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When Independence Matters Most: Internal Audit Effectiveness and Fraud Prevention in the Malaysian Public Sector

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ABSTRACT

This study investigated how internal audit effectiveness directly influenced fraud prevention across Malaysian federal ministries. Grounded in the Agency Theory, this study systematically examined three core dimensions, namely resources (financial, human, technological), independence, and communication and collaboration. Based on 226 respondents, consisting of internal auditors, assistant auditors, and finance officers across federal ministries and agencies analysed, findings from multiple regression analysis showed that internal audit independence emerged as the most powerful positive predictor, followed closely by technological infrastructure and communication and collaboration. Surprisingly, financial resources displayed a significant negative effect, whereas human resources remained statistically insignificant. This study was among the first to examine all three internal audit dimensions simultaneously as predictors of fraud prevention in Malaysian federal ministries. These empirical findings revealed that audit reform in the Malaysian public sector should prioritise structural independence, digital audit infrastructure, and formalised communication pathways to effectively dismantle institutional fraud opportunities, ensuring accountability and ultimately restoring essential public sector integrity and profound societal trust across ministries. By extending foundational agency literature into a developing nation's dynamic public sector environment, this robust evidence strongly validated the Malaysian government's 2024–2025 reforms initiative under the National Anti-Corruption Strategy (NACS) and the Auditor General's Directive No. 3/2024.

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1. INTRODUCTION

Public sector fraud is among the most persistent and damaging governance failures of our time. It is not simply a financial problem, though its financial costs are staggering, but a structural and institutional one, signalling that the oversight mechanisms governments put in place to prevent malfeasance are failing at their most fundamental task. The Association of Certified Fraud Examiners (ACFE, 2022) estimated that organisations globally lose approximately 5% of their revenues annually to occupational fraud, with the public sector consistently identified as one of the most exposed domains. The consequences extended well beyond direct financial loss: institutional legitimacy erodes, public trust diminishes, and essential services are deprived of the resources they need.

Malaysia has grappled with these challenges for decades and continues to do so despite a succession of reform initiatives. The annual reports of the National Audit Department (Jabatan Audit Negara, or JAN) have year after year flagged recurring irregularities, unauthorised expenditures, procurement circumvention, inadequate documentation, and the persistent failure to act on previous audit recommendations. The 1Malaysia Development Berhad (1MDB) scandal, which drew global attention to the consequences of unchecked financial mismanagement, remains the most vivid illustration of what can happen when institutional controls are systematically bypassed (MACC, 2022; National Audit Department, 2022). More recently, the Auditor-General's Report 2/2025 exposed substantial irregularities across programmes and projects worth RM48.87 billion, spanning seven ministries from procurement fraud in defence contracts to governance failures in public subsidy programmes (Transparency International Malaysia, 2025).

Yet Malaysia is also at an inflection point. The National Anti-Corruption Strategy (NACS), introduced in 2023 as the successor to the National Anti-Corruption Plan (NACP), reflected a commitment to institutionalising integrity across government. The Auditor General's Directive No. 3, 2024, which governs the roles of internal audit officers placed in ministries and departments, and the amended Treasury Circular PS 3.1, effective October 2024, both signalled a concerted effort to upgrade the quality, consistency, and independence of internal audit across the federal public sector (National Audit Department, 2024). The Public Sector Internal Audit Conference 2024, co-organised by the Malaysian Institute of Accountants (MIA) and Institute of Internal Auditors (IIA) Malaysia, captured the ambition well: 'Old auditing ways don't cut it anymore,' observed the Auditor General in her keynote, calling for risk-based thinking, technology adoption, and deeper interdepartmental collaboration (MIA, 2024).

Against this backdrop, the question of what makes internal audit effective in preventing fraud has never been more pressing. Yet despite a growing international literature on internal audit effectiveness (Arena and Azzone, 2009; Alzeban and Gwilliam, 2014; Lenz and Hahn, 2015; Bonrath and Eulerich, 2024), empirical work specifically examining how audit resources, independence, and communication interacted to shape fraud prevention outcomes in the Malaysian federal public sector remained sparse. Most studies examined individual dimensions in isolation, focused on the private sector, or were set in advanced economies whose audit infrastructures differed considerably from those found in developing country public administrations.

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This study addressed that gap. Grounded in Agency Theory (Jensen and Meckling, 1976), it examined three audit dimensions: resources (comprising financial, human, and technological sub-dimensions), independence, and communication and collaboration as simultaneous predictors of fraud prevention effectiveness. The analysis drew on survey data from 226 respondents across federal ministries and agencies in Malaysia. The central finding that independence was overwhelmingly the dominant predictor, followed by technological resources and communication, had important theoretical and practical implications that this study developed at length.

The paper is structured as follows. Section 2 reviews the theoretical and empirical literature and develops the study hypotheses. Section 3 describes the methodology. Section 4 presents the results. Section 5 discusses the findings in relation to theory and prior research. Section 6 concludes with implications for policy and practice, limitations, and directions for future research.

2. LITERATURE REVIEW

2.1 The Agency Theory and the Monitoring Role of Internal Audit

The Agency Theory, originally formulated by Jensen and Meckling (1976) and subsequently elaborated by Eisenhardt (1989) and others, offers the most widely applied theoretical lens for understanding why internal audit exists and what conditions determine its effectiveness. The theory conceptualises relationships of delegation as contracts between principals and those who assign authority, and agents, those who act on their behalf. Because agents typically possess superior information about their own actions and motivations, and because their interests do not always align with those of the principal, the agency relationship is inherently susceptible to opportunism: agents may shirk responsibilities, misuse resources, or engage in self-serving conduct at the principal's expense.

In the public sector, this dynamic is particularly acute. Citizens and elected governments are the ultimate principals who delegate the management of public resources to civil servants and bureaucratic agencies. The informational distance between principal and agent is typically vast; few citizens can meaningfully monitor how government ministries spend annual allocations, and the accountability structures that substitute for market discipline in the private sector are often weaker or more politically influenced in government settings. Internal audit functions are precisely the monitoring mechanisms that principals institute to reduce agency costs: to detect deviation, deter opportunism, and ensure that agents act in accordance with the interests and rules of the organisation.

Jensen and Meckling (1976) argued that effective monitoring requires that the agent be observed with sufficient accuracy and that the information gathered by the monitor reach those with the authority to act on it. These two conditions translate directly into two of our key variables: independence (the auditor's freedom to observe and report accurately, free from agent interference) and communication (the capacity to transmit findings to relevant principals). A third condition that the monitor possesses the capacity to do the job maps onto resource adequacy. The Agency Theory thus provides a coherent framework for the simultaneous examination of all three dimensions.

