“Bridging governance and technology for fraud detection: Evidence from regional development banks in Indonesia”

AUTHORS	Angginun Juwita Sari Harahap Erlina

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Angginun Juwita Sari Harahap (Indonesia), **Erlina Erlina** (Indonesia)

BRIDGING GOVERNANCE AND TECHNOLOGY FOR FRAUD DETECTION: EVIDENCE FROM REGIONAL DEVELOPMENT BANKS IN INDONESIA

Abstract

Fraud remains a pervasive challenge undermining financial integrity and stability in the banking sector, particularly in developing economies. This study investigates the determinants of fraud detection effectiveness in Indonesian Regional Development Banks (RDBs), focusing on auditor competency, internal control effectiveness, risk-based internal audit, risk management processes, and information technology utilization. The study population consisted of internal auditors, managers, and audit committee members at Indonesian Regional Development Banks. Using a quantitative approach with 204 survey responses analyzed through Partial Least Squares-Structural Equation Modeling (PLS-SEM), the results show that all five factors have a significant positive effect on fraud detection ($R^2 = 0.554$). Risk-based internal audit demonstrates the strongest influence (sig 0.000 < 0.05), followed by risk management processes (sig 0.003 < 0.05), information technology (sig 0.002 < 0.05), internal control effectiveness (sig 0.001 < 0.05), and auditor competency (sig 0.017 < 0.05). The results reveal that all five factors significantly enhance auditors' ability to detect fraud. These findings indicate that governance mechanisms and digital capabilities jointly enhance fraud detection effectiveness in RDBs.

Keywords fraud detection, auditor competency, internal control, risk-based internal audit, risk management, information technology, Regional Development Banks, Indonesia

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Angginun Juwita Sari Harahap, Doctoral Student, Faculty of Economics and Business, Department of Accounting, Universitas Sumatera Utara [University of Northern Sumatra], Indonesia.

Erlina Erlina, Ph.D., Professor, Head of Study Program Magister and Doctoral of Accounting, Faculty of Economics and Business, Department of Accounting, Universitas Sumatera Utara [University of Northern Sumatra], Indonesia. (Corresponding author)

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INTRODUCTION

Fraud is widely recognized as a critical threat to organizational integrity, financial stability, and institutional reputation worldwide. Conceptually, fraud refers to the deliberate misrepresentation of facts or concealment of material information with the intent to induce actions that ultimately disadvantage other parties. Although often treated as misconduct, fraud may also constitute a crime in many jurisdictions. In Indonesia, the seriousness of this issue is evident. According to the 2022 Association of Certified Fraud Examiners (ACFE) survey, Indonesia's fraud prevalence rate was 48.5%, ranking the country fourth-highest in the Asia-Pacific region for the number of reported cases, with 23 incidents recorded in 2022. The majority of these incidents were attributed to corruption (64%), followed by asset misappropriation (28.9%) and financial statement fraud (6.7%). The 2023 Corruption Perception Index (CPI) by Transparency International underscored Indonesia's ongoing difficulties with corruption as a systemic issue. Within the banking sector, fraud manifests in diverse forms such as document forgery, fund embezzlement, manipulation of financial data and reports, and abuse of authority. These fraudulent practices not only cause significant financial losses but also erode

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public trust, which is the cornerstone of financial intermediation. The Indonesian Financial Services Authority (OJK) has responded by issuing regulations such as POJK No. 12/2024 on the Implementation of Anti-Fraud Strategy, which emphasizes the four-pillar approach of prevention, detection, investigation, and monitoring. Such regulatory initiatives aim to strengthen resilience in both conventional and Islamic banking institutions, acknowledging that Islamic banks – though relatively newer entrants – play a growing role in Indonesia's financial ecosystem as financial intermediaries tasked with mobilizing public funds and channeling them into productive financing.

Corporate governance forms the backbone of fraud mitigation in Indonesian banking. The governance framework requires

(i) rigorous fit and proper testing;
(ii) the independence of bank management; and
(iii) accountability for compliance with prevailing regulations.

Yet governance, in isolation, is insufficient. Fraud detection effectiveness requires a convergence of auditor competency, robust internal control systems, and the deployment of advanced information technology (IT). Emerging technologies such as artificial intelligence (AI), machine learning (ML), and blockchain-based auditing have revolutionized fraud detection practices by enabling early warning systems that identify abnormal transaction patterns, enhance transparency, and minimize data manipulation risks (Taherdoost, 2021). Recent innovations, including generative AI and adversarial networks, have demonstrated fraud detection accuracy rates of up to 97%, significantly outperforming earlier techniques with 77% accuracy (Selvarajan et al., 2025). These advancements underscore a paradigm shift in fraud detection, presenting unprecedented opportunities for banks in developing countries to close the technology gap with advanced economies. Despite this progress, Regional Development Banks (RDBs) in Indonesia face notable disadvantages compared to state-owned and private national banks. Limitations in digital infrastructure – including outdated core banking systems, insufficient hardware and software, and weak cybersecurity measures – hinder their capacity to detect fraud effectively. While major banks such as Bank Mandiri, BRI, and BCA have invested heavily in AI-driven fraud detection, big data analytics, and integrated digital payment systems, many RDBs remain constrained by budgetary and scale limitations. This technological disparity has tangible consequences: delayed detection of suspicious transactions, lower efficiency in data-driven auditing, and heightened operational risks. Furthermore, human capital constraints exacerbate these challenges, as internal auditors and IT staff in RDBs often lack access to training in forensic accounting, continuous auditing, or advanced data analytics.

