., 2018). The contingency perspective posits that the impact of ERM on performance is contingent upon the quality and scope of IC. Prior research, including that of Ni et al. (2019), Subaida et al. (2018), and Khan et al. (2019) has identified a positive correlation between IC, ERM implementation, and performance, with IC exerting a positive moderating influence on the ERM-performance relationship. This research builds upon these theoretical and empirical foundations to propose the following hypothesis.

H6: Intellectual capital positively moderates the influence of enterprise risk management on firm performance.

3. RESEARCH METHODOLOGY

3.1. Data

The data for this study was collected through a documentation technique, utilizing information from existing documents and reliable databases, including Bloomberg and the annual financial reports of companies. The population under consideration comprises all mining companies listed on Southeast Asian stock exchanges (Indonesia, Malaysia, Singapore, Thailand, Vietnam, and the Philippines) from 2016 to 2022. A purposive sampling method was employed to select companies with complete financial statement data for the entire

study period, thereby ensuring the sample's relevance to the research hypotheses. Over the course of the study period, 227 mining companies were listed on Southeast Asian stock exchanges. Nevertheless, 22 companies failed to provide complete financial statements, resulting in a final sample of 205 companies. The research encompasses a seven-year period, from 2016 to 2022, with a total of 1,435 entries analyzed.

3.2. Variables

3.2.1. Dependent variable

Financial performance (*FP*). Measured by Tobin's Q, which is a widely used metric to assess market valuation relative to the asset base of the company. The formula for Tobin's Q is adjusted for simplicity in this study:

$$Tobin's\ Q = total\ market\ value + total\ book\ value\ of\ liabilities\ total\ book\ value\ of\ asset \quad (1)$$

3.2.2. Independent variables

Board of directors (*BOD*). Measured by the ratio of the number of directors to the natural logarithm of sales, reflecting the monitoring capacity of the board;

Chief risk officer (*CRO*). A dummy variable where the presence of a *CRO* or a risk committee is coded as 1, and 0 otherwise.

3.2.3. Moderating variable

Intellectual capital (*IC*). Represented by the MVAIC™ model, which includes human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE). This composite measure captures the value added by the company's *IC*.

3.2.4. Intervening variable

Enterprise risk management (*ERM*) is a process that identifies, assesses, and manages risks affecting an organization. The evaluation of *ERM* utilizes the modified risk management index (MERMi), aligned with the Committee of Sponsoring Organizations (COSO) 2017 framework (Pangestuti et al., 2023). This index is calculated based on information from the company's annual report on its *ERM* implementation. Scores of 0, 1, or 2 are assigned depending on the level of disclosure: 0 for no disclosure of COSO (n.d.) principles, 1 for general or qualitative disclosure, and 2 for quantitative disclosure. These scores are then weighted, aggregated, and totaled to determine the MERMi value.

3.2.5. Control variables

Firm size (*FZ*) and financial leverage (*FL*) are utilized as control variables due to their impact on *FP*. *FZ* is measured by the natural logarithm of average total assets, while *FL* is calculated as the ratio of book liabilities to market equity.

3.3. Methodology

3.3.1. Research models

The linear regression model without moderation is referred to as Model 1, while the linear regression model with moderation is referred to as Model 2.

Model 1 (Determining factors of ERM)

$$ERM = \alpha + \beta_1 BOD + \beta_2 CRO + \beta_3 FZ + \beta_4 FL + u_{it} \quad (2)$$

Model 2 (Impact on FP)

$$FP = \alpha + \beta_1 BOD + \beta_2 CRO + \beta_3 FZ + \beta_4 FL + \beta_5 ERM + \beta_6 ERM * IC + u_{it} \quad (3)$$

where, *ERM* — enterprise risk management; *FP* — firm performance; *BOD* — board of directors; *CRO* — chief risk officer; *FZ* — firm size, *FL* — financial leverage, *IC* — intellectual capital, α — constant term; β_1–β_6 — regression coefficients; u_{it} — error term.