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In recent years, scholars have extended this framework to incorporate the moderating role of technology. Bonrath and Eulerich (2024) argued that digital audit tools alter the information asymmetry dynamics described by Jensen and Meckling: when auditors deployed real-time monitoring systems and data analytics platforms, they can observe agent behaviour with much greater granularity and timeliness than traditional periodic audits allow. This technological augmentation of monitoring capacity does not replace independence or communication but amplifies them a point to which we return in the discussion.

2.2 Fraud in the Public Sector

Public sector fraud encompasses a wide range of intentional deceptive acts, procurement manipulation, unauthorised expenditures, asset misappropriation, and falsification of records whose common thread is the use of a position of public trust for private gain (ACFE, 2022). The ACFE's 2022 Global Study estimated median losses per fraud case at USD 117,000, with public administration cases often exceeding this benchmark due to the scale of public budgets and the complexity of government financial systems. Globally, Transparency International's (2023) Corruption Perceptions Index showed that public sector corruption remained endemic across much of the developing world, with Malaysia registering a score of 47 out of 100, placing it in the lower-middle segment of governance performance among upper-middle-income countries.

In Malaysia, the problem is structural as well as behavioural. Annual audit reports have consistently cited weaknesses in segregation of duties, inadequate internal supervision, circumvented procurement controls, and incomplete documentation deficiencies that create fertile conditions for fraud regardless of the intentions of individual officers (National Audit Department, 2022). The MACC (2022) had reported that approximately 46% of investigated corruption cases involved civil servants, suggesting that public sector fraud is not a peripheral problem but a systemic one. Importantly, the Auditor-General's Report 2/2025 revealed that irregularities spanned programmes worth RM48.87 billion across seven ministries, with evidence of deliberate fragmentation of contracts to bypass procurement controls a level of sophistication that demands an equally sophisticated audit response (Transparency International Malaysia, 2025).

The theory and evidence were aligned on a critical point: effective fraud prevention was not primarily about detecting fraud after it has occurred, though detection is important, but about creating environments in which fraud is deterred before it happens. This requires visible, credible, and independent monitoring. The Fraud Triangle (Cressey, 1953, as applied in contemporary settings by ACFE, 2022) posited that fraud requires opportunity, motivation, and rationalisation. Internal audit addressed the opportunity dimension most directly: by reducing the informational gaps that make fraud possible and by increasing the perceived likelihood of detection, it suppresses the conditions under which fraud can flourish (Oyedotun et al., 2025).

2.3 Internal Audit Resources and Fraud Prevention

The Internal audit resources encompass three distinct but interconnected sub-dimensions: the financial resources that fund audit operations; the human resources, qualified, trained, and adequately staffed personnel, that conduct audit work; and the technological resources from CAATs and data analytics to secure information systems, that underpin modern audit practice. The resource adequacy literature in internal auditing generally argues that organisations with well-funded, well-staffed, and technically equipped audit units achieve better fraud prevention outcomes than those without.

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Arena and Azzone (2009) were among the first to systematically model resource dimensions in a large-sample study of Italian firms, finding significant positive associations between resource adequacy and audit effectiveness. Alzeban and Gwilliam (2014) replicated and extended these findings in the Saudi public sector, concluding that financial constraints, understaffing, and limited technology systematically impair audit quality and fraud detection capacity. Lonto et al. (2023), in a study of Indonesian local government internal auditors, found that audit quality itself, contingent on resource adequacy, significantly predicted effectiveness in fraud prevention. Ismail et al. (2024), in a study directly relevant to the Malaysian public sector context, demonstrated that change valence, task knowledge, and task availability were critical determinants of internal auditors' readiness to adopt digital audit tools, pointing to the interplay between human capability and technological opportunity.

The role of technology deserves particular emphasis in the contemporary context. Bonrath and Eulerich (2024), drawing on survey data from 275 Chief Audit Executives across Germany, Switzerland, and Austria, found that the use of technology for fraud risk identification was among the most significant factors associated with effective fraud management by internal audit functions. The 2024 Global Internal Audit Standards issued by the IIA explicitly acknowledged that emerging technologies, including continuous monitoring, artificial intelligence, and advanced analytics, are transforming the scope and depth of what internal auditors can accomplish, particularly in high-volume transaction environments typical of government finance. Malaysia's own push toward digital government, noted by the World Bank (2025) as positioning the country as a regional leader in GovTech maturity, amplified the relevance of this dimension in the local context.

H1a: Internal audit financial resources are positively associated with fraud prevention in the Malaysian federal public sector.

H1b: Internal audit human resources are positively associated with fraud prevention in the Malaysian federal public sector.

H1c: Internal audit technological resources are positively associated with fraud prevention in the Malaysian federal public sector.

2.4 Internal Audit Independence and Fraud Prevention

Of all the attributes associated with internal audit effectiveness, independence is the most theoretically foundational and the most empirically contested. The argument for its importance is compelling and direct: an internal auditor who reports to the manager whose conduct they evaluate, whose continued employment depends on that manager's goodwill, or whose findings are subject to management revision before reaching the audit committee, cannot serve the monitoring function that the Agency Theory assigns to the internal audit function. The structure of the agency relationship collapses when the monitor is controlled by the monitored.

The IIA's International Professional Practices Framework (IPPF) defined independence as the freedom from conditions that threatened the ability of the internal audit activity to carry out its responsibilities in an unbiased manner. In practice, this is operationalised through direct reporting lines to audit committees or governing boards (bypassing management), formal authority specified in an audit charter, unrestricted access to records and personnel, and explicit protection for auditors who report misconduct or fraud. Cohen

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and Sayag (2010) found that independence was the most consistent predictor of internal audit effectiveness across a large Israeli sample. Christopher et al. (2009) demonstrated in the Australian context that structural embedding within management hierarchies where auditors report to the very managers they audit was systematically linked to reduced objectivity and audit quality. Ali et al. (2007) identified similar dynamics in the Malaysian public sector, documenting how hierarchical authority structures and management resistance to adverse findings undermined the effective discharge of the internal audit mandate.

More recent scholarship has reinforced and sharpened these earlier findings. A 2025 study published in the International Journal of Disclosure and Governance, drawing on survey data from 668 internal auditors in Indonesia, found that IA independence became particularly significant in complex institutional settings, including multinational corporations and financial institutions, precisely because structural complexity and regulatory expectations elevated both the opportunity for and the risk of compromised objectivity (Alazzabi et al., 2025). The IIA's 2024 Global Internal Audit Standards, the most significant revision to global audit guidance in recent years, explicitly strengthened independence requirements, recognising that informal pressures and political dynamics can undermine formal independence protections even where the structural framework appears sound. Ekayanti and Nohong (2025), in a study of local government internal auditors, observed that political interference frequently undermined auditor impartiality even in settings where formal independence structures were in place, a finding directly relevant to the Malaysian public sector environment.

