Predicting Fraudulent Financial Statements Using Fraud Score Model and Fraud Hexagon Theory: Evidence from Mining Companies Listed in the Indonesia Stock Exchange

Eldio Alfian Tombang[1] and Agus Setiawaty[1*]

[1] Department of Accounting, Faculty of Economics and Business, Mulawarman University, Indonesia

*setiawaty_agus@yahoo.co.id

Abstract. This study aims to examine the influence of the Fraud Hexagon Theory elements on financial statements predicted to contain fraudulent reporting among mining companies listed on the Indonesia Stock Exchange (IDX) during the 2022–2024 period. The six elements of the Fraud Hexagon pressure, opportunity, rationalization, capability, arrogance, and collusion—are represented by selected financial and governance indicators obtained from annual reports. Logistic regression analysis is employed using the F-Score model to classify companies as potentially engaging or not engaging in fraudulent financial statements. The results indicate that financial stability and total accruals to total assets (TATA), representing the pressure and rationalization elements, respectively, have a positive and significant relationship with predicted fraudulent financial statements. Meanwhile, ineffective monitoring, representing the opportunity element, does not show a significant effect. Other elements, including capability, arrogance, and collusion, also do not exhibit significant effects. This study focuses on the post-pandemic period (2022–2024) to provide more reliable evidence and avoid potential bias caused by the economic disruptions of the COVID-19 crisis. From the perspective of the Fraud Hexagon Theory, financial stability and TATA are identified as the most influential factors in explaining predicted fraudulent financial statements.

Keywords: Fraud Hexagon Theory, Fraudulent Financial Statements, Fraud Score Model.

1 Introduction

Investment activity in Indonesia has surged, leading investors to depend on clear and trustworthy financial statements to evaluate corporate fiscal health and future potential [1]. Transparency is crucial for maintaining market confidence, as the precision of financial disclosures influences investor decision-making and regulatory evaluations of compliance [2]. Fraudulent manipulation of financial reports persists, consistently harming shareholders and eroding public confidence in corporate governance systems [3].

The global history of accounting scandals, including major cases like Enron and WorldCom, shows how pressure from managers to meet market expectations can lead to dishonest reporting [4]. In Indonesia, dishonest financial statements are often

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connected to aggressive earnings management and income smoothing that are meant to protect a company's good name [5]. The Association of Certified Fraud Examiners [6] says that financial statement fraud is only 5% of all occupational fraud cases, but it causes the most median losses among all types of fraud.

Industries characterized by intricate business frameworks, such as mining and manufacturing, encounter elevated fraud risks attributable to operational complexities, insufficient internal controls, and significant performance pressures [7]. Previous studies have shown that these industries often use accounting tricks, like changing the value of inventory and doing business with related parties, to hide their real financial performance [8]. The mining sector has the highest median loss per case, according to the [6]. This shows how easy it is for fraud to happen in this industry. **Figure 1** shows these differences between industries even more clearly.

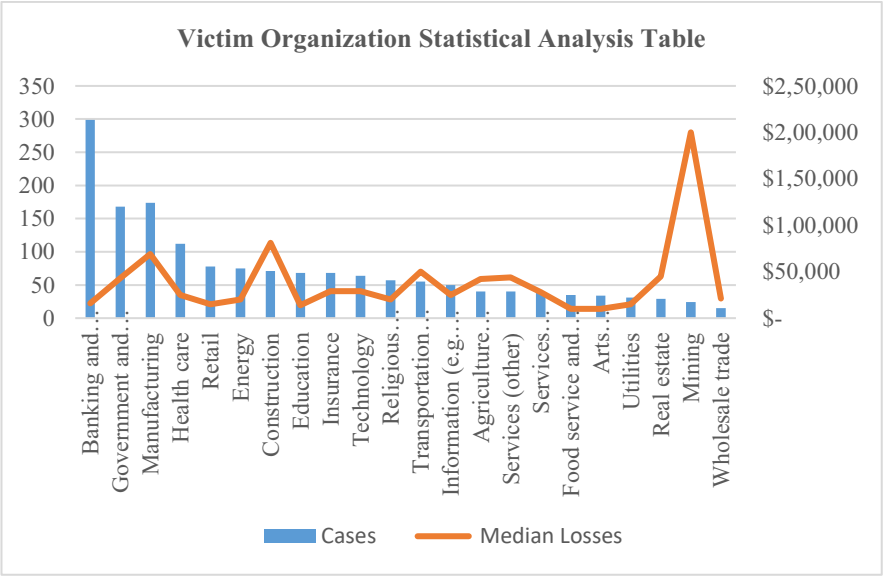


Fig. 1. Distribution of Fraud Cases and Median Losses by Industry [6]

