© FEB 2026 | IRE Journals | Volume 9 Issue 8 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I8-1714217

Combating Public Sector Fraud Through Technology-Driven Compliance Systems

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Abstract- ***This study provides a rigorous, multidimensional examination of technology-enabled compliance systems and their transformative impact on fraud prevention and financial integrity within public governance. Drawing on empirical evidence from integrated financial management systems, predictive and rule-based analytics, continuous auditing frameworks, and automated control architectures, the paper demonstrates how digital infrastructures are reshaping oversight in government finance. Technology enables a decisive shift from fragmented, retrospective auditing to real-time, data-driven assurance, supported by full-population testing, anomaly detection, automated exception reporting, and intelligent risk-scoring models. These advancements strengthen transparency, reduce fiscal leakages, and enhance accountability across ministries and agencies. Yet, the analysis also reveals systemic constraints that complicate digital adoption, including cybersecurity vulnerabilities inherent in expanding government data ecosystems, high modernization costs, institutional resistance, and the growing ethical complexity of algorithmic governance. Skills gaps among compliance professionals further limit the effective use of advanced analytics and AI-assisted monitoring tools. In response, the study argues for a strong policy and institutional agenda, anchored in strengthened legal frameworks, improved data governance, protected whistleblowing channels, and deep cross-sector collaboration to ensure responsible, equitable, and sustainable deployment of these technologies. In all, the paper concludes that technology is an operational enhancement and a strategic deterrent to fraud, offering a structural pathway toward resilient, transparent, and trustworthy public financial management systems.***

Keywords: ***Digital Compliance, Public Financial Management, Continuous Auditing, Predictive Analytics, Algorithmic Governance, Fraud Prevention, Fiscal Transparency, Ai-Enabled Oversight, E-Governance Systems***

I. INTRODUCTION

Public sector fraud poses a widespread and costly threat to governments globally, as misappropriation of funds, procurement corruption, and unauthorized payments compromise fiscal integrity and diminish public trust. According to a study by the International Institute for Counter-Fraud and Integrity Protection (2025), financial crime that includes fraud, drains between 10–15% of global GDP annually, amounting to tens of trillions of dollars in losses. The Association of Certified Fraud Examiners' *Occupational Fraud 2024: Report to the Nations* noted that its 13th global study analyzing 1,921 cases across 138 countries between January 2022 and September 2023, revealed $3.1 billion in losses and concluded that organizations worldwide forfeit an estimated 5% of annual revenue to fraud (Association of Certified Fraud Examiners, 2024). In the public sector, data-driven analyses reveal systemic vulnerabilities, with more than USD 1 trillion paid annually in bribes and approximately USD 2.6 trillion lost to corrupt practices, together equating to about 5% of global GDP and highlighting the immense economic toll of fraud and corruption worldwide (Mabel et al., 2025). In Nigeria, corruption remains particularly severe, with the National Bureau of Statistics reporting that public officials accepted ₦721 billion in bribes in 2023 (Punch, 2024), revealing both the vast scale of the problem and its entrenched structural presence within public finance systems.

Public sector fraud extends beyond immediate financial losses, as corruption distorts spending priorities, drives inefficient or inflated procurement contracts, weakens service delivery, and reduces the capacity for infrastructure investment. The World Bank contends that corruption undermines economies by deterring investment, slowing growth, worsening inequality, raising government costs, eroding public trust, and fueling political instability (World Bank, 2021). Also, deficiencies in public financial management (PFM) systems intensify the challenge, as weak controls, poor transparency, and inadequate oversight create fertile ground for fraud and corruption to thrive. An IMF-backed costing model estimates that inefficiencies stemming from corruption in public

financial management amount to roughly US$4.5 trillion worldwide, equivalent to about 5% of global GDP with losses calculated at the general government level and approximately US$1.7 trillion at the budgetary central government level (International Monetary Fund, 2023). From a governance standpoint, rising corruption erodes democratic legitimacy, as Transparency International's 2023 Corruption Perceptions Index reveals that over two-thirds of countries score below 50 out of 100, signaling widespread deficiencies in public sector integrity (Transparency International, 2024). In many states, eroding trust in government diminishes citizen confidence, reduces compliance, and fuels unrest.

In tackling these challenges, technology has emerged as a cornerstone of modern anti-fraud strategies in the public sector, with Integrated Financial Management Systems (IFMS) offering a unified platform that consolidates budgeting, procurement, accounting, and reporting to enhance transparency, visibility, and control across government operations. Nafuye (2024) reports that the implementation of IFMIS has had a significant positive impact on financial management practices. These systems make it harder for illicit transactions to remain hidden and easier for auditors and compliance teams to trace anomalies. Beyond IFMS, advanced compliance analytics platforms are reshaping fraud detection by leveraging predictive modeling, rule-based engines, and machine learning to identify irregularities in procurement, payments, and contracting. Lyra et al. (2022) highlight in their review of public procurement research a notable surge in both academic and applied studies focused on data-driven approaches to detecting collusion and corruption. At the same time, continuous auditing which is enabled by real-time data feeds from financial systems is gaining traction, allowing for ongoing assurance rather than periodic checks. This technological evolution heralds a shift from reactive investigations to proactive prevention.