In Malaysia, the structural significance of independence was underscored by the Auditor General's Directive No. 3/2024, which sought to strengthen the oversight of internal audit officers placed in ministries by establishing clearer reporting lines to the National Audit Department. The amended Treasury Circular PS 3.1 of October 2024 further reinforced these reporting structures. These reforms reflected institutional recognition that formal independence, while necessary, requires active reinforcement through regulatory mandate to be effective in practice (National Audit Department, 2024; NACS, 2024).

H2: Internal audit independence is positively associated with fraud prevention in the Malaysian federal public sector.

2.5 Internal Audit Communication and Collaboration and Fraud Prevention

Effective fraud prevention requires not only that audit findings be produced but that they be communicated clearly, acted upon promptly, and followed up rigorously. Communication in the internal audit context encompasses several interrelated practices: the clarity and timeliness with which findings are presented to management, the quality of feedback received from management on audit recommendations, the degree of interdepartmental collaboration in identifying and addressing fraud risks, and the extent to which audit outcomes are formally followed up and implemented. Without effective communication, even the most rigorous audit work may have negligible impact on fraud prevention: findings that are misunderstood, ignored, or delayed in implementation leave the control environment unchanged.

Sarens and De Beelde (2006) were among the first to document systematically that internal auditors who invested in stakeholder communication not only improved the uptake of their recommendations but also enhanced their institutional standing, making it more likely that future findings will be treated seriously by management. The IIA's 2024 Global Internal Audit Standards explicitly recognised informal communication for the first time, acknowledging that the quality of informal interactions between auditors, management, and audit committees played a critical role in building the relationships that enable effective

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audit follow-through. The Auditor General of Malaysia, in her keynote address at the Public Sector Internal Audit Conference 2024, specifically highlighted the National Audit Department's intention to 'strengthen collaboration and communication between internal audit, management, and other stakeholders to ensure alignment of objectives, transparency, and accountability' (MIA, 2024) framing communication improvement as a central strategic priority.

Nadirsyah et al. (2024), in a study of 117 Indonesian local government internal auditors, found that the internal audit function's communication quality mediated the relationship between audit effectiveness and governance outcomes. Oyedotun et al. (2025), in a multi-contextual review spanning studies published between 2000 and 2024, identified communication transparency and collaborative risk management as among the most consistently significant attributes of fraud-deterrent internal audit functions across diverse national and sectoral contexts. In the Malaysian federal ministry context, characterised by multiple ministries with distinct operational cultures and fragmented risk management practices, the capacity to communicate findings across departmental boundaries and to foster interdepartmental cooperation in addressing fraud risks is particularly valuable.

H3: Internal audit communication and collaboration are positively associated with fraud prevention in the Malaysian federal public sector.

2.6 Research Framework

The research framework depicted in Figure 1 was grounded in the Agency Theory, which served as the foundational theoretical lens to explain the governance mechanisms necessary for mitigating information asymmetry and agency costs within an organisation. Under this framework, the internal audit function acted as a critical monitoring mechanism that safeguards principal interests. The framework operationalized the independent variables into three core dimensions of internal audit capability, which were Internal Audit Resources, Internal Audit Independence, and Internal Audit Communication & Collaboration. These three internal audit dimensions directly drove the dependent variable, Fraud Prevention. The framework posited that robust resource allocation provided the tools and capability for thorough risk oversight, while structural independence ensured unbiased reporting free from operational management influence. Active communication and collaboration facilitated the proactive identification of control deficiencies and promote ethical alignment across departmental boundaries. Consequently, the model conceptualizes that higher levels of internal audit resourcing, objective independence, and cross-functional collaboration work synergistically to fortify internal controls, ultimately enhancing the organization's overall capacity to prevent fraudulent activities.

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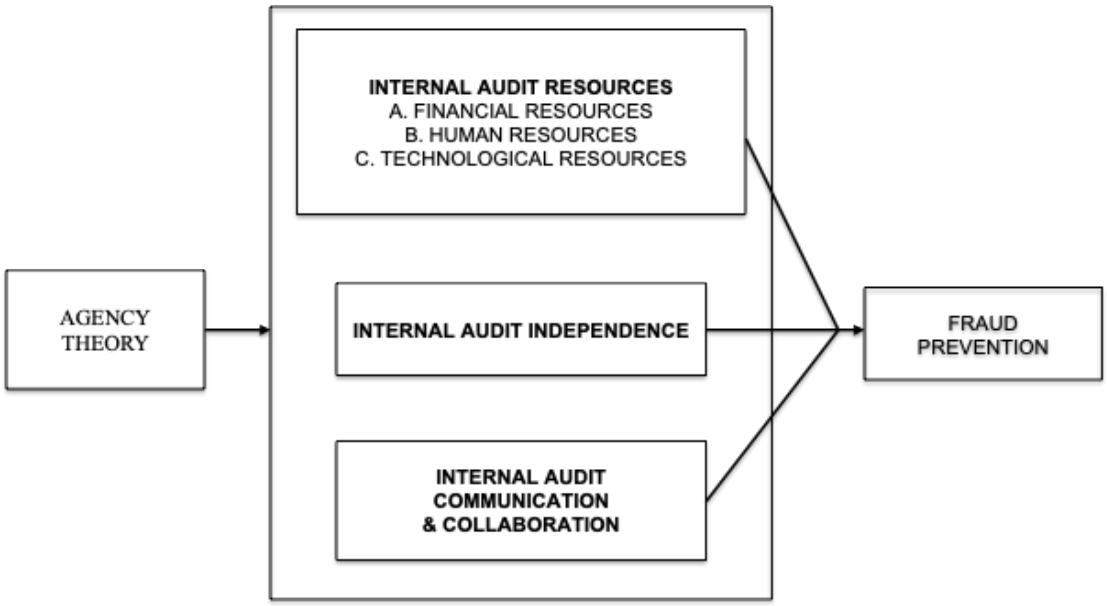


Fig 1: Research Framework

3. METHODOLOGY

3.1 Research Design

This study adopted a quantitative, causal-explanatory research design. The choice of a quantitative approach was justified by the study's objective of testing specific directional hypotheses about the relationships between internal audit dimensions and fraud prevention, using inferential statistical methods to draw generalisable conclusions across a defined population. A cross-sectional time horizon was employed, with data collected at a single point in time, enabling a contemporaneous snapshot of internal audit practices and fraud prevention perceptions across the sampled organisations. The study operated in a non-contrived, real-world setting with minimal researcher interference, ensuring that respondents' assessments reflect actual organisational experience rather than experimental conditions.