1. LITERATURE REVIEW

Fraud detection in the banking sector is fundamentally embedded within broader corporate governance and risk oversight mechanisms. Banks operate under conditions of high information asymmetry, complex financial products, and significant public trust, making them particularly vulnerable to fraudulent behavior. Agency theory provides a foundational explanation for this vulnerability, positing that conflicts of interest between principals (shareholders and regulators) and agents (management) create incentives for opportunistic behavior, including financial misreporting and asset misappropriation. Within this framework, internal audit, internal control systems, and risk management functions serve as monitoring mechanisms designed to reduce information asymmetry and enhance accountability (Alzeban & Gwilliam, 2014).

The competence of internal auditors emerges as a critical determinant of fraud detection effectiveness. The proficiency of internal auditors is a crucial factor in the efficacy of fraud detection. Based on the resource-based view (RBV) approach (Barney, 1991), auditor competency is defined as a strategic organizational asset that enhances competitive advantage. Produced results of internal auditor quality that may be used to reduce

the impact of internal audits on fraud detection (Nwaobia et al., 2021). Proficient auditors integrate technical knowledge, command of auditing standards, and analytical skills, enabling them to detect fraudulent indicators with enhanced precision. Previous studies confirm that professional skepticism, independence, and sufficient training substantially improve fraud detection (Khulsum et al., 2025; Wahidahwati & Asyik, 2022). The efficacy of internal control systems is equally crucial. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) presented its integrated framework, which includes control environment, risk assessment, control actions, information and communication, and monitoring. Robust internal control cultivates a risk-conscious company culture that mitigates potential for fraud and improves the auditor's detection capabilities.

Empirical research demonstrates that consistently implemented internal control systems are favorably correlated with outcomes in fraud prevention and detection (Sihombing et al., 2023). Typically, a person acts in accordance with his/her own or other people's behavior. A behavioral decision-making model can be easily connected to the attribution process (Agustina et al., 2021). Internal control is a procedure created and influenced by those in charge of management, governance, and authority to provide sufficient assurance that the procedure will achieve the entity's goals with regard to the accuracy of financial records, the usefulness and proficiency of the procedure, and compliance with the principles, rules, and regulations (Haladu, 2018).

Another key mechanism is the adoption of Risk-Based Internal Auditing (RBIA). Risk-Based Internal Auditing (RBIA) represents a strategic shift from traditional, compliance-oriented auditing toward a proactive, risk-focused approach. Rather than uniformly allocating audit resources, RBIA prioritizes high-risk areas, enabling organizations to concentrate on processes and transactions that pose the greatest threat to financial integrity. From an agency theory perspective, this approach strengthens the monitoring role of internal audit by aligning audit priorities with stakeholder risk concerns. Research has further refined RBIA with multi-objective optimization frameworks, ensuring more systematic audit planning in line with organizational risk profiles (Wang et al., 2024). From the standpoint of agency theory, RBIA functions as an institutional safeguard to alleviate conflicts of interest between management and stakeholders, hence enhancing accountability and transparency. Le et al. (2022) demonstrated that risk-based audit approaches significantly improve the reliability of audit outcomes, while Mujalli (2024) found that RBIA implementation strengthens financial reporting quality through more targeted and systematic audit planning. Risk-based internal audits significantly enhance the capacity to detect fraud (Atmanegara et al., 2021a).

Research findings indicate that the use of risk management and risk-based internal auditing significantly enhances the identification of fraudulent activities. Risk management methods are intricately linked to the efficacy of fraud detection. A systematic risk management cycle encompassing risk identification, analysis, evaluation, treatment, and ongoing monitoring enhances corporate governance and diminishes the probability of fraudulent conduct. Recent studies indicate that good risk management mediates the relationship between governance and financial performance, hence providing enhanced reporting integrity (Bonrath & Eulerich, 2024). Despite these benefits, the effectiveness of RBIA and risk management is highly context-dependent. In developed markets, these systems are often integrated into sophisticated digital platforms and supported by strong regulatory oversight. In contrast, in emerging economies such as Indonesia, governance maturity, resource constraints, and uneven regulatory enforcement can moderate their impact (Albawwat, 2022).