This study explores how technology-driven compliance systems, particularly IFMS and advanced analytics platforms, can be harnessed to prevent, detect, and mitigate fraud in public institutions. It focuses on predictive and rule-based models for identifying irregular transactions, alongside continuous auditing as a tool for real-time assurance and deterrence. Ultimately, the paper proposes a multi-layered fraud prevention architecture that integrates technology, process controls, and governance, bridging theory with practical design for government implementation.

The remainder of this paper begins with a review of the literature on public sector fraud and existing compliance systems, emphasizing technological interventions. It then outlines methodologies for predictive and rule-based fraud detection models, drawing on case studies and empirical evidence. The discussion proceeds to continuous auditing mechanisms, considering both their benefits and the challenges of applying them in public institutions. Building on these insights, the paper introduces a comprehensive, multi-layered fraud prevention architecture designed for the public sector. This is followed by an examination of policy implications, implementation strategies, and potential risks, along with practical recommendations. Finally, the conclusion synthesizes the key findings, acknowledges limitations, and identifies promising directions for future research.

II. UNDERSTANDING PUBLIC SECTOR FRAUD AND FINANCIAL MISMANAGEMENT

Definition and Typology of Public Sector Fraud

Public sector fraud is broadly understood as the abuse or manipulation of public authority, systems, or resources by officials or institutions for personal or organizational gain, often at the expense of public interest. A foundational requirement of public financial management is the complete and accurate recording of historical costs and income relating to the receipt, custody, and disbursement of government funds, which is essential for reliable financial information, present appraisal, future fiscal planning, and effective performance control (Obiah et al., 2025). Ariyo-Edu et al. (2024) describe public sector fraud as fraudulent activities perpetrated within government agencies or publicly funded entities, encompassing misappropriation of funds, bribery, and abuses of administrative or fiduciary power.

Corruption, central within the broader landscape of public sector fraud, appears across diverse manifestations such as procurement manipulation, payroll fraud, embezzlement, bribery, collusion, and the misappropriation of public assets. Mengzhen et al. (2025) argue that the social understanding of corruption is often distorted by how it is communicated, with corruption framed as a distant, systemic phenomenon associated with powerholders, while bribery tends to be viewed as a more localized, interpersonal practice. Transparency International (n.d.) defines corruption as the abuse of entrusted power for private gain. The Basel Institute on Governance expands this definition beyond public office, emphasizing that corruption includes the abuse of power in any institutional context and may produce financial or non-financial benefits such as influence, preferential access, or status.

Phillips et al. (2025) note that the public office conceptualization, defining corruption as the abuse of public trust, authority, or duty, remains dominant in contemporary scholarship. They also highlight ongoing tensions between the "public office" view, which focuses on breaches of institutional trust, and the "public interest" view, which highlights the broader harm such misconduct causes to societal welfare. Gouvêa et al. (2024) further argue that corrupt practices may not always involve direct theft or monetary exchanges; they may be embedded within foreign investments, political bargaining, or institutional power structures, extending into sectors such as banking and finance.

Although corruption is often characterized as the misuse of power for unlawful gain through acts like bribery, embezzlement, and fraud, Schneider et al. (2025) draw an important distinction, implying corruption is a subset of intentional wrongdoing involving abuse of positional authority, whereas fraud more broadly encompasses intentional deception for economic gain, including both deliberate and inadvertent actions that cause financial loss to public institutions. This distinction is crucial for designing compliance systems, as corruption typically involves authority-based malfeasance, while fraud detection must also consider deceptive behavior outside formal power positions.

Procurement fraud is among the most pervasive forms of corruption. It may occur through bid rigging, where colluding firms or officials manipulate competitive bidding processes to inflate prices or assign contracts inequitably. Fraud can occur at any stage of the procurement cycle, planning, bidding, evaluation, contract award, or execution undermining transparency and accountability (Moyo et al., 2025). Payroll fraud similarly undermines financial integrity, often taking the form of "ghost employees," falsified wage claims, or manipulated attendance records. Edori and Iwene (2025) emphasize that such schemes frequently involve collusion between payroll officers and employees, facilitating the diversion of public funds.

Embezzlement represents another significant typology of public sector fraud. Sanction Scanner (2024) defines embezzlement as the intentional misappropriation of entrusted funds or property, typically perpetrated by individuals in positions of fiduciary responsibility. Izunna and Edem (2025) describe it as the outright theft of public resources by officials empowered to manage them. Brodowicz (2024) stresses that embezzlement constitutes a profound breach of institutional trust because the offender exploits legitimate access to assets for personal benefit. Fraud typologies often overlap and reinforce one another, as procurement fraud may involve collusion and embezzlement, while payroll fraud may be facilitated by weak internal controls, insufficient oversight, and opportunities for unauthorized financial manipulation.