Fraud detection models have developed over decades, starting with the Fraud Triangle, which identifies pressure, opportunity, and rationalization as the main causes of fraud [9]. Later changes added capability to the Fraud Diamond model [10] and arrogance to the Fraud Pentagon model [11]. The most recent development is the Fraud Hexagon Theory put forward by [12]. This theory says that collusion is an important part of more complex types of fraud that need coordinated actions from more than one person.

The empirical evidence regarding the Fraud Hexagon remains inconclusive. Some studies indicate that only specific factors, such as opportunity and pressure, consistently demonstrate significance in predicting fraudulent financial reporting [13]. Some assert that capability, arrogance, or collusion exhibit variable impacts across different industries and research settings [14]. Other studies have also found that collusion may

be the best predictor in some areas, while other factors are not as important [15]. These diverse outcomes highlight the necessity for additional empirical validation of the Hexagon model, especially within high-risk sectors.
Furthermore, previous research frequently depends on restricted timeframes or datasets that fail to reflect post-pandemic economic conditions, which may have transformed fraud pressures, monitoring efficacy, and financial reporting practices. Since the factors that lead to fraud change over time, it is important to do new analyses to keep theoretical frameworks like the Fraud Hexagon useful.

Given the mining sector's significant vulnerability to fraud, operational intricacy, and the considerable financial repercussions of fraudulent reporting, a more thorough analysis of the six components of the Fraud Hexagon in this industry is necessary. This study seeks to fill this void by assessing the impact of pressure, opportunity, rationalization, capability, arrogance, and collusion on the probability of fraudulent financial statements in Indonesian mining firms.

2 Theory foundation and hypothesis development

2.1 Fraud

Fraud is the act of intentionally lying to get something that isn't rightfully yours [16]. The Association of Certified Fraud Examiners (ACFE) divides occupational fraud into three groups: corruption, asset misappropriation, and financial statement fraud. Asset misappropriation is when someone steals or misuses company resources. Corruption is when someone takes bribes, has a conflict of interest, or extorts money.

When managers change accounting information on purpose to trick users, like by overstating revenues or changing the value of assets, this is called financial statement fraud. This type of fraud happens less often, but it costs the most money. Mining and other industries with complicated operations are at greater risk because they have high-value transactions and big problems with governance.

2.2 Fraud Hexagon Theory

The Fraud Hexagon Theory, proposed by [12], builds upon previous frameworks including the Fraud Triangle [9], Fraud Diamond [10], and Fraud Pentagon [11]. The Fraud Hexagon adds collusion to the list of things that its predecessors focus on, like pressure, opportunity, rationalization, capability, and arrogance. This is because modern fraud schemes often involve cooperation between more than one person. Here are the six parts:

(1) Pressure

Pressuree is the internal or external forces that push people to commit fraud, such as financial instability, high performance goals, or expectations from investors. In the mining industry, these pressures are made worse by unstable prices for goods and high costs of doing business [17].

(2) Opportunity

When internal controls are weak or monitoring isn't done well, fraud can happen without anyone noticing. Mining companies often have opportunities because they are very complicated to run, not very open, and don't have enough oversight [18].

(3) Rationalization

Rationalization is when people who do bad things try to make themselves feel better about it by making excuses and seeing dishonest actions as okay. People often say that manipulating financial statements is only temporary, necessary for the survival of the business, or a common practice in the industry, which lets managers justify lying about their reports [19].

(4) Capability

Capability encompasses the perpetrator's skills, authority, access, and position that facilitate the commission and concealment of fraud. People who have a lot of managerial freedom and technical knowledge can take advantage of systemic weaknesses more easily [11].

(5) Arrogance

When you think you're better than everyone else, you're too sure of yourself, or you don't think you'll have to deal with the consequences, you're being arrogant. Executives with concentrated power, such as those holding dual positions or wielding significant influence, frequently exhibit these characteristics [20].