Moreover, risk management aligns with the Technology Acceptance Model (TAM) (Monteiro et al., 2022) as integrating IT systems enhances user acceptance and satisfaction, thereby embedding fraud detection tools into organizational routines. Nevertheless, institutional and contextual differences between advanced and emerging economies cannot be ignored. While developed markets demonstrate consistent benefits from risk-based auditing and advanced IT adoption, findings in emerging markets such as Indonesia reveal mixed results. Digital tools such as big data analytics, artificial intelligence (AI), machine learning (ML), and

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continuous auditing systems enable auditors and risk managers to analyze large volumes of transactional data, identify anomalous patterns, and detect potential fraud at an early stage (Taherdoost, 2021). Constraints in governance maturity, auditors' independence, and management support may moderate the effectiveness of fraud detection systems (Albawwat, 2022; Syamsuddin et al., 2023). This highlights the necessity of contextualizing theoretical frameworks to reflect institutional realities in developing countries. Recent studies demonstrate that advanced analytical techniques significantly enhance fraud detection accuracy. Selvarajan et al. (2025) reported that generative AI and adversarial networks outperform traditional rule-based systems in identifying complex and evolving fraud schemes. Similarly, Matta and Chamoun (2025) found that auditors with high levels of IT literacy exhibit greater adaptability and effectiveness in technology-enabled audit environments. Recent systematic reviews highlight that deep learning and hybrid AI models outperform traditional rule-based systems in detecting complex and evolving fraud schemes, particularly in digital banking environments (Khan et al., 2025; Chen et al., 2025).

In conclusion, fraud detection in Indonesia's Regional Development Banks is shaped by the dynamic interplay of auditor competency, internal control effectiveness, risk-based internal audit, structured risk management, and information technology integration. Collectively, these elements create a synergistic system that strengthens organizational resilience against fraud. However, significant technological and human capital gaps persist between RDBs and larger national banks. For policymakers and regulators, the findings underscore the urgency of accelerating digital transformation programs, enhancing auditor training, and reinforcing governance frameworks to safeguard financial stability. For scholars, this context provides fertile ground for comparative studies that explore how institutional environments moderate the effectiveness of fraud detection mechanisms across developed and developing economies. Ultimately, bridging governance principles with technological innovation represents the most promising pathway toward effective fraud detection and sustainable banking integrity in Indonesia and beyond. Overall, prior studies have established that auditor competency, internal control systems, risk-based auditing, risk management, and information technology individually contribute to fraud detection effectiveness. However, existing research remains fragmented, often examining these mechanisms in isolation and predominantly within developed or central banking contexts. Limited empirical evidence is available on how these governance and technological factors interact within Regional Development Banks in emerging markets, creating a clear gap that this study seeks to address.

The purpose of this study is to examine the effect of auditor competency, internal control ef-

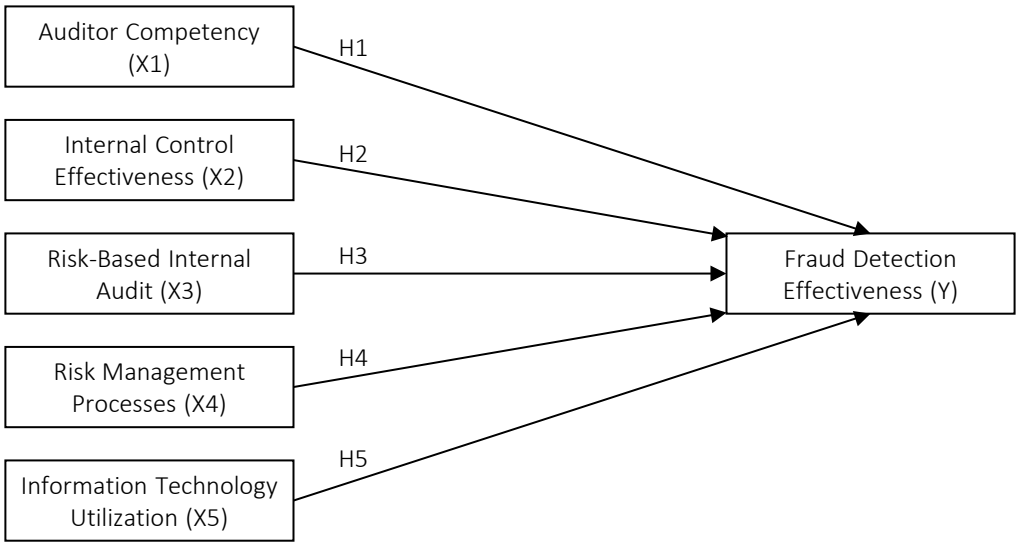

Figure 1. Conceptual framework

fectiveness, risk-based internal audit, risk management processes, and information technology utilization on fraud detection effectiveness in Indonesian Regional Development Banks. Based on this framework, the following hypotheses are formulated:

H_1: *Auditor competency has a positive effect on fraud detection effectiveness in Regional Development Banks.*

H_2: *Internal control effectiveness has a positive effect on fraud detection effectiveness in Regional Development Banks.*

H_3: *Risk-based internal audit has a positive effect on fraud detection effectiveness in Regional Development Banks.*

H_4: *Risk management processes have a positive effect on fraud detection effectiveness in Regional Development Banks.*

H_5: *Information technology utilization has a positive effect on fraud detection effectiveness in Regional Development Banks.*