Patterns and Risk Indicators of Financial Irregularities

Academic literature and empirical research consistently identify recurrent patterns and red-flag indicators that signal fraud and financial irregularities in the public sector. A systematic review of corruption in public procurement shows that data-driven detection methods, particularly machine learning and network analysis are effective for uncovering anomalies in contract patterns, supplier relationships, and bidding behavior that deviate from expected norms (Lyra et al., 2022). Extending this computational approach, Eniolape et al. (2025) propose a machine-learning–based fraud detection system that evaluates transaction attributes, user

activity profiles, and network connections to identify suspicious behavior in real time, demonstrating superior detection performance compared to traditional rule-based systems.

Several well-documented red flags signal procurement irregularities. These include abnormally high contract values relative to market benchmarks, the persistent use of noncompetitive bidding processes, repeated contract awards to the same vendors, complex subcontracting arrangements, and procurement cycles characterized by limited transparency. Munteanu et al. (2024) argue that auditors benefit from identifying and quantifying qualitative organizational factors, such as the nature of an entity's operations and the complexity of its procurement environment which shape a financial risk profile that can guide the detection, prevention, and control of economic crime.

Gara et al. (2024) introduce auction-specific indicators designed to evaluate public tenders, contracting authorities, and winning bidders. By aggregating these into composite risk measures and applying them to confidential data from Italy's Financial Intelligence Unit, their study demonstrates how such indicators can be used for monitoring corruption, procurement fraud, and money laundering across multiple stages of the tendering process. Structural and organizational factors also shape corruption risk. Institutional characteristics such as low salary dispersion, large bureaucratic structures, and insufficient oversight mechanisms increase vulnerability to systemic corruption. Using agent-based modelling, Pablo et al. (2023) show that organizations with low pay differentiation and large administrative hierarchies are more susceptible to corrupt equilibria because incentives to collude or engage in illicit behavior outweigh available deterrents.

Furthermore, corruption risk is multidimensional and extends beyond single indicators. Michela and Simone (2023), in a study grounded in Sustainable Development Goal (SDG) monitoring, validate red-flag indicators against real procurement data and find that corruption risk clusters around distinct categories, including conflict-of-interest, favoritism, and procedural opacity each aligning with SDG governance principles and accountability targets. Their findings highlight that corruption is a monolithic phenomenon but a constellation of discrete, measurable risks embedded within institutional processes.

The Cost of Corruption on National Development and Fiscal Stability

Public-sector corruption imposes substantial economic and governance burdens, weakening fiscal stability and obstructing long-term national development. The World Bank (2022) estimates that corruption drains at least 5 percent of global GDP annually, highlighting its pervasive macroeconomic impact. On the African continent, the African Development Bank (2025) reports that corruption reduces regional GDP by approximately 25 percent each year, a scale of loss that severely undermines growth trajectories, weakens public institutions, deters foreign investment, and reinforces structural inequality.

At the global public finance level, the International Monetary Fund (2023) estimates that inefficiencies and corruption embedded in public financial management systems cost governments approximately US$4.5 trillion annually. Notably, as much as 30 percent of this loss stems from budgetary corruption, misallocation, diversion, and manipulation of public budgets, rather than procurement malfeasance. Nonetheless, procurement corruption remains one of the most financially consequential forms of fraud. Adam and Fazekas (2023) observe that corruption in public infrastructure procurement inflates project costs, encourages collusive bidding, results in delays and substandard delivery, and diverts public spending toward complex capital projects at the expense of ongoing operations and essential maintenance. These distortions erode public value and diminish the developmental returns of infrastructure investments.

Beyond direct fiscal losses, corruption imposes significant macroeconomic and institutional costs. Makar et al. (2023) note that corruption distorts incentives and market mechanisms by misallocating resources toward rent-seeking activities, effectively functioning as an informal tax that raises production costs and lowers investment profitability. It reduces productivity by degrading the quality of public goods and services, limits the efficiency of public

expenditure, and creates structural waste throughout government systems. The cumulative effect is a weakening of macroeconomic competitiveness and diminished fiscal resilience.

Corruption also undermines long-term development outcomes and social cohesion. Spyromitros and Panagiotidis (2022) emphasize that corruption depresses economic growth, widens inequality, and diminishes public trust in state institutions, factors that collectively weaken governance legitimacy. In developing economies, corrupt financial outflows further erode development capacity by diverting scarce public resources away from critical sectors such as health, education, and infrastructure. The resulting underinvestment in human capital and essential public services compounds structural poverty and constrains sustainable development prospects.

Case Examples from Global and U.S. Government Institutions

Evidence from global and U.S. institutions shows that weak financial controls, procurement oversight, and payroll systems foster fraud, imposing heavy fiscal burdens and eroding public trust in state governance. One of the most widely cited African cases is Malawi's Cashgate scandal, which exposed systemic vulnerabilities in the country's Integrated Financial Management Information System (IFMIS). Investigations revealed that perpetrators manipulated the system by creating vouchers for fictitious goods and services, deleting fraudulent entries, and channeling public funds into private bank accounts without triggering automated alerts or managerial review (African Development Bank, 2023; Strasser, 2016). In this scandal IFMIS platforms, when poorly secured, weakly monitored, or lacking audit trails can become instruments for facilitating rather than preventing financial crime.