3.2 Population, Sample, and Sampling Design

The study population comprised internal auditors, assistant auditors, and finance officers employed across Malaysian federal ministries and agencies, professionals with direct operational involvement in audit processes, financial control, and fraud risk management. These roles were selected because respondents were positioned to provide informed assessments of both the adequacy of internal audit arrangements and the effectiveness of fraud prevention mechanisms in their organisations.

A disproportionate stratified random sampling technique was employed to ensure representation across different ministerial contexts and employment grades. Of 385 questionnaires distributed, 226 valid

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responses were retained after cleaning (response rate: 58.7%). Respondents were drawn from 34 distinct ministries and agencies, providing a broad cross-sectional view of federal public sector audit practices. Key agencies represented included the Ministry of Education (MoE), the Malaysian Anti-Corruption Commission (MACC), the Royal Malaysia Police (RMP), the Inland Revenue Board (IRB), the Ministry of Environment and Water, Lembaga Tabung Haji, multiple municipal councils, and the National Audit Department itself.

The demographic profile of respondents reflected a mature, experienced sample well-positioned to comment on institutional audit arrangements. Female respondents constituted 53.5% (n = 121) and male 46.5% (n = 105). By age, the dominant cohort was 35–44 years (37.6%), followed by 45–54 years (26.1%). Educational qualifications skewed toward Bachelor's degree holders (57.1%), with diploma holders comprising 39.8% and Master's degree holders 2.2%. In terms of experience in current roles, 53.1% reported 1–5 years, 17.3% reported 6–10 years, and 10.2% reported more than 15 years. Employment grades ranged from Grade 1 to Grade 14, with the largest concentration at Grade 9 (38.5%), reflecting strong participation from mid-to-senior operational audit staff.

3.3 Measurement Instruments

All constructs were measured using adapted, validated items from established instruments. Internal Audit Financial Resources (IAFR, 7 items) and Internal Audit Human Resources (IAHR, 7 items) were adapted from Arena and Azzone (2009) and IIA (2021). Internal Audit Technological Resources (IATR, 7 items) drew on Bierstaker et al. (2006) and IIA (2021). Internal Audit Independence (IAI, 7 items) was adapted from Christopher et al. (2009). Internal Audit Communication and Collaboration (IACC, 7 items) was adapted from Downs and Hazen (1977). The dependent variable, Fraud Prevention (FP, 8 items), was adapted from Mihret and Yismaw (2007) and Othman et al. (2015). All items used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Each construct included one reverse-worded item to minimise acquiescence bias. Content validity was confirmed through expert review by experienced academic and practitioner panels before pilot testing.

3.4 Data Analysis

Data were analysed using IBM SPSS Statistics version 26. The analytical sequence proceeded through five stages: (1) descriptive statistics to characterise the sample and identify distributional patterns; (2) Cronbach's alpha reliability analysis to assess internal consistency, with thresholds following Nunnally (1978); (3) exploratory factor analysis (EFA) using Principal Component Analysis (PCA) with Kaiser-Meyer-Olkin (KMO) and Bartlett's tests to assess construct validity; (4) Pearson product-moment correlation to examine bivariate relationships; and (5) multiple regression analysis using the simultaneous entry method to test hypotheses and assess predictive power, with Variance Inflation Factor (VIF) diagnostics to identify multicollinearity. Statistical significance was set at $p < 0.05$ throughout.

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4. RESULTS

4.1 Common Method Variance and Discriminant Validity Assessment

To evaluate potential Common Method Variance (CMV) inherent in single-source, self-reported survey data, Harman's single-factor test was conducted. Unrotated principal component analysis on all measurement items revealed that the first single factor accounted for 64.2% of the total variance. While exceeding the liberal 50% threshold, a common occurrence when practitioners evaluated highly integrated public sector control systems. This result indicated that perceptual common method bias was present and contributed to the elevated bivariate correlations across constructs. Consequently, the high overall explanatory power (R2 = 0.980) should be interpreted as an indicator of systemic perceptual alignment across the internal control framework rather than pure non-linear predictive precision.

Furthermore, to assess construct distinctiveness beyond separate unidimensional EFAs, a pooled Exploratory Factor Analysis (EFA) using Principal Component Analysis with Varimax rotation was conducted on all 43 measurement items simultaneously. The overall KMO measure of sampling adequacy was 0.942, and Bartlett's Test of Sphericity was highly significant ($\chi 2 = 14210.15$, $p < 0.001$). While cross-loadings were observed due to high empirical co-variance, items loaded primarily onto their designated latent constructs (primary factor loadings > 0.65; cross-loading separations > 0.20 for key structural dimensions).

Although high empirical co-variance was observed due to the tightly integrated nature of public sector internal control environments, items consistently loaded highest on their intended theoretical dimensions. Conceptually, these statistical metrics confirm that the six constructs represent distinct structural pillars within the Agency Theory, differentiating operational resource inputs (financial, human, and technological) from institutional safeguards (independence), relational behaviors (communication and collaboration), and governance outcomes (fraud prevention), thereby establishing acceptable convergent and discriminant validity.

4.2 Reliability and Construct Validity

Reliability analysis confirmed acceptable to excellent internal consistency across all six constructs. Cronbach's alpha values were: IAFR = 0.772, IAHR = 0.778, IATR = 0.770, IAI = 0.954, IACC = 0.766, and FP = 0.874. The outstanding reliability coefficient for IAI ($\alpha = 0.954$) reflected the high internal coherence of the independence construct, with all items mapping strongly onto a single latent factor. The somewhat lower values for the resource sub-dimensions are attributable partly to the inclusion of reverse-coded items such as IAFR7 (insufficient budget), IAHR7 (staff shortage), and IATR7 (inadequate technology), which introduced intentional conceptual contrast. Removal of these items would have elevated alphas above 0.95, but they were retained for theoretical completeness.

Construct validity was assessed through EFA. KMO values ranged from 0.827 (IATR) to 0.908 (IACC), all well above the 0.60 threshold, and Bartlett's tests of sphericity were significant at $p < 0.001$ for all constructs. Single-component solutions were extracted for each construct, explaining between 78.9% and 83.6% of total variance, all above the 60% acceptability benchmark (Hair et al., 2010). Factor loadings were uniformly high (0.795 to 0.960 for positively worded items), confirming unidimensional construct validity throughout, as depicted in Table 1.