2. METHOD

This study employs a quantitative, cross-sectional research design to examine the effects of auditor competency, internal control effectiveness, risk-based internal audit, risk management processes, and information technology utilization on fraud detection effectiveness in Indonesian Regional Development Banks (RDBs). The target population comprises organizational actors directly involved in governance, audit, and risk oversight functions within RDBs, namely internal auditors, risk managers, and members of audit committees. These respondents were selected because of their formal responsibility for designing, implementing, and evaluating internal controls, risk management systems, and fraud detection mechanisms. Data were collected between March and August 2025 from RDBs operating across 34 provinces in Indonesia, reflecting heterogeneity in governance maturity, operational scale, and levels of digital transformation. A purposive sampling technique was applied to ensure that respondents met the following inclusion criteria:

1) a minimum of two years of professional experience in internal auditing, risk management, or supervisory roles;

2) direct involvement in internal control evaluation, risk assessment, or fraud reporting processes; and

3) employment at an RDB that has implemented a digital or core banking information system.

A total of 230 structured questionnaires were distributed electronically via official institutional email addresses and secure online survey platforms. Of these, 204 complete and valid responses were retained for analysis, yielding an effective response rate of 88.7%. This sample size exceeds the minimum threshold required for Partial Least Squares–Structural Equation Modeling (PLS-SEM), based on both the ten-times rule and statistical power considerations for detecting medium effect sizes at a 5% level of significance. All constructs were measured using multi-item scales adapted from prior validated studies and assessed on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The empirical model was estimated using SmartPLS version 4.0, and the measurement model was evaluated by examining indicator reliability (factor loadings > 0.70), convergent validity (Average Variance Extracted > 0.50), and internal consistency reliability (Composite Reliability and Cronbach's Alpha > 0.70). Ethical standards were upheld through informed consent, anonymity, and the use of data solely for academic purposes, and methodological limitations include the cross-sectional design and reliance on self-reported perceptual data.

3. RESULT

Following the data analysis, the descriptive statistics for the variables under investigation are reported in Table 1, offering an overview of the central tendencies, dispersion, and distributional characteristics of the dataset.

Table 1 presents the descriptive statistics of the variables investigated in this study. The mean scores of all constructs – Auditor Competency (3.67), Internal Control Effectiveness (3.80), Risk-Based Internal Audit (3.78), Risk Management

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Table 1. Descriptive statistics variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Auditor Competency (X1)	204	1.83	5.00	3.6740	.92187
Internal Control Effectiveness (X2)	204	2.00	5.00	3.8000	.98381
Risk-Based Internal Audit (X3)	204	1.67	5.00	3.7843	1.05994
Risk Management Process (X4)	204	1.88	5.00	3.6808	1.03786
Information Technology (X5)	204	1.60	5.00	3.6941	1.03637
Fraud Detection (Y)	204	1.60	5.00	3.9275	.99982
Valid N (listwise)	204				

Process (3.68), Information Technology (3.69), and Fraud Detection (3.92) – fall within the high category. This indicates that the respondents generally perceive a strong presence of these factors within Regional Development Banks (RDBs). The relatively low standard deviations across variables suggest consistency in responses, implying that perceptions regarding auditor competency, internal control effectiveness, risk-based internal audit, risk management, and technology utilization are homogenous across the sample.

Figure 2 Measurement model assessment (Loading factor) (see Figure 2) was validated using PLS-SEM. All indicators exhibited loading factors above the threshold of 0.70, ensuring convergent validity (Chin, 1998). Furthermore, the Average Variance Extracted (AVE) values for all constructs exceeded 0.50, while Composite Reliability (CR) and Cronbach's Alpha values surpassed 0.70. These findings confirm the reliability and validity of the constructs as measures of their respective latent variables, consis-