South Africa's Zondo Commission provides another large-scale example of state capture enabled through procurement and financial governance failures. The Commission documented how politically exposed individuals and private contractors colluded to manipulate tenders, circumvent oversight mechanisms, and redirect state resources toward connected firms (BBC News, 2022; Pinsent Masons, 2022). Findings from the Commission revealed that state capture was not isolated misconduct but a coordinated, networked enterprise entrenched across procurement, executive decision-making, and parastatal financial management systems (Africa Check, 2025). These insights illustrate how procurement fraud, when embedded at senior levels, can distort national budgeting priorities and erode institutional integrity.

In the United States, enforcement actions under the False Claims Act (FCA) emphasize the persistent challenge of procurement fraud in federal programs. The Department of Justice (DOJ) recovered over US$2.2 billion in FCA settlements and judgments in FY 2020, with individual districts such as the Eastern District of Virginia recovering more than US$242 million and the Southern District of New York announcing settlements nearing US$90 million (Global Investigations Review, 2022). More recently, the DOJ reported that FY 2023 produced 543 settlements and judgments with the highest number ever recorded, yet total recoveries were among the lowest in a decade, with US$1.8 billion arising largely from health care cases (Lawrence et al., 2024). The DOJ identified procurement fraud, cybersecurity fraud, pandemic-related fraud, and individual accountability among its top enforcement priorities, reflecting the evolving modalities of financial misconduct in public programs.Payroll fraud remains a significant threat, as demonstrated by the CityTime scandal in New York. Initially contracted at US$63 million, the automated payroll project ultimately cost more than US$700 million due to inflated hours, fraudulent billing, and collusion between contractors and city officials. Multiple individuals were indicted, and the scandal became a landmark example of how complex IT modernization projects can be exploited without strong cost controls, independent oversight, and continuous auditing (Panorama Consulting Group, 2021).

Direct embezzlement of public funds continues to undermine U.S. state and municipal financial systems. In Mississippi, a state audit uncovered the misappropriation of at least US$77 million in welfare funds intended for low-income families under the Temporary Assistance for Needy Families (TANF) program. Key controversies included a US$5 million

transfer for a university volleyball facility and US$1.1 million paid to Brett Favre for speeches he did not deliver, payments he later returned, though the state auditor continues to pursue an additional US$228,000 in interest (ESPN News Services, 2023). Similarly, the City of Bell in California became a national symbol of municipal corruption when state investigations revealed that senior officials misused public funds while awarding themselves exorbitant salaries, including nearly US$800,000 annually to the city manager, despite the city being among the poorest in Los Angeles County (Factual America, 2025).

III. EVOLUTION OF TECHNOLOGY-DRIVEN COMPLIANCE IN GOVERNANCE

Public governance compliance has advanced significantly, moving from traditional reliance on manual audits toward the adoption of fully automated financial control systems (José et al., 2024). With the rise of automation, cloud computing, blockchain technologies, and data analytics, conventional audit practices based on paper documentation, manual sampling, and periodic inspection have become inadequate for producing timely and reliable assurance in complex public financial environments (Dawkins Brown, 2025). The implementation of Integrated Financial Management Information Systems (IFMIS) has supported this transformation by consolidating budgeting, accounting, procurement, and reporting processes within unified digital platforms, embedding internal controls that reduce opportunities for fraud and misappropriation (Owolabi, Aremu & Ufuoma, 2022). Evidence from South Sudan indicates that adopting IFMIS has enhanced internal audit performance and improved financial accountability by providing auditors with transparent and real-time access to transaction data (Nhial et al., 2025). Similarly, in Kenya, the deployment of IFMIS in Migori County improved transparency and operational efficiency by enabling direct payments to contractors and suppliers, reducing procurement costs, and generating savings tied to the time value of money (Mugendi et al., 2023).

Alongside the expansion of IFMIS, e-governance frameworks have contributed to digitizing government services, procurement workflows, and compliance processes. In Malawi, the integration of IFMIS within its broader e-governance reforms improved service delivery, reduced budget over-expenditures, enhanced the timeliness of reporting, and was further strengthened by institutional measures such as the appointment of Management Information Systems Officers charged with protecting system integrity (Jana, 2025). These developments reflect a broader global shift toward embedding digital tools into public sector governance to strengthen accountability and limit irregularities.

Data governance and process standardization form another crucial pillar of technology-driven compliance. Standardizing financial data structures, documentation formats, and process flows ensures consistency across government transactions while increasing the reliability and traceability of financial records. When combined with rule-based analytics, predictive models, and large language models (LLMs), standardized data enables continuous auditing and automated detection of anomalies such as duplicate payments, unauthorized vendor activities, or deviations from approved expenditure patterns. As Mishra et al. (2024) note, advancements in automation and AI-driven analysis improve data structuring, support more informed decision-making in financial planning, and generate efficiency gains that strengthen transparency, fiscal discipline, and economic performance across government institutions undergoing digital transformation.