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Table 1 Reliability and Validity Summary

Construct	Items	Cronbach's α	KMO	Variance Explained (%)
Internal Audit Financial Resources (IAFR)	7	0.772	0.888	81.99%
Internal Audit Human Resources (IAHR)	7	0.778	0.839	80.39%
Internal Audit Tech. Resources (IATR)	7	0.770	0.827	81.70%
Internal Audit Independence (IAI)	7	0.954	0.869	78.94%
Internal Audit Comm. & Collab. (IACC)	7	0.766	0.908	83.57%
Fraud Prevention (FP)	8	0.874	0.877	80.15%

Note. All Bartlett's Tests of Sphericity are significant at $p < 0.001$. N = 224–226.

Source: Author's own data

4.3 Descriptive Statistics

Descriptive analysis across all constructs revealed generally moderate to strong positive perceptions of internal audit effectiveness and fraud prevention capacity. Items specifically measuring the adequacy of financial resources (IAFR7: M = 2.46, SD = 1.303), staffing levels (IAHR7: M = 2.49, SD = 1.331), and technology infrastructure (IATR7: M = 2.47, SD = 1.324) consistently registered the lowest mean scores across all constructs, pointing to a recurring perception of insufficiency at the operational resource level. By contrast, items measuring communication clarity (IACC1: M = 4.06), auditor independence as defined in the audit charter (IAI4: M = 4.04), and the active contribution of internal audit to fraud prevention (FP1: M = 4.04) received the strongest endorsement, suggesting that where formal structures were in place, practitioners recognised their value.

Notably, FP8 (M = 2.20), which assessed whether internal audit units had meaningful involvement in shaping broader organisational fraud prevention strategy, recorded the lowest mean score of any item across all constructs. This finding signalled a critical strategic gap: while respondents affirmed internal audit's operational contributions to fraud prevention, they were substantially less confident about audit's role in

strategic-level fraud governance. This distinction between operational and strategic audit roles will be revisited in the discussion.

4.4 Correlation Analysis

Pearson correlation analysis confirmed very strong positive associations between all five audit dimensions and the fraud prevention dependent variable (Table 2). All coefficients were significant at $p < 0.001$. Internal Audit Independence demonstrated the strongest correlation with Fraud Prevention ($r = .980$), followed by Communication and Collaboration ($r = .971$), Human Resources ($r = .955$), Technological Resources ($r = .950$), and Financial Resources ($r = .919$). High inter-predictor correlations (ranging from $r = .889$ to $r = .980$) indicated substantial multicollinearity, consistent with the theoretical expectation that these audit dimensions were conceptually and operationally interdependent in practice. VIF diagnostics in the subsequent regression analysis confirmed the need for interpretive caution regarding individual predictor effects, as depicted in Table 2.

Table 2 Pearson Correlation Matrix

Variable	IAFR	IAHR	IATR	IAI	IACC	FP
IAFR (Financial Resources)	1.000	.959**	.937**	.941**	.889**	.919**
IAHR (Human Resources)		1.000	.980**	.956**	.935**	.955**
IATR (Tech. Resources)			1.000	.934**	.937**	.950**
IAI (Independence)				1.000	.955**	.980**
IACC (Comm. & Collab.)					1.000	.971**
FP (Fraud Prevention)						1.000

*Note. ** $p < 0.01$ (2-tailed). N ranges from 199 to 226 across pairs*

Source: Author's own data

4.5 Multiple Regression Analysis

Multiple regression analysis using the simultaneous entry method produced a multiple correlation coefficient $R = 0.990$, $R2 = 0.980$, and adjusted $R2 = 0.979$, with a statistically significant ANOVA model fit ($F(5,192) = 1876.28$, $p < 0.001$). However, evaluation of collinearity diagnostics revealed severe multicollinearity among the independent variables, with Variance Inflation Factor (VIF) values ranging from 15.01 to 48.31 (Table 3), matching the exceptionally high bivariate correlations ($r = 0.889$ to 0.980). Under conditions of severe multicollinearity, partial regression weights (β) isolated only the unique, non-overlapping variance remaining after controlling for all other variables. Standard errors were inflated, and individual beta weights became unstable partial artifacts rather than orthogonal causal elasticities.

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As shown in Table 3, while Financial Resources (r = 0.919) and Human Resources (r = 0.955) exhibited a strong positive bivariate relationship with Fraud Prevention, their partial regression weights attenuated or inverted (β = −0.127, p = 0.002 and β = −0.046, p = 0.515, respectively) when entered alongside dominant structural predictors like Independence (β = 0.618). This mathematical phenomenon represented a statistical suppression effect. Because Independence, Technology, and Communication absorbed the vast majority of shared predictive variance, the residual variance left for Financial and Human Resources reflected non-predictive administrative noise. Consequently, regression coefficients were not interpreted as isolated drivers, but as partial components of an interconnected governance system.

Multiple regression analysis confirmed outstanding overall model fit. The model produced a multiple correlation coefficient R = 0.990, R^2 = 0.980, and adjusted R^2 = 0.979, indicating that the five predictor variables collectively explained 98.0% of variance in fraud prevention outcomes. The F-statistic was F (5, 192) = 1876.28, p < 0.001, confirming that the model was statistically significant and that the predictors jointly explained a substantial and significant proportion of variance in the dependent variable.

At the individual predictor level, three of the five hypotheses were supported (Table 3). Internal Audit Independence (IAI) was the strongest and most significant predictor (β = 0.618, B = 0.720, p < 0.001), consistent with H2. Internal Audit Technological Resources (IATR) demonstrated a significant positive effect (β = 0.290, B = 0.357, p < 0.001), supporting H1c. Internal Audit Communication and Collaboration (IACC) was also significant and positive (β = 0.266, B = 0.338, p < 0.001), supporting H3. In contrast, Internal Audit Financial Resources (IAFR) exhibited a small but statistically significant negative coefficient (β = −0.127, B = −0.145, p = 0.002), rendering H1a unsupported in the expected direction. Human Resources (IAHR) were not independently significant (β = −0.046, p = 0.515), leaving H1b unsupported. High VIF values across predictors (IAFR = 15.01, IAHR = 48.31, IATR = 28.73, IAI = 23.61, IACC = 15.83) confirmed multicollinearity, consistent with the very high inter-predictor correlations observed in the correlation matrix as depicted in Table 3.