3.3.2. Analysis of data

This study employs the two-stage least squares (2SLS) method, a regression technique designed to address endogeneity, thereby ensuring the accuracy of coefficient estimates. The 2SLS process comprises two stages. Initially, each endogenous variable is regressed on instrumental and exogenous variables, thereby obtaining predicted values. Subsequently, these values are substituted for the endogenous variables, thus eliminating endogeneity bias. This method yields robust and consistent estimations. The data analysis comprises descriptive statistics (mean, median, and standard deviation), a Pearson correlation test (significance level of 0.05), and panel data regression, which combines time series and cross-sectional data. Additional robustness can be achieved through alternative methods, including the generalized method of moments (GMM) for addressing endogeneity and heterogeneity, fixed and random effects models for controlling unobserved heterogeneity, and propensity score matching (PSM) for controlling selection bias in observational studies. These methods serve to complement the 2SLS approach, thereby facilitating the validation of the primary findings.

4. ANALYSIS AND RESULTS

4.1. Descriptive statistics

In order to accurately distill the descriptive results of the research on the influence of governance, risk management, and *IC* on *FP* in the Southeast Asian mining industry between 2016 and 2022, the following summary presents the key findings. The objective of this analysis is to provide insights into the variables of the *BOD*, the *CRO*, *ERM*, *IC*, and *FP*, and their respective impacts on the industry during the study period.

Table 1. Descriptive statistics test results

Variable	*Mean*	*Median*	*Max*	*Min*	*Std. dev.*	*N*
BOD	0.974741	0.848623	12.87609	0.206380	0.725117	1435
CRO	0.500348	1.000000	1.000000	0.000000	0.500174	1435
ERM	0.018818	0.020000	0.032340	0.003640	0.003161	1435
IC	15.51273	15.83260	23.93284	5.034281	3.230805	1435
FP	1.321890	1.130298	5.403289	0.212390	0.632898	1435

Table 1 presents the descriptive statistics of the variables under investigation. The mean value of the *BOD* variable is 0.974741, indicating a strong positive correlation between the number of directors and company sales. This finding reflects the effectiveness of governance practices. The range of 0.848623 to 12.87609 and a standard deviation of 0.725117 indicate a moderate degree of variability in the composition of the boards in question. The mean value of the *CRO* variable is 0.500348, indicating that approximately half of the surveyed Southeast Asian mining companies have appointed a *CRO*. This suggests a balanced approach to risk leadership. The binary range of 0 to 1 corroborates the hypothesis that there is an even split in the presence of a *CRO* across firms. The mean value for *ERM* practices is 0.018818, which is relatively low but exhibits a consistent trend across the sample, with a range of 0.003640 to 0.032340. This indicates that there is minimal variation in the effectiveness of *ERM* practices. The mean value for *IC* is 15.51273, with a range of 5.034281 to 23.93284. This reflects a considerable degree of variation in the manner in which firms leverage *IC*, which is a key driver of innovation and competitive advantage. The mean value of Tobin's Q, a measure of *FP*, is 1.321890, indicating that the market generally values the assets of these firms at a premium. The range of 0.212390 to 5.403289 highlights the significance of effective governance and risk management in improving performance outcomes.

This study employs Tobin's Q to examine the financial performance of mining companies in Southeast Asian countries. Tobin's Q is a valuation ratio that compares a company's market value to the replacement cost of its assets. Values above 1 indicate a positive market valuation. The analysis reveals several insights based on Tobin's Q values for mining companies in Southeast Asian countries. In the Philippines, the observed mean and median values are low, accompanied by a high degree of variability, which collectively suggest that the majority of companies are undervalued. Conversely, Singapore exhibits elevated mean and median values, indicating robust market sentiment. However, the moderate variability observed suggests discrepancies between individual companies. The Thai market demonstrates a mixed trend, with some companies exhibiting strong performance, while overall valuations remain close to asset costs. In Indonesia, the median values are close to 1, and the variability is low, indicating stability and consistent valuations. Malaysia's mean values exhibit fluctuations, indicating optimism in certain years; however, the median is frequently below 1, suggesting that the majority of companies are not highly valued by the market. The mean and median values for Vietnam are generally around or below 1, indicating weak market confidence. An analysis of growth trends reveals that Singapore experienced the most favorable growth, with consistently high Tobin's Q values, reflecting strong market sentiment and improved valuations. In contrast, other countries showed fluctuating or stable trends without significant growth. Therefore, investors might consider Singapore for growth opportunities, while policy interventions could help improve market valuations in other countries.