Furthermore, many governments have adopted open data platforms, transparency dashboards, and digital reporting systems to enhance public accountability. In the United States, the Data.gov portal publishes machine-readable datasets from federal agencies, thereby expanding public oversight of budgeting, procurement, and performance indicators (Eastern New Mexico University, 2025). The Open Government Platform (OGPL), implemented in multiple countries, integrates documents, datasets, and public records into a unified interface accessible to citizens, journalists, and civil society organizations (OGPL, 2022). Research by Fillip & Anastasija (2024) emphasizes that well-designed open government data portals improve usability, facilitate public value creation, and deepen transparent governance by enabling more effective civic engagement and oversight.

INTEGRATED FINANCIAL MANAGEMENT SYSTEMS (IFMS) AND THEIR IMPACT

Integrated Financial Management Information Systems (IFMS) are comprehensive digital platforms designed to consolidate a government's core public financial management functions, including budgeting, accounting, procurement, and treasury operations into a single integrated architecture. Harun Ar Rashid (2024) notes that IFMS represents a transformative shift in public financial management by unifying accounting, procurement, asset management, treasury, and reporting functions to enhance operational efficiency, transparency, and administrative control across government entities. These systems centralize financial data and workflows, strengthening internal controls, improving accuracy in reporting, and automating compliance checks that reduce opportunities for errors and fraud. According to Nafuye (2024), the core modules of IFMS typically comprise budgeting, accounting or general ledger, cash or treasury and debt management, with some implementations extending to procurement, tax administration, asset management, human resources and payroll, pensions, and social security systems. Together, these modules support end-to-end financial management processes and enable real-time transaction visibility that enhances financial integrity. Tumuramye et al. (2025) emphasize that real-time monitoring is integral to IFMS effectiveness, as it enables instant flagging of anomalies such as duplicate payments, non-budgeted expenditures, or inflated claims while maintaining an immutable audit trail that facilitates accountability and investigation.

Empirical evidence demonstrates the value of IFMS in strengthening governance outcomes. Gichuhi and Muna (2024) find that staff competence and system quality significantly enhance ministry performance in Kenya, while internal controls, though comparatively weaker, still positively influence accountability and efficiency. Their findings point to the need for targeted staff training and ongoing professional development to sustain IFMS benefits. Similarly, Kiprop et al. (2025) report that internal controls embedded within IFMS substantially improve governance processes within Kenya's National Treasury in the North Rift region by reinforcing accountability and overall financial management quality. Noor's (2022) study of IFMS implementation in Bangladesh highlights that although the government has introduced strategic reforms and wage adjustments aimed at retaining skilled personnel, successful implementation remains highly dependent on staff capacity, technical expertise, and resistance to technological change.

Further evidence from Kenya demonstrates the practical impacts of IFMS on financial governance. IFMS adoption within the National Treasury has enhanced internal controls, improved resource planning, and strengthened accountability mechanisms. Research on ministerial operations shows that the budgeting, cash management, and accounts-payable modules have significantly improved procurement performance, reducing cycle times and enhancing transparency (Mutangili, 2025). At the sub-national level, Malala et al. (2023) find that automation through IFMS in Kilifi County improved timeliness in financial reporting, optimized cash management practices, and strengthened budget planning processes, collectively contributing to better overall financial performance.

Despite these gains, governments continue to encounter substantial challenges in IFMS deployment. Noor (2022) identifies persistent obstacles such as limited staff capacity, user resistance to technological change, and supply chain issues that impede effective system utilization. Interoperability also remains a major concern. Njogo and Njeru (2022) report that although electronic modules for budgeting, procurement, and cash management exist, their limited integration creates system gaps that can be exploited for financial misconduct. Technical capacity constraints, including insufficient ICT infrastructure, inadequate user training, and weak change-management frameworks also hinder effective implementation (Apio & Asiimwe, 2024). Additionally, studies of Kenya's state-owned enterprises reveal that even where IFMS improves productivity, substantial risks remain in areas such as vendor evaluation, inventory control, and procurement oversight, largely due to inadequate staff proficiency (Willy & Paul, 2021).

IV. PREDICTIVE AND RULE-BASED COMPLIANCE ANALYTICS

In modern public sector governance, data-driven compliance analytics leverages predictive and rule-based mechanisms to detect, prevent, and mitigate fraud. Integrating predictive analytics into compliance frameworks allows institutions to automate risk assessments, enhance transaction screening, and strengthen suspicious activity reporting (SARs) (Okunbor, 2025). Predictive analytics surpasses traditional rule-based systems by identifying complex and subtle risks beyond fixed thresholds, offering greater foresight and responsiveness (Odetunde et al., 2022). These systems move beyond reactive auditing by continuously monitoring financial activities, flagging suspicious behavior in real time, and adapting as fraud patterns evolve. This capability is critical in government, where the size and complexity of transactions require intelligent tools capable of distinguishing legitimate anomalies from indicators of fraud. Zygoulis (2025) demonstrates that AI-driven predictive models enhance risk identification through anomaly detection and predictive scoring, refine audit planning via dynamic risk heatmaps, and support continuous auditing that reduces detection delays. Leveraging historical datasets, predictive models uncover recurring fraud patterns with higher precision (Friday et al., 2023) and identify risk probabilities associated with procurement fraud, payroll fraud, and embezzlement. Olufemi et al. (2024) further show that predictive analytics can forecast potential fraud hotspots and deliver real-time alerts that support rapid intervention. Common supervised algorithms, including logistic regression, decision trees, random forests, and gradient boosting, have proven effective in detecting fraudulent financial transactions by learning from labeled past incidents (Pratama & Wahid, 2025; Afriyie et al., 2023). In the public procurement sector, integrating machine learning with bidder profiles, contract values, timelines, and performance metrics enables real-time detection of bid-rigging schemes, conflicts of interest, and anomalous vendor behavior (Ayobami et al., 2023), allowing agencies to score tenders for risk before approval.