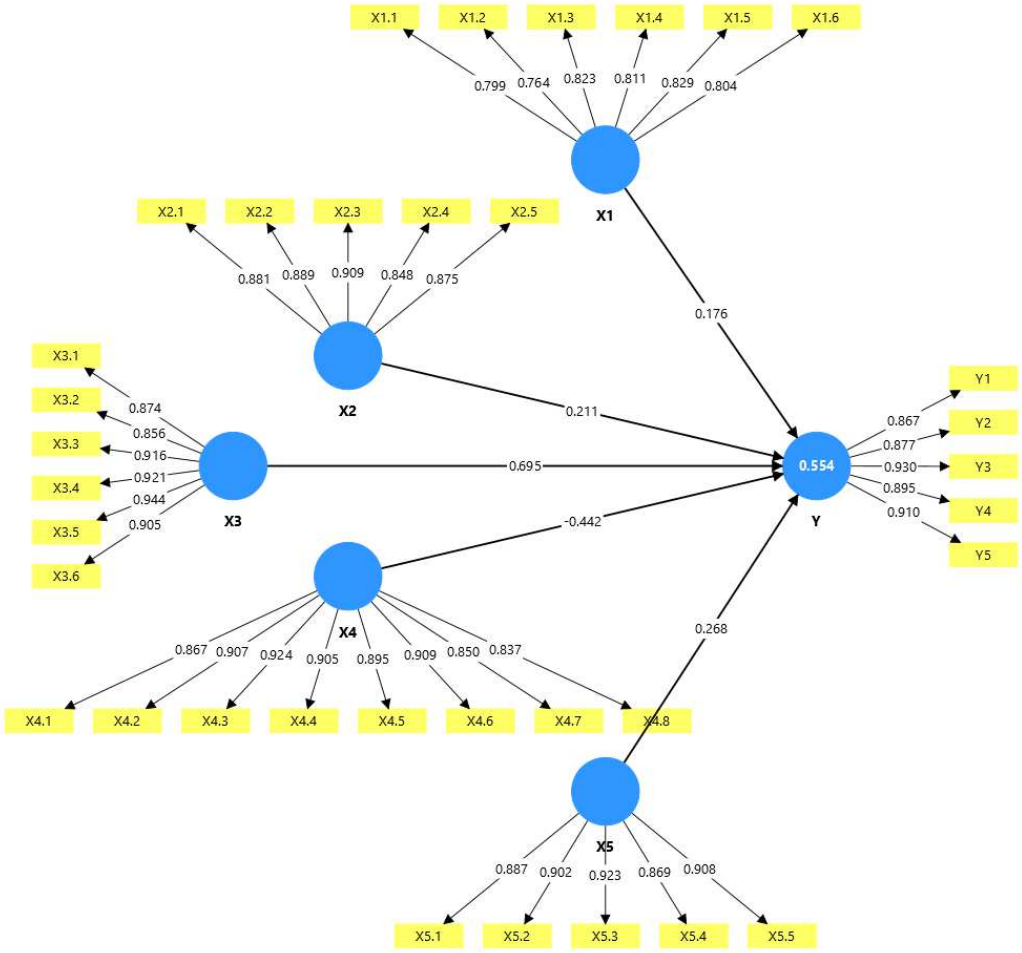

Figure 2. Measurement model assessment (loading factor)

Table 2. Correlation matrix between latent variable scores

Variable	Cronbach's alpha	Rhoa	Rho	AVE
Auditor Competency (X1)	0.892	0.894	0.917	0.649
Internal Control Effectiveness (X2)	0.928	0.933	0.945	0.776
Risk-Based Internal Audit (X3)	0.955	0.959	0.964	0.816
Risk Management Process (X4)	0.961	0.962	0.967	0.787
Information Technology (X5)	0.940	0.943	0.954	0.806
Fraud Detection (Y)	0.938	0.941	0.953	0.803

tent with the criteria suggested by Fornell and Larcker (1981) and Hair et al. (2020).

3.1. Structural model assessment

The coefficient of determination (R^2) for fraud detection was 0.554, with an adjusted R^2 of 0.543. According to Cohen (2013), this value indicates a moderate explanatory power of the model, implying that 54.3% of the variance in fraud detection can be explained by auditor competency, internal control effectiveness, risk-based internal audit, risk management process, and information technology. The remaining 45.7% is influenced by other factors outside the scope of this study.

Bootstrapping analysis confirmed the significance of all hypothesized relationships. Auditor Competency ($\beta = 0.176$, $t = 2.394$, $p = 0.017$), Internal Control Effectiveness ($\beta = 0.211$, $t = 3.274$, $p = 0.001$), Risk-Based Internal Audit ($\beta = 0.695$, $t = 5.367$, $p < 0.001$), Risk Management Process ($\beta = 0.442$, $t = 2.958$, $p = 0.003$), and Information Technology ($\beta = 0.268$, $t = 3.142$, $p = 0.002$) all demonstrated significant positive effects on fraud detection. These results empirically validate the theoretical assumption that fraud detection effectiveness is shaped by both governance-related mechanisms and technology-driven enablers.

Based on the hypothesis testing results presented in Table 3, all independent variables have a positive and significant effect on the dependent variable. This is evidenced by the t-statistics values exceeding 1.96 and p-values below 0.05. Auditor Competency demonstrates a significant positive effect with a path coefficient of 0.176, t-statistics of 2.394, and p-value of 0.017. Internal Control Effectiveness also has a positive and significant influence with a coefficient of 0.211, t-statistics of 3.274, and p-value of 0.001. Furthermore, Risk-Based Internal Audit shows the strongest positive effect among all variables, with a coefficient of 0.695, t-statistics of 5.367, and p-value of 0.000. Risk Management Process significantly affects the dependent variable with a coefficient of 0.442, t-statistics of 2.958, and p-value of 0.003. Likewise, Information Technology has a positive and significant effect with a coefficient of 0.268, t-statistics of 3.142, and p-value of 0.002. Therefore, all proposed hypotheses in this study are accepted, indicating that the examined variables significantly contribute to the dependent variable within the proposed research model.