4.2. Pearson correlation

The following table presents the Pearson correlation coefficients among the key variables examined in this study, including the *BOD*, the *CRO*, the *FZ*, the *FL*, *ERM*, *IC*, and *FP*. The correlations elucidate the relationships between these variables, thereby furnishing insights into their potential interdependencies and the significance of these relationships.

Table 2. Pearson correlation test result

Variable	*BOD*	*CRO*	*FZ*	*FL*	*ERM*	*IC*	*FP*
BOD	1.000	0.095**	0.210**	0.240	0.070**	0.028	0.031
	0.000	0.000	0.000	0.179	0.008	0.029	0.024
CRO	0.095**	1.000	0.223**	0.044**	0.022**	0.079**	0.050
	0.000	0.000	0.000	0.036	0.000	0.003	0.048
FZ	0.210**	0.115**	1.000	0.114**	0.042*	0.413**	0.77**
	0.000	0.000	-	0.000	0.015	0.000	0.001
FL	0.240**	0.044**	0.114**	1.000	0.103**	0.000	-0.001
	0.000	0.036	0.000	-	0.000	0.000	0.000
ERM	0.070**	0.022	0.042*	0.103**	1.000	0.071**	0.126**
	0.008	0.000	0.015	0.000	-	0.007	0.000
IC	0.028	0.079**	0.431**	0.000	0.071**	1.000	0.067**
	0.029	0.003	0.000	0.000	0.007	-	0.000
FP	0.031	0.050	0.077**	-0.001	0.126**	0.067**	1.000
	0.024	0.048	0.001	0.000	0.000	0.000	0.000

*Note: ***, **, * indicates significance level at 1%, 5%, and 10%.*

Table 2 presents the Pearson correlation results among the variables under investigation, including the *BOD, CRO, FZ, FL, ERM, IC*, and *FP*. The *BOD* demonstrates a notable positive correlation with the *CRO, FZ, ERM*, and *FP*. The strength of these correlations varies, with some reaching a level of statistical significance ($p < 0.01$). The results indicate a positive and statistically significant correlation

between the *CRO* and *FZ* (r = 0.223), *FL* (r = 0.044), *ERM* (r = 0.022), *IC* (r = 0.079), and *FP* (r = 0.050) at varying levels of significance ($p < 0.05$ for some correlations). *FZ* demonstrates a significant positive correlation with nearly all variables, including *BOD, CRO, FL, ERM, IC*, and *FP*. The highest correlation is observed with *IC* (r = 0.431) at $p < 0.01$. A significant positive correlation is observed between *FL* and *BOD, CRO, FZ*, and *ERM*. Conversely, a very small and negative, non-significant correlation is evident between *FL* and *FP* (r = -0.001). *ERM* exhibits a significant positive correlation with *BOD, FZ, FL, IC*, and *FP*, with the highest correlation observed with *FP* (r = 0.126) at $p < 0.01$. There is a positive and significant correlation between *IC* and *FZ, ERM*, and *FP*. The highest correlation is between *IC* and *FZ* (r = 0.431) at $p < 0.01$. *FP* is positively and significantly correlated with *BOD, CRO, FZ, ERM*, and *IC*, with the highest correlation observed between *FP* and *FZ* (r = 0.077) at $p < 0.01$.

The Chow test is utilized to distinguish between the common effect model approach and the fixed effect model. In accordance with this hypothesis, if the probability value of the cross-section Chi-square is less than 0.05, the null hypothesis (H_0), which states that there is no impact, will be rejected. Conversely, if the probability value of the cross-section Chi-square for the alternative hypothesis is greater than 0.05, it will be accepted as H_0 is rejected. The results of the Chow test are presented in Table 3, where the probability value is recorded as 0.0000. In accordance with the test outcome, if the p-value falls below the 0.05 significance level, the fixed effect model is preferred, rendering the Lagrange multiplier (LM) test unnecessary.