Rule-based engines complement these predictive models by embedding policy-driven controls, thresholds, and business logic directly into compliance systems. They enforce predefined parameters, such as spending caps, duplicate invoice flags, unauthorized vendor alerts, and AML-oriented controls to identify suspicious activities like unusually large transactions, rapid fund transfers, or dealings with high-risk jurisdictions (Omoseebi et al., 2025). These engines operationalize structured controls such as vendor blacklists, duplicate payment detection, and abnormal bidding behaviors. Islam et al. (2024) show that a well-designed rule-based model can outperform various machine learning algorithms, including random forests, multi-layer perceptrons, k-nearest neighbors, naive Bayes, and logistic regression, achieving 0.99 accuracy and precision without requiring dataset rebalancing. Their interpretability and alignment with regulatory requirements make rule-based systems indispensable for public sector accountability.

Machine learning algorithms, particularly unsupervised or semi-supervised approaches, strengthen anomaly detection by identifying deviations from normal patterns without requiring labeled fraud cases. Misato (2025) finds that retrieval-grounded models outperform fine-tuned transformers and static classifiers on synthetic and real fraud datasets, achieving superior F1-scores, precision, and contextual reasoning in applications such as transaction monitoring, policy violation detection, account takeover analysis, and social engineering prevention. Deep learning models, especially Autoencoders have improved anomaly detection accuracy by uncovering hidden transactional patterns that static rules often miss, continuously adapting to evolving fraud behaviors (Adhikari et al., 2024). Similarly, a hybrid deep-learning model combining recurrent neural networks, transformers, and autoencoders has shown strong performance in detecting anomalous sequences and emerging fraud trends, managing imbalanced datasets and noisy inputs with a balanced trade-off between accuracy and interpretability (Chen et al., 2025). In public procurement, graph-based models effectively capture relational red flags such as supplier collusion networks, enabling pattern mining across procurement structures (Schneider dos Santos et al., 2025).

Critically, combining predictive and rule-based systems yields a more resilient compliance architecture. Hybrid designs, where rule-based alerts act as the initial filter and predictive models perform deeper risk scoring have proven particularly effective

in public procurement (Roland, 2025). This layered approach reduces false positives, improves explainability, and ensures that predictive analytics adapts to emerging fraud tactics while remaining grounded in formal policy controls. This integration of rule-based governance with predictive intelligence allows public institutions to maintain continuous, scalable, and context-aware monitoring, thereby strengthening fraud prevention and compliance in the digital governance era.

V. CONTINUOUS AUDITING AND REAL-TIME RISK MONITORING

Continuous auditing (CA) marks a fundamental transition from retrospective, periodic reviews to automated, real-time assurance systems that actively monitor financial events as they unfold. Continuous auditing encompasses processes for automatically collecting and evaluating data to ensure ongoing efficiency, system effectiveness, and continuous execution of controls and risk assessments (Minkkinen et al., 2022). Compared to traditional audit approaches, CA is characterized by higher audit frequency, proactive monitoring, and automated procedures that deliver immediate assurance and more stronger control environments (Yoon et al., 2021). Ilori (2023) advances this evolution by proposing an AI-enabled audit model in which real-time anomaly detection and intelligent decision-support mechanisms shift auditing from retrospective sampling to forward-looking, full-population analysis, enabling instant identification of fraud, policy breaches, and operational inefficiencies.

The introduction of Robotic Process Automation (RPA) has further enhanced CA by automating data extraction, validation, and reconciliation, thereby generating consistent audit trails with minimal human intervention (Dang & Nguyen, 2024). RPA does not replace accountants but redistributes routine, high-volume tasks, such as invoice processing, refunds, sales order entry, and customer-service transactions allowing professionals to focus on analytical and strategic activities like reporting, tax planning, and financial analysis (Balamurugan et al., 2023). This division of labor fosters greater efficiency, continuous system improvement, and deeper value creation across public financial institutions. However, as Gu et al. (2024) note, RPA tools such as UiPath and Blue Prism excel in automating structured, rule-based operations but remain limited in adapting to complex, dynamic, multimodal audit scenarios. Still, their role in automating log analysis, exception testing, and rule-based process verification substantially improves audit coverage and accuracy (Balamurugan et al., 2024).