(6) Collusion

Collusion is when two or more people work together to commit fraud, which makes it harder to find out about it. In mining companies, relationships with contractors, suppliers, or government regulators often lead to collusion [21]

2.3 hypothesis development

The Fraud Hexagon Theory posits that fraudulent financial reporting is influenced by six fundamental conditions: pressure, opportunity, rationalization, capability, arrogance, and collusion. Each element offers a theoretical foundation for forecasting managers' inclination to distort financial statements. The hypotheses that follow are therefore created.

(1) Pressure and fraudulent financial statements

When companies are financially unstable, don't meet performance goals, or have higher expectations from outside sources, they feel pressure. These kinds of situations make managers want to change reported earnings to keep things looking stable. Based on the discussion above, the following hypothesis is put forward:

H1. It is suspected that pressure has a positive effect on the likelihood of fraudulent financial statements.

(2) Opportunity and fraudulent financial statements

Opportunity arises from weak internal controls, ineffective monitoring, or insufficient oversight by governance bodies. When such weaknesses exist, managers are more able to engage in manipulation without detection. Based on the above discussion, the following hypothesis is proposed:

H2. It is suspected that opportunity has a negative effect on the likelihood of fraudulent financial statements.

(3) Rationalization and fraudulent financial statements

Rationalization reflects the cognitive justification used by perpetrators to legitimize unethical behavior. When managers perceive manipulation as acceptable or necessary, they are more likely to misstate financial information. Based on the above discussion, the following hypothesis is proposed:

H3. It is suspected that rationalization has a positive effect on the likelihood of fraudulent financial statements.

(4) Capability and fraudulent financial statements

Capability refers to the authority, experience, access, and technical competence that enable individuals to commit and conceal fraud. Managers with high capability can more easily override controls and exploit systemic weaknesses. Based on the above discussion, the following hypothesis is proposed:

H4. It is suspected that capability has a positive effect on the likelihood of fraudulent financial statements.

(5) Arrogance and fraudulent financial statements

Arrogance is associated with excessive confidence, dominance, or perceived immunity to sanctions, often linked to concentrated executive power such as CEO duality. Such leaders are more inclined to disregard governance mechanisms. Based on the above discussion, the following hypothesis is proposed:

H5. It is suspected that arrogance has a positive effect on the likelihood of fraudulent financial statements.

(6) Collusion and fraudulent financial statements

Collusion involves cooperation among multiple parties, which allows fraud to be executed more smoothly and remain undetected for longer periods. Collaborative manipulation increases the sophistication of fraudulent schemes. Based on the above discussion, the following hypothesis is proposed:

H6. It is suspected that collusion has a positive effect on the likelihood of fraudulent financial statements.

2.4 Theoretical framework

The description above can be presented in a theoretical framework as in **Figure 2** below.

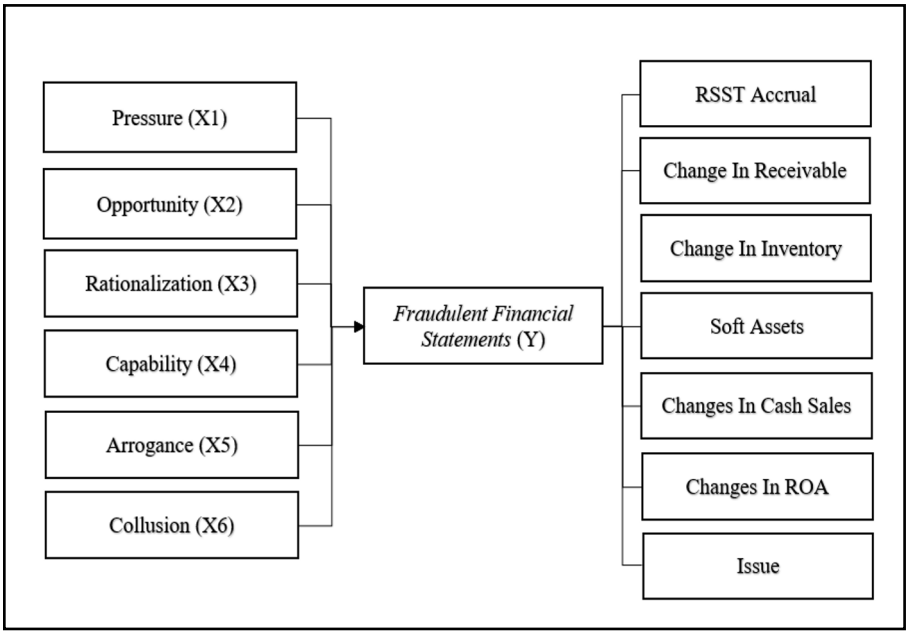


Fig. 2. Theoretical framework source from author

3. Research methods

3.1 Dependent variable

The dependent variable is fraudulent financial statements, assessed as a binary variable. Companies that are thought to be cheating on their finances are given a code of 1, while companies that follow the rules are given a code of 0. This classification employs the F-Score model, which relies on seven indicators specified in Table 1. The last F-Score is then compared to a set threshold to see if a company is fraud or not.