Table 3. Chow test result

Effect test	*Statistic*	*df*	*Prob.*
Cross-section F	9.548326	215.2112	0.0000
Cross-section Chi-square	1129.142899	215	0.0000

The Hausman test is employed to further distinguish between the fixed effect model approach and the random effect model. In accordance with the aforementioned hypothesis, the alternative hypothesis is rejected if the probability value of the cross-section Chi-square is less than 0.05. Conversely, if H_0 yields a probability value of the cross-section Chi-square greater than 0.05, it is accepted as the correct hypothesis. As illustrated in Table 4, the results of the Hausman test indicate a probability value of 0.0051. In the Hausman test, if the p-value is less than 0.05, the fixed effect model is the preferred estimation model. In light of the aforementioned evidence, it can be concluded that the fixed effect model represents the most appropriate regression estimation model.

Table 4. Hausman test result

Test summary	*Chi-sq. statistic*	*Chi-sq. df*	*Prob.*
Cross-section random	32.3489021	215.2112	0.0051

4.3. Hypothesis test result

Table 5 presents the results of the hypothesis evaluation through a regression analysis. This analysis shows the direct effects of the independent variables on the outcome variables in two models, as well as the results of a moderating effect.

Table 5. Hypotheses test result

Variables	*Coefficient (β)*	*Std. error*	*t-statistics*	*Prob.*
Model 1. Outcome variable: ERM				
Main effect				
Constant	0.000650	0.002341	2.123090	0.0328
BOD	2.02E-09	1.93E-05	2.423960	0.0152
CRO	0.028138	0.014961	1.983452	0.0423
Control variables				
FZ	0.000200	0.000233	2.650394	0.0070
FL	0.000215	3.53E-06	4.341280	0.0000
Adjusted R-squared	0.652348	-	-	-
Model 2. Outcome variable: FP				
Main effect				
Constant	0.656560	0.229034	2.845343	0.0045
BOD	0.005223	0.001845	2.830400	0.0047
CRO	1.053884	1.429455	1.737263	0.0498
ERM	17.593490	2.730163	6.523108	0.0000
Adjusted R-squared	0.536388	-	-	-
Control variables				
FZ	0.022349	0.012394	2.13280	0.0378
FL	-0.004320	0.003231	-2.43280	0.0057
Results of MRA				
*ERM * IC*	0.783012	0.23123	3.74039	0.0007
Adjusted R-squared	0.543280	-	-	-
Total panel observations	1435	1435	1435	1435

Model 1: Outcome variable — ERM. The constant term has a coefficient of 0.000650, with a t-statistic of 2.123090 and a p-value of 0.0328. These values indicate that the constant term is statistically significant at the 5% level. The coefficient for *BOD* is notably small (2.02E - 09), with a t-statistic of 2.423960 and a p-value of 0.0152. This indicates a statistically significant positive effect on *ERM* at the 5% level of significance. The coefficient for *CRO* is 0.028138, with a t-statistic of 1.983452 and a p-value of 0.0423, indicating a significant positive effect on *ERM* at the 5% level. The following variables were identified as potential control variables:

- *FZ*: The coefficient is 0.000200, with a t-statistic of 2.650394 and a p-value of 0.0070, indicating a significant positive effect on *ERM*.
- *FL*: The coefficient is 0.000215, with a t-statistic of 4.341280 and a p-value of 0.0000, indicating a highly significant positive effect on *ERM*. The adjusted R-squared value of 0.652348 indicates that approximately 65.2% of the variability in *ERM* is explained by the model.

Model 2: Outcome variable — FP. The constant term has a coefficient of 0.656560, with a t-statistic of 2.845343 and a p-value of 0.0045, indicating statistical significance at the 1% level. The coefficient for *BOD* is 0.005223, with a t-statistic of 2.830400 and a p-value of 0.0047, indicating a statistically significant positive effect on *FP* at the 1% level. The coefficient for *CRO* is 1.053884, with a t-statistic of 1.737263 and a p-value of 0.0498, indicating a significant positive effect on *FP* at the 5% level. The coefficient for *ERM* is 17.593490, with a t-statistic of 6.523108 and a p-value of 0.0000, indicating a highly significant positive effect on *FP*. The adjusted R-squared value of 0.536388 indicates that approximately 53.6% of the variability in *FP* is explained by the model.