4. DISCUSSION

The findings confirm that auditor competency is a pivotal determinant of fraud detection capacity. Competent auditors, equipped with technical expertise, professional skepticism, and analytical skills, are more capable of identifying irregularities and uncovering concealed fraudulent activities. This result aligns with prior studies emphasizing the importance of professional skills and independence in enhancing detection accuracy (Khulsum et al., 2025). Auditor competence and

Table 3. Path coefficients hypothesis

Variable	Original sample	Sample mean	STDEV	T statistics	P values
Auditor Competency	0.176	0.176	0.073	2.394	0.017
Internal Control Effectiveness	0.211	0.208	0.064	3.274	0.001
Risk-Based Internal Audit	0.695	0.697	0.130	5.367	0.000
Risk Management Process	0.442	0.443	0.150	2.958	0.003
Information Technology	0.268	0.266	0.085	3.142	0.002

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system quality significantly influence the effectiveness of using *computer-assisted audit techniques* in detecting fraud (Purnamasari & Hartanto, 2022). This is in line with research by Wahidahwati and Asyik (2022) and Noch et al. (2022), which confirms that auditor competence and independence, reinforced by professional skepticism, contribute significantly to improving fraud detection. Furthermore, the effectiveness of internal controls also supports the auditor's detection capabilities, although not all components have a significant effect. Within the framework of the Resource-Based View (RBV) (Barney, 1991), auditor competency constitutes a strategic resource that provides Regional Development Banks (RDBs) with a sustained advantage in safeguarding organizational integrity. In addition, this study supports the argument of agency theory, where auditors act as monitoring agents that reduce information asymmetry between management and stakeholders. Auditors who combine technical expertise with professional skepticism serve as an effective deterrent against opportunistic behavior, thereby reinforcing accountability.

Similarly, internal control effectiveness exerts a positive influence on fraud detection. Effective controls provide a structured environment for monitoring transactions, reducing opportunities for misconduct, and ensuring compliance with regulatory frameworks. However, as highlighted in previous research, the magnitude of this effect may vary depending on the consistency of implementation. While strong and well-integrated controls create a preventive environment, weaknesses or inconsistencies can undermine their contribution. Albawwat (2022) and Hariyani et al. (2024) also supported research in the context of local government. These findings resonate with the COSO framework, which underscores that an integrated control system – comprising control environment, risk assessment, control activities, information and communication, and monitoring – is critical in fostering organizational integrity and resilience against fraud. Recent literature also emphasizes that competence, independence, and organizational support for the internal audit function are prerequisites for its contribution to real risk mitigation; these findings are consistent in the context of both emerging markets and government (Alqudah et al., 2023). In a study by Alhebri (2025), the effectiveness of internal audit had a positive effect on the quality of financial reports in detecting fraud. In the banking sector, a recent PLS-SEM-based study confirms that strengthening internal audit functions and risk management processes is associated with increased bank resilience, including during the pandemic (Ali & Harb, 2023). In addition, technological developments (data analytics, automation) expand the capabilities of internal audit for early anomaly detection and *control environment* strengthening, thereby deepening its role in strategic risk management (Wang & Liang, 2025). Overall, evidence from 2020–2025 shows that an empowered, risk-oriented internal audit function design that is integrated with ERM can produce meaningful improvements in risk management effectiveness and governance quality (Jabbour et al., 2025).

This study further extends the literature by highlighting that internal controls are most effective when coupled with competent auditors who can interpret, test, and adapt these systems to evolving fraud risks. The interaction between auditor competency and internal control effectiveness suggests a synergistic relationship, where robust governance structures are only as effective as the professionals who enforce and monitor them. In other words, even the most sophisticated control systems may fail if not accompanied by auditors with adequate expertise and independence. Conversely, competent auditors can compensate for certain weaknesses in control systems by exercising judgment, professional skepticism, and forensic investigation skills. From a comparative perspective, this finding is particularly relevant for emerging markets such as Indonesia, where institutional maturity and governance enforcement often lag behind developed economies. In developed contexts, strong institutional frameworks ensure that internal controls are consistently implemented, thereby producing predictable improvements in fraud detection. However, in developing contexts, variability in governance practices and limited enforcement capacity mean that the role of individual auditor competency becomes disproportionately more important. The resource-based view (RBV) theory explains that human resource competence is a strategic asset that can improve organizational capabilities (Barney, 1991). Some studies in developed countries support (Sarens &

De Beelde, 2006) found that highly competent internal auditors are more trusted by management in their supervisory function. This may explain why studies in advanced economies consistently report significant effects of internal controls on fraud detection, while findings in emerging markets are more mixed (Albawwat, 2022; Alzeban & Gwilliam, 2014). The resource-based view (RBV) theory explains that human resource competence is a strategic asset that can improve organizational capabilities (Barney, 1991). Several studies in developed countries support this proposition.