After calculating the seven indicators, their values are entered into the Predicted Value (P.V.) equation to generate the model's initial estimate of misstatement risk. The P.V. results from a linear combination of these indicators using coefficients from [22].

$$\text{Predicted Value (P.V)} = -7.893 + 0.790 \times (\text{rsst acc}) + 2.518 \times (\text{ch rec}) + 1.191 \times (\text{ch inv}) + 1.979 \times (\text{soft assets}) + 0.171 \times (\text{ch cs}) + (-0.932) \times (\text{ch roa}) + 1.029 \times (\text{issue})$$

The P.V. is then converted into a probability ranging from 0 to 1 using a logistic function, producing a bounded likelihood of misstatement.

$$\text{Prob.} = \frac{e^{P.V}}{1 + e^{P.V}},$$

where *e* represents the mathematical constant 2.71828183.

The final step is to convert the probability into the F-Score, which standardizes the misstatement likelihood based on the unconditional probability proposed by [22]. The resulting F-Score serves as the basis for determining whether a firm is classified as fraudulent or non-fraudulent within the study.

$$\text{F-Score} = \frac{\text{Pro}}{0.0037'}$$

where 0.0037 represents the unconditional probability.

Table 1. Indicators Used in the F-Score Fraud Detection Model

No.	Variable	Formula
1	RSST Accruals (*rsst acc)*	$\frac{\Delta WC + \Delta NCO + \Delta FIN}{Average\ Total\ Assets}$
2	Change In Receivables (*ch rec)*	$\frac{Receivables_t - Receivables_\{t-1\}}{Sales_t}$
3	Change Inventory (ch inv)	$\frac{Inventory_t - Inventory_\{t-1\}}{Sales_t}$
4	Change In Cash Sales (ch cs)	$\frac{Inventory_t - Inventory_\{t-1\}}{Sales_t}$
5	Soft Assets	$\frac{Total\ Assets - PPE}{Total\ Assets}$
6	Change In ROA (ch roa)	$\frac{Earnings_t - Earnings_\{t-1\}}{\lvert Earnings_\{t-1\}\rvert}$
7	Issue of Securities	Indicator = 1 if firm issues equity or debt, else 0

3.2 Independent Variable

The independent variables in this study are derived from the six components of the Hexagon Fraud Theory. Pressure is proxied by financial stability, reflecting the firm's ability to sustain asset levels. Opportunity is represented by Ineffective Monitoring, which captures conditions that allow managerial discretion. Rationalization is measured through total accruals to total assets, while competence is proxied by CEO education. Arrogance is reflected in the frequency of CEO images in the annual report, and collusion is measured through related-party transactions. The variables and their measurement indicators are presented in Table 2 below.

Table 2. Variable operationalization

Element	Independent variables	Variable Measurement	References
Pressure	financial stabilty (fs)	$\frac{Assets_t \; - \; Assets_\{t-1\}}{Assets_\{t-1\}}$	[23]
opportunity	Ineffective monitoring	$\frac{Board\ Independence}{Total\ Assets}$	[24]
rationalization	total accrual to total assets (tata)	$\frac{NI - Cash\ Flow\ from\ Activities}{Total\ Assets}$	[25]
competence	CEO Education (CEOEDU)	Dummy Variable takes number 1 if The CEO has an educational background in economics and business, otherwise 0	[26]
arrogance	Frequency Number of CEO Image (CEO_Pic)	The accumulated number of CEO images in the annual report of company	[27]
collusion	Related Party Transactions (RPTS)	$\frac{Related\ Party\ Receivables}{Receivables}$	[28]

3.3 Research population and sample

This study utilizes secondary data obtained from the annual reports and financial statements of mining companies listed on the Indonesia Stock Exchange for the 2022–2024 period. The sample was selected using a purposive sampling approach based on criteria aligned with the research objectives. The detailed screening process used to determine the final sample is presented in Table 3.