The results of the moderating effect (MRA) indicate that the interaction term has a coefficient of 0.783012, with a t-statistic of 3.74039 and a p-value of 0.0007. This suggests a significant positive moderating effect of *IC* on the relationship between *ERM* and *FP*. The adjusted R-squared value of 0.543280 for the moderating model indicates that approximately 54.3% of the variability in *FP* is explained by the model, which includes the interaction term.

5. DISCUSSION

5.1. The impact of the board of directors on enterprise risk management

The results of the hypothesis testing demonstrated a probability value of 0.0152, which is less than the 0.05 significance level. This finding indicates that the *BOD* exerts a significant influence on *ERM* in Southeast Asian mining companies. The findings revealed a positive correlation between the *BOD* and *ERM*, with COSO (n.d.) emphasizing that effective ERM necessitates active board involvement. The BOD plays a pivotal role in determining the strategic direction of the company, ensuring compliance with regulations, and monitoring performance, particularly with regard to integrating risk management into strategic decision-making processes. The presence of diversity in the characteristics of the board, including backgrounds and expertise, has been demonstrated to enhance the capacity to identify and manage risks, thereby contributing to the development of more robust governance and risk management frameworks (Merendino & Melville, 2019; Pucheta-Martínez & Gallego-Álvarez, 2020). This is consistent with the findings of Bhat et al. (2020), who discovered that the presence of diverse members on a board is positively associated with the effectiveness of ERM implementation. Khaireddine et al. (2020) further emphasize the vital role of boards with extensive risk management knowledge in the successful implementation of ERM. Active board involvement is a crucial factor in optimizing ERM practices, as evidenced by the findings of Gordon et al. (2009) and SEC regulation 33-9089, which require boards to oversee risk management policies. Although this study lends support to the assertion that the board exerts a beneficial influence on *ERM*, as evidenced by the findings of Cecasmi and Samin (2017) and other researchers, its conclusions diverge from those of Chen et al. (2018). These latter authors reported a negative impact, which may have resulted from deficiencies in risk management skills or a lack of involvement. The study suggests that Southeast Asian mining companies should prioritize the role of the board in environmental, social, and governance (ESG) risk management, leveraging the diversity of the board and ensuring that members possess the requisite competence in risk management. The integration of ERM into strategic decision-making processes is contingent upon the presence of experienced and knowledgeable boards.

5.2. The impact of chief risk officers on enterprise risk management

The hypothesis test yielded a probability value of 0.0423, which is below the 0.05 threshold, indicating a statistically significant impact of the *CRO* on *ERM* effectiveness in the region. In the context of high-risk mining, the role of the *CRO* in identifying, assessing, and managing risks is of paramount importance. Their involvement can confer a competitive advantage and facilitate the achievement of long-term objectives for mining companies. The CRO is responsible for ensuring that risks inherent to the company are effectively identified, evaluated, and managed. As the principal figure in the domain of risk management, the CRO engages in collaborative endeavors with the senior management team and a multitude of departments. This is done with the objective of identifying critical risks, assessing their impact, and developing risk management strategies that are commensurate with the identified risks. Moreover, the CRO incorporates ERM practices into strategic decision-making processes, as evidenced by Bailey (2022), who underscored the pivotal role of the CRO in ensuring ERM success. Furthermore, the CRO bears the responsibility of maintaining continuous supervision and monitoring of ERM practices, with the aim of ensuring the efficacy of risk monitoring and reporting systems. Such oversight allows for the prompt identification of risks and the implementation of mitigation measures. Mladenović (2012) underscored the importance of the CRO in communicating the significance of risk management throughout the organization and maintaining resilience, which is vital for a company's survival during crises.

Al-Farsi (2020) highlighted the crucial role of the CRO in the adoption and implementation of ERM in volatile industries such as oil, underscoring the significance of their contribution to high-risk sectors. Similarly, Beasley et al. (2013) found that companies with a CRO experienced improved asset opacity, reduced market-to-book ratios, and decreased earnings volatility, thereby supporting the CRO's positive impact on corporate transparency and stability. Given the CRO's significant impact on ERM, mining companies in Southeast Asia should strengthen the CRO's role through training, resources, and management support. Integrating the CRO into strategic decisions, communication, and crisis planning is essential for managing emerging risks and ensuring business continuity.