Theoretically, these findings contribute to the ongoing debate about the relative importance of structural mechanisms versus human capital in fraud detection. While internal controls represent organizational structures designed to limit opportunities for fraud (opportunity dimension of the fraud triangle theory), auditor competency reflects human capital that addresses rationalization and pressure through professional skepticism and ethical judgment. Together, they provide a more holistic defense mechanism, consistent with the IIA's Three Lines Model (2020), in which management controls and internal audit function operate as complementary layers of defense against fraud. From a practical standpoint, the results emphasize the importance of continuous training, certification, and professional development for internal auditors, particularly within Regional Development Banks that often face resource constraints compared to larger state-owned and private banks. Investments in human capital should be complemented by strengthening control environments, ensuring not only compliance with regulatory frameworks but also adaptability to new fraud risks emerging from digital banking and financial innovation. Finally, the policy implication is clear: regulators such as OJK and Bank Indonesia must not only mandate robust internal control frameworks but also establish standardized competency requirements for internal auditors. However, results in developing countries show varying findings. Wahidahwati and Asyik (2022) focused audit procedures on significant risks. Syamsuddin et al. (2023) and Khairunnisa et al. (2025) emphasize that auditor competence significantly improves the ability to detect fraud, especially when supported by Albawwat (2022). In Indonesia, it was found that auditor competence does not always have a direct influence, as independence, management support, and the effectiveness of internal controls are more dominant. This dual approach ensures that governance mechanisms are effectively designed and consistently implemented, while human capital is adequately prepared to leverage these structures for effective fraud detection. In addition, this study also emphasizes the importance of implementing risk-based audits, good risk management processes, and the use of information technology systems as determining factors that strengthen the role of auditors in detecting fraud. Risk-based auditing has been proven to improve audit quality (Le et al., 2022), while the integration of risk management with internal auditing has significance (Harahap & Erlina, 2024). State that risk management and risk-based internal audit influence fraud detection capabilities, while the risk management framework with the workload is considered to have no significant influence on fraud detection capabilities (Atmanegara et al., 2021b; Erlina et al., 2018). The use of information technology systems, including big data analytics and knowledge-based audit approaches, provides strong support for auditors in analyzing large amounts of data (Putra et al., 2022; Taherdoost, 2021; Wang et al., 2021). Auditors with high information technology literacy skills demonstrate much better adaptability in the audits (Matta & Chamoun, 2025). Recent literature confirms that the combination of auditor competence, internal control effectiveness, risk-based audit implementation, and information system support forms a synergy that enhances the effectiveness of the audit function in fraud prevention and detection (Abu Kwaik et al., 2023; Albawwat, 2022; Harahap & Erlina, 2024; Putra et al., 2022; Purnamasari & Hartanto, 2022).

Prior study (Bonrath & Eulerich, 2024) showed that risk management processes mediate the relationship between governance and financial performance, improving financial integrity and reducing fraud incidence. Similarly, Sihombing et al. (2023) argued that risk management enhances fraud awareness within organizations, thereby mitigating the likelihood of fraudulent practices. From the perspective of agency theory, risk management helps reduce information asymmetry by ensuring that risks, including those arising from opportunistic managerial behavior, are systemati-

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cally identified, reported, and mitigated. The risk management process encompasses multiple interrelated stages. Risk identification allows banks to detect potential vulnerabilities in their operations, such as weaknesses in loan approval processes or gaps in IT systems. Risk assessment quantifies the likelihood and potential impact of these vulnerabilities, prioritizing areas that require immediate attention. Risk treatment involves the implementation of policies, controls, or technological tools to mitigate these risks. Finally, continuous monitoring and review ensure that risks are managed dynamically in response to evolving threats. In the context of Regional Development Banks, where resources and technology may be limited compared to national or private banks, a strong risk management process compensates for these structural constraints. By embedding accountability mechanisms into governance structures, risk management fosters a culture of vigilance, enabling institutions to proactively identify fraudulent schemes such as fictitious loans, asset misappropriation, or collusion in procurement processes. The effectiveness of risk management processes varies across institutional contexts. In developed markets, risk management is typically embedded in sophisticated enterprise-wide systems, integrated with digital tools, and supported by strong regulatory frameworks. In contrast, in emerging markets such as Indonesia, the maturity of risk management practices is uneven across institutions.

Some RDBs have adopted advanced practices aligned with the ISO 31000 risk management standard, while others still rely on manual processes and fragmented oversight mechanisms. This discrepancy underscores the need for regulators to provide clearer guidance and stronger enforcement mechanisms to ensure consistent application of risk management practices. Empirical studies highlight this divergence. For example, Mujalli (2024) found that the implementation of risk-based internal auditing in Saudi Arabia significantly enhanced financial reporting reliability, whereas Albawwat (2022) showed that in Jordan, inconsistencies in governance frameworks weakened the effectiveness of risk management in curbing fraud. These findings suggest that while the principles of risk management are universally applicable, their effectiveness is contingent upon institutional maturity, regulatory oversight, and cultural context. Recent research shows consistent results. Wang et al. (2021) found that *audit information knowledge graphs* are effective in analyzing financial fraud risks. (Putra et al., 2022) also confirmed that *big data analytics* and IT-based *whistleblowing* systems can mediate the prevention of fraudulent behavior. Information technology, with its current innovations and developments, is capable of improving the industry's ability (Ali & Maelah, 2025). Meanwhile, in developing countries, research (Wahidahwati & Asyik, 2022) shows that technology is only effective if supported by adequate auditor competence. This confirms that the institutional context and level of technological literacy moderate the effectiveness of IT use in auditing.