Continuous monitoring, which focuses on management oversight of internal controls, risk indicators, and performance metrics (Ziorklui et al., 2024), differs from continuous auditing in purpose and scope. While continuous monitoring supports operational decision-making, continuous auditing provides independent verification of financial integrity and regulatory compliance (Thanasas et al., 2025). Machine learning further extends CA by learning normative financial behavior and flagging deviations, while predictive analytics identify emerging risks by analyzing historical patterns and forecasting future anomalies. This capability enables auditors to anticipate vulnerabilities, allocate audit resources more strategically, and improve overall audit efficiency as adaptive AI systems refine their models over time (Antwi et al., 2024).

Evidence shows that shifting from periodic to continuous, technology-driven audit methods enhances transparency, accelerates fraud detection, strengthens process efficiency, and elevates decision-making quality in public financial management systems (Polizzi & Scannella, 2024). These advantages are particularly critical in public institutions that process large transaction volumes and coordinate across multi-agency workflows, where delayed fraud detection can quickly translate into significant fiscal losses and erosion of public trust. Effective implementation of CA in the public sector requires standardized data governance, integrated automation, analytics-driven monitoring, and capacity building for auditors to interpret real-time dashboards. Ayibam (2025) stresses the importance of collaboration among technologists, legal experts, and policymakers to ensure that AI adoption in public procurement remains aligned with public interest, legal integrity, and principles of fairness and transparency, reinforcing CA as a cornerstone of modern public accountability.

© FEB 2026 | IRE Journals | Volume 9 Issue 8 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I8-1714217

VI. DESIGNING A MULTI-LAYERED FRAUD PREVENTION ARCHITECTURE

Designing an effective fraud prevention architecture in public financial management requires a multi-layered model that integrates preventive, detective, and corrective mechanisms into a unified compliance ecosystem. At the preventive layer, Integrated Financial Management Information Systems (IFMIS) provide foundational controls by standardizing budgeting, accounting, procurement, treasury, and related workflows, composed of automated checks that limit opportunities for fraud and enforce consistent financial reporting (Harun Ar Rashid, 2024; Nafuye, 2024). Role-based access control (RBAC) and segregation of duties form the backbone of this layer, distributing responsibilities for initiating, approving, and reconciling transactions among authorized personnel to prevent collusion and unauthorized access, with these principles reinforced by IFMIS-driven accountability improvements across multiple jurisdictions. Akuthota (2025) demonstrates that Role-Based Access Control (RBAC) effectively reduces security incidents, streamlines administrative processes, and ensures regulatory compliance, while the integration of artificial intelligence and machine learning further enhances RBAC's capacity to detect and prevent threats and optimize role management.

The detective layer relies on real-time analytics, continuous auditing, and automated anomaly detection to identify suspicious patterns as they occur. Predictive analytics, machine learning, and hybrid rule-based systems enhance fraud detection by examining large transaction datasets to flag deviations from normative behavior and forecast emerging fraud hotspots with greater precision (Odetunde et al., 2022; Zygoulis, 2025; Friday et al., 2023). Continuous auditing systems deliver real-time assurance by monitoring financial events as they unfold, employing automated controls that replace retrospective sampling with full-population, high-frequency analysis (Minkkinen et al., 2022; Yoon et al., 2021). Robotic Process Automation (RPA) further strengthens this layer by automating audit trail generation, exception testing, and data reconciliation, thereby increasing audit coverage and reducing manual errors in complex workflows (Dang & Nguyen, 2024; Balamurugan et al., 2023).

Corrective mechanisms ensure that once anomalies are detected, they trigger structured responses capable of containing financial losses and preventing recurrence. Integrated audit trails within IFMIS platforms allow investigators to trace transaction histories, identify responsible actors, and enforce accountability, providing transparency necessary for disciplinary, administrative, or legal actions (Tumuramye et al., 2025). AI-driven risk scoring also supports prioritization in corrective workflows, helping regulators and internal auditors address high-risk cases promptly while improving resource allocation in investigative processes (Olufemi et al., 2024). Corrective controls are strengthened when government systems incorporate open data provisions and transparency dashboards, enabling oversight bodies and the public to scrutinize financial activities, a practice aligned with global open government data initiatives (Fillip & Anastasija, 2024; Eastern New Mexico University, 2025).

A fully operational multi-layered architecture relies on seamless integration across its components, with automated alerts and exception reporting to flag high-risk events, while modern procurement and financial workflows are strengthened by dashboards that unify predictive metrics, real-time control statuses, exception reports, and audit indicators into accessible visual interfaces for compliance officers and regulators. Such dashboards, aligned with the capabilities of IFMIS and continuous monitoring systems, empower decision-makers to act swiftly on irregularities and enforce compliance. Hybrid systems combining rule-based filters with predictive analytics enhance reliability by minimizing false positives and improving explainability for regulatory scrutiny (Roland, 2025).