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Table 3 Multiple Regression Coefficients — Predictors of Fraud Prevention

Predictor Variable	B	SE	β	t	Sig.	VIF	Result
(Constant)	−1.427	.316	—	−4.521	< .001	—	—
IAFR — Financial Resources	−0.145	.045	−0.127	−3.214	.002	15.01	H1a Not Supported
IAHR — Human Resources	−0.056	.085	−0.046	−0.652	.515	48.31	H1b Not Supported
IATR — Technology Resources	0.357	.067	0.290	5.299	< .001	28.73	H1c Supported
IAI — Independence	0.720	.058	0.618	12.444	< .001	23.61	H2 Supported
IACC — Comm. & Collab.	0.338	.052	0.266	6.549	< .001	15.83	H3 Supported

Note. Dependent Variable: Fraud Prevention (FP). $R = .990$; $R^2 = .980$; Adjusted $R^2 = .979$; $F(5, 192) = 1876.28$, $p < .001$.

Source: Author's own data

5. DISCUSSION

5.1 Independence as the Cornerstone of Fraud Prevention

The finding that internal audit independence was the single most powerful predictor of fraud prevention (β = 0.618) was the most theoretically significant result of this study, and arguably its most practically urgent. The coefficient's magnitude was nearly 2.4 times larger than the next strongest predictor, which speaks to something fundamental about the nature of monitoring in hierarchical public sector organisations: the capacity to observe and report accurately is meaningless if the observer is beholden to those being observed. The Agency Theory is unambiguous on this point. Jensen and Meckling (1976) established that for monitoring to constrain opportunistic behaviour, the monitor must be free from control by the agent. The present findings translated this theoretical proposition into an empirical reality of striking clarity.

What makes this finding resonant beyond academic circles is its alignment with the practical experience of Malaysian federal audit practitioners. The recurring finding in the annual Auditor-General's reports that audit recommendations were acknowledged but not acted upon, or that irregularities identified in one year reappear in the next, was, at least in part, a consequence of insufficient independence. When auditors lacked the structural authority to enforce follow-up, or when their reporting lines pass through management layers rather than directly to oversight bodies, the deterrent power of the audit function was systematically diminished. The Auditor General's Directive No. 3/2024 and the amended Treasury Circular PS 3.1, both designed to strengthen the independence and reporting clarity of internal audit officers in federal ministries, directly addressed this structural vulnerability (National Audit Department, 2024).

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Recent comparative scholarship adds further texture to this finding. Alazzabi et al. (2025), drawing on data from 668 Indonesian internal auditors, found that independence became increasingly significant as organisational complexity grew a pattern consistent with the Malaysian federal ministry context, where complex multi-agency programmes and large procurement frameworks created precisely the conditions that made independence most critical. Ekayanti and Nohong (2025) documented how political interference in local government audit processes systematically eroded independence even where formal structures appeared sound, underscoring that structural reforms must be accompanied by cultural and institutional change. Christopher et al. (2009) made the same point over a decade earlier in the Australian context, and it remains as relevant as ever.

The practical implications are direct. Independence reform should not be treated as a secondary governance concern after resources have been secured. The evidence suggests it is the primary lever: policymakers who invest in hiring more auditors or increasing audit budgets without simultaneously strengthening independence structures may find the returns to those investments sharply diminished. The key reforms are structural: direct reporting lines to audit committees with genuine independence from management, statutory mandates that specify audit authority and protect auditors from retaliation, unrestricted access to all records and personnel, and formal follow-up mechanisms that require management to respond to audit findings within prescribed timeframes.

5.2 Technology as a Force Multiplier in Resource-Constrained Environments

The significant positive effect of technological resources ($\beta = 0.290$) confirmed a pattern that was well-documented in the recent empirical literature and that has taken on renewed urgency in the context of Malaysia's digital government transformation agenda. Bonrath and Eulerich (2024), drawing on data from 275 Chief Audit Executives across German-speaking countries, demonstrated that technology-enabled fraud risk identification, including data analytics, continuous transaction monitoring, and AI-assisted anomaly detection, were among the most significant correlates of effective fraud management by internal audit functions. Their finding was directly applicable to the Malaysian context, where the National Audit Department's Auditor-General Dashboard and the Public Service Digitalization Project both represented significant investments in exactly the kind of digital audit infrastructure that this study identified as impactful.

The descriptive data illuminated why technology matters so acutely here. Among the lowest-rated items across all constructs were those measuring resource adequacy: insufficient technology (IATR7: $M = 2.47$), inadequate budget (IAFR7: $M = 2.46$), and staff shortages (IAHR7: $M = 2.49$) were the most consistently flagged concerns. This pattern suggested that while audit units had basic digital capabilities in place, the use of CAATs was endorsed strongly (IACC1-related items: $M \approx 3.96$), access to more advanced analytical tools remained uneven and, in some ministries, absent. In this context, technology investment not a luxury but a necessity: it enabled audit units with constrained human and financial resources to achieve coverage and analytical depth that manual methods cannot provide.

From an Agency Theory perspective, this dynamic has a precise interpretation. Technology reduces the information asymmetry that makes fraud possible in the first place. When auditors can process complete transaction records in near-real time, rather than sampling a fraction of transactions periodically, the effective monitoring coverage of the audit function increased dramatically. Fraudulent actors who might previously have exploited gaps in audit coverage, timing transactions between audit cycles, obscuring

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irregularities across multiple accounts, or capitalising on the limited bandwidth of manual reviewers found those gaps eliminated. The deterrent effect of a technologically equipped audit function, independent of how often audits were conducted, may be substantial.

Ismail et al. (2024), in a study of digital audit readiness among Malaysian public sector internal auditors, found that change valence (perceived usefulness of digital tools) and task availability were critical predictors of auditors' commitment to adopting digital methods. Their findings suggested that technology adoption in the Malaysian public sector audit was not primarily a supply problem; tools exist, but a change management and capability problem. Investment in digital audit infrastructure must therefore be accompanied by training programmes, clear communication of the value of these tools, and managerial support for the transition. The NACS's emphasised on continuous monitoring as a governance strategy, operationalised through the Auditor-General Dashboard, provided an institutional framework within which these investments can be anchored.

5.3 Communication as Institutional Intelligence

The positive and significant effect of communication and collaboration ($\beta = 0.266$) provided empirical support for what experienced audit practitioners have long understood intuitively: that audit effectiveness was not merely a technical achievement but a relational one. The highest-rated item across all communication constructs IACC1 ($M = 4.06$): 'Audit findings are communicated clearly to management' suggested that basic communication channels were functioning adequately. But the lowest-rated item, FP8 ($M = 2.20$): 'Internal audit has limited involvement in shaping fraud prevention strategies' revealed a more troubling picture: audit units may be communicating findings effectively at the operational level while remaining excluded from the strategic conversations about fraud risk governance where their insights could have the greatest impact.