Table 3. Distribution of Research Samples

Sample determination criteria	Total
Mining companies listed on the Indonesia Stock Exchange (IDX) consecutively during 2022–2024	75
Companies do not publish a complete annual report on their website or on the IDX website during the research period	(20)
Companies that are not under suspension or delisting and have data that match the variables being studied.	(2)
The number of companies that meet the research criteria	53
The number of samples that meet the research criteria	159

3.4 Data Analysis Method

This study employs logistic regression analysis to examine the influence of the independent variables on the likelihood of fraudulent financial statements. Logistic regression is appropriate when the dependent variable is binary, as in this study, where firms are classified as fraudulent (1) or non-fraudulent (0) based on the F-Score model. This analytical method allows the estimation of the probability that a firm engages in fraudulent reporting by modeling the relationship between the fraud indicator and the six components of the Hexagon Fraud Theory. Logistic regression is also suitable because it does not require normally distributed data and can handle predictor variables measured on different scales. The regression model for this study is expressed as follows:

$$In\ P/(1-PP) = \beta 0+\beta 1FS+\beta 2BDOUT+\beta 3TATA+\beta 4CEOEdu+\beta 5CEOPic+\beta 6RPTS+e$$

Annotation:

FS = Financial Stability
BDOUT = Board Independence
TATA = Total Accruals to Total Assets
CEOEDU = Chief Executive Officer Education
CEOPIC = Chief Executive Officer Image Frequency
RPTS = Related-Party Transactions
FRAUD = Fraudulent Financial Statements
P.V. = Predicted Value
Prob = Probability
F-Score = Fraud Score
RSST = RSST Accruals (Richardson, Sloan, Soliman, and Tuna Accruals)
ΔREC = Change in Receivables
ΔINV = Change in Inventory
SA = Soft Assets
ΔCS = Change in Cash Sales
ΔROA = Change in Return on Assets
ISSUE = Security Issuance Indicator
IDX = Indonesia Stock Exchange
CEO = Chief Executive Officer

4 Research results

4.1 Descriptive statistics

Descriptive statistics provide an overview of the data based on the mean, standard deviation, and the minimum and maximum values of each variable [29] Table 4

Table 4. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
FS	153	-0,53	5,08	0,1194	0,48008
BDOUT	153	0,25	1,00	0,4292	0,12855
TATA	153	-0,62	0,29	0,0445	0,11442
CEOEDU	153	0,00	3,00	0,7059	0,51148
CEOPIC	153	0,00	6,00	2,4118	0,99028
RPTS	153	0,00	1,00	0,2258	0,33060
FSCORE	153	0,00	1,00	0,0850	0,27975
Valid N (listwise)	153				

4.2 Logistic regression analysis

The goodness-of-fit of the logistic regression model was assessed using the Hosmer–Lemeshow test, originally introduced by [30]. The obtained significance value of 0.973 indicates that the model fits the data well, as the predicted probabilities align closely with observed outcomes. A p-value greater than 0.05 suggests that the model does not suffer from specification errors and is therefore suitable for further analysis.

Model adequacy was further examined through the log-likelihood statistic, a concept first established by [31] in the development of maximum likelihood estimation. The reported −2 Log Likelihood value of 45.349 shows a strong improvement compared to the null model. A lower −2LL value reflects a better-fitting model, and the observed reduction confirms that the inclusion of the six predictors substantially enhances the explanatory capability of the model in detecting fraudulent financial statements.

The Nagelkerke R^2, an adjusted coefficient of determination suggested by [32] to make pseudo-R^2 values in logistic regression easier to understand, was used to measure the model's overall explanatory power. The value of 0.563 means that the predictors explain about 56.3% of the differences in fraudulent financial statements. In fraud detection research, this level of explanatory power is thought to be strong, while behavioral and managerial predictors usually have a moderate effect.