5.3. The impact of enterprise risk management on firm performance

The discussion underscores the pivotal function of ERM in optimizing the performance of mining companies in Southeast Asia. The effective integration of ERM into management practices

enables companies to more effectively navigate industry challenges, improve performance, and increase overall value. Effective risk management is not merely a technical matter; it also encompasses communication and adaptation to market conditions. This is crucial for meeting the evolving demands of the industry. The study's analysis demonstrates a substantial positive impact of ERM on FP, with a probability value of 0.000, thereby substantiating its efficacy. These findings are consistent with the proposition that strategic risk management has a significant positive impact on FP, optimizing decision-making, resource allocation, stakeholder trust, adaptability, resilience, regulatory compliance and fostering innovation (Anton & Nucu, 2020; Chairani & Siregar, 2021; Lechner & Gatzert, 2017; Phan et al., 2020).

The implementation of ERM strategies contributes to the enhancement of shareholder value, as evidenced by the stabilization of stock prices, reduction of external capital costs, and optimization of capital efficiency. This ultimately mitigates the risk of total failure. This approach serves to protect and enhance shareholder value, enabling more optimal investment decisions that align with investor risk preferences and confidence. The prioritization of material risks and the implementation of robust risk management techniques have been demonstrated to enhance company performance and shareholder value. The implementation of advanced ERM practices has been observed to result in a reduction in stock price volatility and an enhancement in the efficacy of capital management. This ultimately serves to safeguard and potentially increase shareholder value (Gordon et al., 2009). The mining sector, like other high-risk industries, benefits significantly from robust ERM frameworks. However, ERM's impact depends on its integration with firm strategies. Mining firms in Southeast Asia should strengthen ERM practices to align with strategic goals and build investor confidence through transparent communication, considering the industry context (Golshan & Rasid, 2012).

5.4. The impact of the board of directors on firm performance

The results of the regression analysis indicate a statistically significant positive correlation between the *BOD* and *FP*, with a probability value of 0.0047, which is below the 0.05 level of statistical significance. This highlights the pivotal role of the *BOD* in improving the performance of mining companies in Southeast Asia. The positive impact of the *BOD* on *FP* is consistent with the tenets of corporate governance and agency theory, which underscore the significance of *BOD* composition, structure, and actions in influencing company performance and strategic direction. Effective governance places significant emphasis on the responsibility of the *BOD* to uphold the interests of shareholders, to ensure transparency, accountability, and ethical conduct within the organization (Pucheta-Martínez & Gallego-Álvarez, 2020; Merendino & Melville, 2019).

It is imperative that the *BOD* be active in order to set strategic directions, thus enabling Southeast Asian mining companies to navigate industry challenges and opportunities. The capacity to make strategic decisions enables companies to remain competitive and adaptable to market changes. Effective oversight by the *BOD* allows for the prompt addressing of operational or financial issues, thereby minimizing negative impacts on performance. Furthermore, the board's active involvement facilitates the acquisition of new resources and opportunities for growth through strategic diversification and innovation (Kanakriyah, 2021). Diversity among members of the *BOD* enhances the identification and management of risks, thereby fostering the development of effective strategies to address multidimensional risks. Furthermore, this diversity encourages innovation and sustainability, enabling companies to adapt to changes in the industry (Bhat et al., 2020; Khaireddine et al., 2020). However, some research findings contradict these conclusions. The studies conducted by Titova (2016) indicate that a smaller *BOD* may enhance communication and accelerate decision-making processes, which could, in turn, lead to an improvement in *FP* under specific circumstances. Other studies, such as those by Choi et al. (2007) have found no significant relationship between *BOD* and *FP*. This may be due to variations in board characteristics. Mining companies in Southeast Asia should carefully consider their board structure and composition, ensuring greater *BOD* involvement in strategic decisions. Enhancing *BOD* competencies through training and diversifying board expertise can improve decision-making and creativity. Implementing strong corporate governance practices will ensure transparency, accountability, and high ethical standards.