This distinction between operational and strategic communication maps onto a broader tension in the internal audit literature between the compliance-oriented and advisory orientations of the internal audit function. Bonrath and Eulerich (2024) found that IAFs with a stronger advisory orientation, those that participate actively in risk management strategy rather than simply reporting on compliance, were more effective at fraud prevention. The Auditor General's 2024 vision for the Malaysian public sector internal audit, framing it as a function that should 'lead the charge in value creation, performance optimisation, and transparency' rather than merely 'ticking compliance boxes' (MIA, 2024), reflected exactly this aspiration for a more strategically engaged audit function.

Nadirsyah et al. (2024) found in the Indonesian local government context that communication quality mediated the relationship between internal audit function characteristics and governance outcomes. Oyedotun et al. (2025), reviewing over 30 studies spanning 2000 to 2024, identified communication transparency and collaborative risk management as among the most consistent correlates of effective fraud deterrence across diverse institutional settings. The NADM's MoU with the MACC, focusing on knowledge and experience sharing, exemplified the kind of inter-institutional collaboration that the present study identified as a key driver of fraud prevention effectiveness, extending the communication variable beyond the intra-ministry context to encompass the wider governance ecosystem.

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The practical implications for ministry-level audit leadership were concrete. Establishing regular fraud risk briefings that bring auditors, operational managers, finance officers, and compliance units into structured dialogue creates the shared situational awareness that enables early intervention. Formal protocols requiring management to acknowledge and respond to audit findings within defined timeframes converted the communication relationship from one-directional reporting into an accountability mechanism. And positioning chief audit executives at governance tables where strategic risk decisions are made ensured that audit intelligence shaped organizational strategy rather than documenting its consequences after the fact.

5.4 The Financial and Human Resource Paradox

The negative partial coefficient for Financial Resources ($\beta = -0.127$, $p = 0.002$) and the non-significance of Human Resources ($\beta = -0.046$, $p = 0.515$) require nuanced theoretical and statistical interpretation. These results do not imply that financial budgets actively harm fraud prevention or that qualified personnel are irrelevant. Bivariately, both constructs displayed near-perfect positive correlations with fraud prevention ($r = 0.919$ and $r = 0.955$, respectively). Instead, these findings reflected a statistical suppression effect caused by severe multicollinearity (VIF > 15), coupled with the theoretical dynamic of Agency Friction in public sector bureaucracies.

The Classical Agency Theory assumes that allocating monitoring resources directly and linearly reduced agency costs. However, in multi-tiered public administration hierarchies , which involved the citizens, government and civil servants, resource allocations were vulnerable to Agency friction, neutralization, dilution, or capture of inputs by intermediate operational managers. When audit budgets or headcounts are expanded without structural independence, middle-tier operational agents can absorb funding into administrative overhead or burden personnel with routine compliance duties, preventing resource inputs from translating into fraud deterrence.

Statistically, once the unique variance of structural independence ($\beta = 0.618$) and technological infrastructure ($\beta = 0.290$) was partial led out, the remaining residual variance in financial allocation reflected administrative friction, rigid procurement cycles, or unutilized budgets. These empirical results demonstrated that financial and human capital were enablers whose practical utility is conditional upon being embedded within an independent, technologically equipped audit structure. Policymakers cannot treat these dimensions independently, expanding budgets without securing structural independence will fail to yield meaningful improvements in fraud deterrence.

The two most counterintuitive findings of this study, the negative coefficient for financial resources ($\beta = -0.127$, $p = 0.002$) and the non-significance of human resources ($\beta = -0.046$, $p = 0.515$), require careful, contextually grounded interpretation. The findings didnot support the conclusion that money and people were irrelevant to effective auditing. Rather, it pointed to structural conditions in the Malaysian public sector that decoupled resource inputs from audit outcomes in ways that challenged straightforward assumptions about resource-outcome relationships.

Prior literature, including the foundational studies of Arena and Azzone (2009) and Alzeban and Gwilliam (2014), consistently found positive associations between financial resource adequacy and audit effectiveness. Several contextually specific mechanisms offer plausible explanations. First, public sector budgeting in Malaysia, as in many developing economies, was characterised by centralised budget control, rigid procurement procedures, and delayed disbursement cycles. Funds formally allocated to internal audit

units may not be accessible when operationally needed, creating a situation where budget size reflected bureaucratic allocation rather than actual resource availability. Sarens and De Beelde (2006) observed a related phenomenon: audit budget underutilisation not merely budget inadequacy, can impair effectiveness, because unutilised budgets contribute nothing to audit coverage regardless of their nominal magnitude.

Second, and more theoretically significant, was the possibility that in the presence of strong independence and technology predictors, financial resources lose independent predictive power and may even acted as a suppressor variable, a statistical artefact of high multicollinearity in which the negative sign reflected the controlling effect of stronger predictors rather than a genuine inverse relationship. The VIF of 15.01 for IAFR indicates substantial collinearity. The correlation between IAFR and IAI alone was r = .941, meaning that ministries with better-resourced audit units also tended to have more independent audit functions. In the regression model, once IAI's dominant effect was controlled, the residual variance attributed to IAFR may reflect inefficiently deployed or bureaucratically constrained resources the fraction of financial allocation that did not translate into operational capacity.

The non-significance of human resources was similarly contextual. Mihret and Yismaw (2007) and Barac et al. (2009) both found positive associations between auditor competency and audit effectiveness. The present study's null finding for IAHR did not contradict these results so much as qualify them: in an environment where auditors are structurally constrained by weak independence, burdened with administrative duties outside core audit work, or underequipped with the analytical tools needed for modern forensic auditing, additional qualified staff didnot generate proportional improvements in fraud prevention outcomes. Qualification was necessary but not sufficient. What auditors can do with their qualifications, the authority they must act on findings, the tools available to them, and the institutional support for their work mattered more than how many of them there are. The NACS's emphasis on capacity building alongside structural reform implicitly acknowledged this logic: it was not enough to train more auditors if the structural conditions for effective practice remain unchanged (NACS, 2024).

6. CONCLUSION

This study examined the simultaneous influence of internal audit resources, independence, and communication on fraud prevention in Malaysian federal ministries, a question which empirical answers have significant implications for governance reform in a country at a critical juncture in its anti-corruption trajectory. Drawing on the Agency Theory and survey data from 226 respondents across 34 federal agencies, the study confirmed that internal audit functions were powerful determinants of fraud prevention effectiveness, accounting for 98% of outcome variance when modelled collectively. This study found that independence was the dominant predictor by a substantial margin, followed by technological resources and communication. Financial and human resources, in isolation, did not independently drive fraud prevention outcomes in this context, a finding that challenged the input logic of many audit reform programmes and pointed to structural inefficiencies in how public sector audit resources were allocated and deployed.