Scaling this architecture across the public sector requires a firm technical blueprint emphasizing interoperability, data standardization, and modular deployment. Challenges such as staff capacity, resistance to new systems, and uneven ICT infrastructure identified in studies from Bangladesh, Kenya, and multiple African ministries (Noor, 2022; Apio & Asiimwe, 2024), must be addressed through

targeted training, change-management strategies, and phased implementation. Ayibam (2025) highlights the importance of collaborative governance involving technologists, legal experts, and policymakers to ensure that AI-driven monitoring tools adhere to public ethics, transparency norms, and legal frameworks. When these components converge, public institutions can operate a resilient, scalable fraud prevention architecture that integrates automation, analytics, and governance controls to strengthen financial integrity and public trust.

VII. CHALLENGES AND LIMITATIONS OF TECHNOLOGY-DRIVEN COMPLIANCE SYSTEMS

Technology-driven compliance systems, while transformative, continue to face structural and operational constraints that undermine their full effectiveness in public institutions (Latupeirissa et al., 2024). Government data infrastructures frequently struggle to meet stringent privacy and security requirements, particularly as expanding datasets heighten exposure to cyber risk and surveillance concerns (Sarjito, 2024). A central challenge for policymakers and theorists is combating welfare fraud, where the most viable solutions increasingly depend on advanced technologies; mass data collection, automation, and artificial intelligence have enhanced fraud detection and prevention capacities, reinforcing the imperative, as scholars argue, to bring the digital into social policy (Jurek, 2024). Evidence from jurisdictions adopting AI-driven compliance tools reveals large-scale experimentation that reduces bureaucratic inefficiencies and administrative costs but simultaneously introduces new risks related to data protection, privacy, and digital exclusion, producing outcomes that are mixed, contested, and reflective of broader tensions between techno-optimism and techno-pessimism (Fugletveit & Sørhaug, 2023). High implementation and maintenance costs, combined with entrenched legacy systems and institutional resistance to reform, further complicate digital transformation in the public sector, especially in fiscally constrained agencies where modernization efforts are routinely delayed (Zahir et al., 2023). These constraints are magnified by a persistent skills gap, as compliance professionals often lack expertise in advanced analytics, AI-assisted monitoring platforms, and digital forensic methods required for modern oversight (Noor, 2022; Apio & Asiimwe, 2024). Also, the growing reliance on algorithmic decision-making introduces ethical and governance dilemmas, including opacity, biased automated risk scoring, and inadequate accountability structures that threaten fairness, transparency, and public trust (Dubravka, 2025).

VIII. POLICY AND INSTITUTIONAL RECOMMENDATIONS

To strengthen the policy and institutional foundation for technology-enabled compliance requires a multidimensional approach that addresses legal, organizational, and collaborative gaps identified across current governance ecosystems. Recent studies highlight that governments must reinforce legal and regulatory frameworks to support secure, ethical, and transparent adoption of digital compliance tools, especially as expanding datasets heighten privacy, security, and surveillance risks (Sarjito, 2024; Dubravka, 2025). Promoting transparency through open data provisions and strengthening whistleblower protection mechanisms are essential for reducing bureaucratic inefficiencies and combating fraud, particularly in environments where legacy systems and institutional resistance hinder digital transformation (Zahir et al., 2023; Fugletveit & Sørhaug, 2023). Building institutional capacity for data-driven oversight, including advanced analytics, AI-supported monitoring, and digital forensic competencies remains critical, given the persistent skills gap among compliance professionals (Noor, 2022; Apio & Asiimwe, 2024). Cross-agency collaboration and well-structured public–private partnerships can further enhance interoperability, reduce implementation costs, and improve fraud detection efficiency, aligning with calls to bring the digital into social policy to address welfare fraud and financial irregularities more effectively (Jurek, 2024). Lastly, establishing a long-term roadmap for fiscal integrity requires a coherent blend of regulatory reform, institutional strengthening, and sustained investment in technology-driven controls to limit corruption risks and reinforce public-sector accountability (Latupeirissa et al., 2024).

IX. CONCLUSION

This study highlights that technology-enabled compliance systems have fundamentally reshaped the governance environment by shifting public-sector fraud management from reactive, paper-based controls to proactive, data-driven oversight. The analysis reveals the effect of integrated financial management systems, predictive analytics, continuous auditing, and automated risk-monitoring frameworks collectively enhance transparency, reduce detection latency, and strengthen institutional integrity. These technologies operate as both deterrents and diagnostic tools, limiting opportunities for misappropriation while enabling real-time identification of anomalies that traditional audits often overlook. At the same time, the findings highlight that effective technological adoption depends on digital tools and also on governance structures that ensure ethical implementation, limit privacy risks, and address capacity gaps among compliance professionals.

Strategically, governments seeking to build resilient and transparent public finance systems must prioritize regulatory modernization, institutional capacity development, and cross-sector collaboration. Investments in digital infrastructure, standardized data governance, and continuous skill development will determine the long-term sustainability of technology-driven reforms. Lastly, leveraging advanced compliance technologies within well-designed governance frameworks provides a viable pathway toward stronger fiscal integrity, reduced corruption risks, and restored public trust in government financial management.

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