5.5. The impact of chief risk officer on firm performance

The notable positive correlation between the *CRO* and organizational performance highlights the pivotal role of the *CRO* in comprehensive risk management. Mining companies stand to gain from the *CRO's* expertise, which serves to refine risk practices and thus contribute to long-term success in the dynamic Southeast Asian mining sector. A regression analysis in this sector demonstrates a statistically significant positive correlation (0.0498) between the presence of a *CRO* and the performance of the firm, which highlights effective risk management as a key driver of success.

Empirical evidence indicates that the presence of a *CRO* and effective risk management enhance operational efficiency and *FP*, underscoring the *CRO's* critical role in aligning risk management with corporate goals (Bailey, 2022). Furthermore, a *CRO* facilitates a balanced approach to risk and return, encouraging companies to undertake calculated risks when the potential rewards are significant and quantifiable. An effective *CRO* also serves to bolster stakeholder confidence, including that of shareholders, customers, employees, and regulators, through the implementation of transparent and efficient risk management strategies, thereby enhancing the company's image and customer trust. The *CRO's* strategic involvement in aligning risk management with business objectives and protecting the organization's assets plays a pivotal role in fostering and sustaining stakeholder trust (Bailey, 2022).

In Southeast Asian mining companies, the *CRO* plays a crucial role in risk stability and management, with high-quality *CROs* significantly enhancing

financial stability (Baesley et al., 2008). This study supports previous findings on the positive impact of *CROs* on performance. However, the effectiveness of *CROs* depends on company characteristics such as leverage, size, and expertise. Thus, mining firms should strengthen the *CRO's* role through training, resources, and strategic integration to optimize *ERM* strategies, improve communication, and ensure business continuity.

5.6. Role of intellectual capital in moderating the influence of enterprise risk management on firm performance

The study highlights the pivotal function of IC in optimizing the efficacy of ERM within the mining sector in Southeast Asia. The integration of IC with ERM enables companies to more effectively manage risks, enhance operational efficiency, and achieve long-term success. Such integration serves not only to mitigate risks but also to implement a proactive strategy for enhancing shareholder value and maintaining a competitive edge.

The results of the MRA indicate that IC functions as a quasi-moderator between ERM and FP, which aligns with the contingency perspective. This indicates that the efficacy of ERM is contingent upon the quality and scope of an organization's IC. The impact of ERM on risk identification, assessment, and management is amplified by human, structural, and relational capital. IC a crucial role in aligning ERM strategies with organizational goals, which is vital for optimizing risk management efforts. Organizations with robust IC foundations exhibit enhanced adaptability and resilience, enabling them to effectively navigate challenges and enhance overall performance. This integration enhances the organization's capacity to flourish in complex environments, resulting in superior outcomes. This study is consistent with the findings of Khan et al. (2019) which show that IC positively moderates the relationship between ERM and FP, enabling companies to better adapt and achieve higher results. Thus, integrating IC into ERM is essential for optimizing risk management and achieving strategic goals, while a diverse board enhances creative and effective decision-making.

6. CONCLUSION

This study offers valuable empirical evidence on the pivotal roles of the BOD and the CRO in strengthening ERM and enhancing FP within the mining sector of Southeast Asia. The findings indicate a positive correlation between active BOD involvement and the effectiveness of ERM practices, underscoring the necessity for robust governance structures in effective risk management. Furthermore, the presence of a CRO has been shown to significantly enhance risk identification, assessment, and mitigation, thereby underscoring the strategic importance of fostering a risk-aware culture and integrating risk management into organizational processes. Furthermore, the research identifies IC as a critical moderating factor in the ERM-performance relationship. The effective leveraging of IC, encompassing human, structural, and relational capital, enables firms to achieve superior performance by enhancing their ERM practices. This highlights the potential for a synergistic relationship between IC and ERM in navigating the complexities of the mining sector's volatile business environment.

This study has some limitations that future research could address, particularly its focus on the Southeast Asian mining sector, which may restrict the generalizability of the findings to other industries or regions. Future studies could explore context-specific factors affecting ERM effectiveness and the role of IC in diverse settings to gain a broader understanding of these dynamics across sectors. Additionally, using longitudinal data could deepen insights into the long-term impact of BOD and CRO roles on FP, further enriching the discourse on corporate governance and risk management.

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