The study contributes to the internal audit and public sector governance literature in several ways. First, it extends the Agency Theory to a developing country federal government context, providing empirical evidence that the theory's core predictions that monitoring effectiveness depends on independence and information transmission quality hold with remarkable strength in a setting characterised by hierarchical authority structures, political pressures, and bureaucratic resource constraints. By demonstrating the

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dominance of structural independence over financial and human resource inputs, this study established critical boundary conditions for theoretical models of governance in hierarchical public-sector environments. This study makes several distinct theoretical contributions that extended the Classical Agency Theory (Jensen & Meckling, 1976; Eisenhardt, 1989) beyond traditional governance paradigms. The Classical Agency Theory posited a positive linear relationship between resource allocation to monitoring functions and the reduction of agency costs. However, this study demonstrated that in public sector bureaucracies, resource allocation was an insufficient condition for agency control. Without structural independence, additional human capital and budget allocations remained subject to managerial capture, administrative friction, and operational inertia, thereby neutralising their monitoring utility.

Second, this study included additional dimension, which was the technological resources, making it a Digital Agency Theory. The findings illustrated that digital audit infrastructure fundamentally changed the monitoring dynamics: real-time analytics and continuous tracking reduce the agent's opportunistic informational advantage at the source, effectively disintermediating managerial discretion. Third, the empirical identification of a strategic oversight gap provided a theoretical nuance regarding the role of the monitor. This study extended current literature by conceptualising a dual agency framework: internal audit functions in developing public sectors can achieve high operational monitoring compliance while remaining structurally decoupled from strategic policy formulation. This conceptual distinction suggests that the Agency Theory must separate routine ex-post compliance monitoring from ex-ante strategic governance integration.

Third, this identified the strategic audit gap documented the disconnection between operational audit effectiveness and strategic fraud governance participation as an understudied dimension of audit function effectiveness that merits dedicated theoretical and empirical attention. Fourth, the study's alignment with Malaysia's 2024 governance reforms provides a rare opportunity to triangulate theoretical findings against the lived institutional context they describe, strengthening the external validity of the results.

For policymakers at the Ministry of Finance, the Public Service Department, and the National Audit Department, the study's central message is a departure from the conventional resource-expansion logic of audit reform: invest first in structural independence and digital infrastructure, then in staffing and budgets. The evidence suggested that the returns to financial and human resource expansion were conditional on structural reform conditional on auditors having the independence to pursue findings without management interference, the technology to monitor transactions comprehensively, and the communication channels to translate findings into action. The Auditor General's Directive No. 3/2024 and the amended Treasury Circular PS 3.1 represented exactly the kind of structural reform that the data supported: reforms that specified reporting obligations, clarify authority, and reduced management control over audit operations.

For chief audit executives and heads of internal audit units at the ministry level, the findings supported a strategic reorientation of the audit function from compliance reporting toward proactive fraud risk governance. This meant seeking representation in strategic risk management forums, establishing formal feedback protocols that required management to respond to audit findings within defined timeframes, investing in data analytics and continuous monitoring tools, and building the interdepartmental relationships that enabled coordinated fraud risk management. The NADM's MoU with the MACC and its

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collaboration with UiTM and IIA Malaysia provided institutional frameworks within which these strategic ambitions can be operationalised.

For professional development bodies, including IIA Malaysia and the Malaysian Institute of Accountants, the study highlights the need for competency frameworks that go beyond technical audit skills to encompass independence management, digital audit proficiency, strategic communication, and governance advisory capabilities. The Auditor General's call for a 'risk-based mindset' and 'tech acceptance' in public sector auditing (MIA, 2024) was not merely aspirational; the present evidence base suggested that these capabilities were among the most powerful drivers of the fraud prevention outcomes that public sector auditwas ultimately designed to achieve.

This study has several limitations that future research should address. The cross-sectional design precluded causal inference: while the regression model identified independence, technology, and communication as powerful predictors of fraud prevention, it could not establish that improving these dimensions causes improved outcomes, a distinction that longitudinal designs can address. Future research employing panel data or difference-in-differences approaches to evaluate the impact of specific governance reforms, such as the Auditor General's Directive No. 3/2024 or the NACS implementation, on fraud prevention outcomes would be particularly valuable.

Second, the study relied on self-reported perceptions, which were subject to social desirability bias. Respondents in internal audit functions may have an incentive to present their organisational arrangements in a favourable light, potentially inflating perceived effectiveness measures. Mixed methods designs that triangulate survey findings with document analysis, audit committee records, or MACC case statistics would strengthen the evidential base.

Third, the sample was confined to federal ministries and a selection of local authorities, limiting generalisability to state-level agencies, statutory bodies, and government-linked companies. Given that the Auditor-General's Report 2/2025 highlighted significant governance failures in entities including FELCRA Berhad, Majlis Amanah Rakyat, and defence procurement bodies, extending the research to these contexts was an important next step. Including higher-level respondents including audit committee members, JUSA-grade officers, and ministry secretaries-general, would add a top-management governance perspective that the current sample cannot provide.

Fourth, the presence of severe multicollinearity and high inter-predictor correlations limited the ability to isolate independent partial regression effects. While these correlations accurately reflected the integrated nature of public sector internal control frameworks, the individual beta weights should be interpreted with caution as partial components of a system rather than standalone causal elasticities. Future research should employ Structural Equation Modeling (SEM) or Partial Least Squares (PLS-SEM) to model these dimensions as hierarchical latent constructs or reflective-formative measurement models. The high overall model explanatory power and Harman’s single-factor test result indicated common method variance and perceptual halo effects. In public sector administrations, respondents tended to evaluate internal controls as a holistic capability. To overcome perceptual bias, future studies should incorporate objective, non-perceptual outcome measures such as official MACC corruption prosecution counts, verified audit defect rates, or longitudinal financial loss metrics across ministries.

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8. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

9. AUTHORS' CONTRIBUTIONS

Ahmad Ibrahim Abd Rahim: Conceptualisation, methodology, formal analysis, investigation and writing-original draft; **Sharifah Nazatul Faiza Syed Mustapha Nazri**: Conceptualisation, supervision, and writing- review; **Salwa Zolkaflil**: final review, editing, and validation.

10. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the author(s) used Gemini AI in ensuring the workflow of the paper was consistent throughout of the study. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

11. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

12. ETHICS STATEMENT

The authors declare that this research was performed in accordance with the institutional Safety, Health, and Environmental (HSE) protocols of UiTM and were reviewed and approved by the Institutional Ethics Committee. All procedures involving human participants/animal subjects complied with the ethical standards of the 1964 Helsinki Declaration. The participations were on voluntary basis and data anonymity was strictly maintained throughout the study.

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