Beyond risk management, this study reveals that information technology (IT) is an increasingly indispensable enabler of fraud detection. The adoption of digital tools such as big data analytics, artificial intelligence (AI), machine learning (ML), and continuous auditing systems allows banks to detect anomalies in real time, substantially improving the timeliness and accuracy of fraud detection. Big data analytics enables auditors and risk managers to process vast volumes of transaction data to uncover patterns that may be indicative of fraudulent behavior (Silvia Dewi et al., 2024; Taherdoost, 2021). This development opens up great opportunities for banks, especially in developing countries, to accelerate the adaptation of technology in strengthening fraud risk control. Despite these benefits, the findings highlight a significant technological gap between Regional Development Banks and larger state-owned or private banks in Indonesia. While banks such as Mandiri, BRI, and BCA have invested heavily in advanced IT infrastructures – including blockchain auditing systems and integrated digital payment platforms – many RDBs remain constrained by budget limitations, outdated core banking systems, and limited IT expertise. This digital divide poses critical challenges. First, the lack of advanced IT infrastructure delays the detection of suspicious transactions, exposing RDBs to greater fraud risks. Second, limited integration between existing systems hampers the efficiency of internal auditors, who often rely on manual

data analysis. Third, the shortage of skilled human capital in IT and forensic auditing further exacerbates RDBs' inability to leverage technology effectively.

From a regulatory perspective, these findings underscore the urgency of digital acceleration initiatives. The OJK Roadmap for RDBs Strengthening (2024–2027) and the Bank Indonesia Blueprint for Payment Systems 2030 already emphasize the digital transformation of banking services, but greater focus must be placed on capacity building, funding support, and technology transfer specifically for RDBs. Generative AI and adversarial networks, for instance, have achieved fraud detection accuracies as high as 97% compared to 77% with traditional methods (Selvarajan et al., 2025). These advanced techniques allow banks to simulate fraudulent behaviors, test their detection systems, and refine algorithms to anticipate novel fraud strategies. The implementation of continuous auditing systems represents a paradigm shift from periodic, sample-based auditing to real-time, transaction-level monitoring. This approach is particularly effective in financial institutions where high volumes of transactions occur daily, making traditional audit approaches insufficient to capture emerging risks. Continuous auditing not only improves fraud detection but also enhances compliance with regulatory requirements, fostering greater transparency and accountability. Taken together, the results suggest that fraud detection effectiveness in RDBs is not merely a function of auditor competency or internal control systems in isolation. Instead, it is the synergistic integration of governance mechanisms and technology adoption that yields the greatest resilience against fraudulent practices. Risk management provides the structural framework for identifying and mitigating risks, while IT provides the analytical and monitoring tools to detect and respond to fraudulent activities in real time. This synergy reflects the evolution of fraud detection from a reactive process – dependent solely on human auditors and manual controls – to a proactive, integrated system that combines human expertise with technological innovation. In line with the Three Lines Model, governance mechanisms (risk management and internal controls) and enabling technologies (AI, big data, continuous auditing) function as mutually reinforcing layers of defense, significantly enhancing the overall robustness of fraud detection systems.

CONCLUSION

The purpose of this study was to examine how governance mechanisms and information technology utilization influence fraud detection effectiveness in Indonesian Regional Development Banks. The results indicate that all proposed factors, including auditor competency, internal control effectiveness, risk-based internal audit, risk management processes, and information technology, have significant positive effects on fraud detection, with risk-based internal audit emerging as the strongest predictor. These findings demonstrate that fraud detection effectiveness is not driven by a single mechanism but by the integration of human capital, governance structures, and digital capabilities.

The findings suggest that regulators and policymakers should emphasize digital transformation, human capital development, and stronger governance practices to close the gap and improve fraud detection effectiveness. Academically, this research contributes by extending the literature on fraud detection in emerging markets, while practically, it offers insights for banking practitioners and regulators seeking to strengthen financial integrity and institutional resilience. In conclusion, bridging governance principles with digital innovation represents the most effective pathway toward resilient fraud detection systems. For academics, this study offers valuable insights for comparative research across emerging and developed economies. For practitioners, it provides actionable strategies to strengthen internal controls, enhance auditor competencies, and leverage technology for fraud detection. For policymakers, it underscores the importance of coordinated efforts to foster digital acceleration, improve governance quality, and sustain public trust in the banking sector. Collectively, these contributions highlight the necessity of an integrated approach that unites governance and technology in combating fraud.

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AUTHOR CONTRIBUTIONS

Conceptualization: Angginun Juwita Sari Harahap, Erlina Erlina.
Data curation: Angginun Juwita Sari Harahap, Erlina Erlina.
Formal analysis: Angginun Juwita Sari Harahap, Erlina Erlina.
Funding acquisition: Angginun Juwita Sari Harahap.
Investigation: Angginun Juwita Sari Harahap, Erlina Erlina.
Methodology: Angginun Juwita Sari Harahap, Erlina Erlina.
Project administration: Erlina Erlina.
Resources: Angginun Juwita Sari Harahap.
Software: Erlina Erlina.
Supervision: Angginun Juwita Sari Harahap, Erlina Erlina.
Validation: Angginun Juwita Sari Harahap, Erlina Erlina.
Writing – original draft: Angginun Juwita Sari Harahap, Erlina Erlina.
Writing – reviewing & editing: Angginun Juwita Sari Harahap, Erlina Erlina.

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