In contrast, capability, arrogance, and collusion are not significant predictors. CEO educational background aligns with the findings of [20] and [15], which suggest that educational attainment alone does not determine managerial misconduct. Similarly, arrogance measured by CEO photo frequency does not significantly predict fraud, consistent with evidence that such proxies may not adequately capture psychological dominance [13] Related party transactions also show no significant effect, consistent with mixed results in prior studies, likely due to stringent disclosure requirements in the mining sector. Table 5

Table 5. Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	FS	4,883	1,600	9,312	1	,002	132,059
	BDOUT	-5,456	4,528	1,452	1	,228	,004
	TATA	17,496	5,810	9,070	1	,003	39.666.795,44
	CEOEDU	-,021	,876	,001	1	,981	0,979
	CEOPIC	-,318	,466	,464	1	,496	0,728
	RPTS	1,145	1,350	,720	1	,396	3,142
	Constant	-,956	1,035	,852	1	,356	0,385

a. Variable(s) entered on step 1: FS,BDOUT, TATA, CEOEDU, CEOPIC, RPTS.

(1) Financial Stability (Pressure Element)

Financial stability exhibits a significant positive effect on fraudulent financial statements ($p = 0.002$). This finding indicates that firms experiencing unstable asset conditions or declining financial performance are more likely to engage in misstatement to present more favorable results. The result is consistent with prior studies showing that financial pressure increases the likelihood of fraudulent reporting as managers attempt to maintain investor confidence and mitigate negative market reactions [33]

(2) Ineffective monitoring (Opportunity Element)

Ineffective monitoring does not significantly affect fraudulent financial statements ($p > 0.05$), indicating that supervisory mechanisms do not effectively reduce fraud opportunities. This result is consistent with [24], who argue that formal board oversight does not guarantee effective supervision due to managerial dominance and information asymmetry, limiting the board's ability to detect financial statement manipulation.

(3) Total Accrual to Total Assets (Rationalization Element).

Rationalization exhibits a strong positive and significant effect on fraudulent financial statements ($p = 0.003$). This result supports the idea that discretionary accruals and accounting judgments allow managers to justify unethical actions, thereby facilitating fraudulent behavior. Consistent with [19], the findings indicate that accrual manipulation serves as a key mechanism through which rationalization translates into fraudulent financial reporting.

(4) CEO Education (Capability Element)

Capability, proxied by CEO educational background, does not significantly influence fraudulent financial statements ($p = 0.981$). This suggests that formal education alone does not determine a manager's ability or inclination to commit fraud. The finding aligns with earlier studies [20] showing that capability often depends on structural opportunities, authority access, and control weaknesses rather than educational attainment.

(5) CEO Picture (Arrogance Element)

Arrogance, measured through CEO photograph frequency, is not significantly associated with fraudulent financial statements ($p = 0.496$). This contradicts theoretical expectations from the fraud hexagon framework but aligns with studies indicating that this proxy may not accurately capture psychological dominance or excessive ego within highly regulated industries [27]. As

mining firms generally operate within rigid governance structures, photo visibility may not reflect managerial arrogance in a meaningful way.

(6) Related party transactions (collusion element)

Collusion, represented by related party transactions, does not significantly affect fraudulent financial statements (p = 0.396). Despite prior findings that RPTs may facilitate opportunistic behavior [21], the insignificant result suggests that mining-sector related party transactions are heavily monitored and subject to strict disclosure requirements, reducing their potential as a vehicle for manipulation. Similar nonsignificant findings have been reported in recent studies [28], reinforcing that collusion-based fraud may be less prevalent in highly regulated industries.

5 Conclusion and limitations of the research

The results of this study offer partial validation for the fraud hexagon theory. Pressure and rationalization are two factors that have a big effect on false financial statements in Indonesian mining companies. The opportunity factor, which is shown by poor monitoring, does not have a big effect. The importance of financial stability supports the theoretical assertion that companies facing economic strain or deteriorating asset performance are more inclined to distort reported outcomes to preserve investor trust and organizational legitimacy.

Ineffective monitoring does not substantially impact fraudulent financial statements, indicating that supervisory mechanisms may serve as formal governance structures rather than efficient instruments to limit managerial discretion. This suggests that in sectors that are heavily regulated and audited, like mining, compliance requirements and outside oversight may lessen the effect of weak internal monitoring on fraud. Rationalization continues to be a key predictor of fraud, underscoring how discretionary accruals and judgment-based accounting practices allow managers to rationalize unethical reporting behavior.

On the other hand, capability, arrogance, and collusion do not show strong links to financial statement fraud. These findings suggest that managerial attributes and relational factors have a minimal impact on the occurrence of fraud in firms operating under stringent regulatory frameworks. In general, the results show that the main causes of fraud risk in the mining industry are economic pressure and accounting discretion, not flaws in monitoring systems or the personalities of individual managers.

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