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The Development of Technology in Supporting the Implementation of Forensic Accounting and Investigative Auditing in Fraud Detection (A Study of the United States, the United Kingdom, China, Indonesia, and Nigeria)

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Abstract: In the current era of globalization and digitalization, maintaining financial integrity and preventing fraud has become increasingly challenging. Fraudulent activities are no longer confined to individual actors but have evolved into systematic and cross-border organizational networks. As a response, forensic accounting and investigative auditing have emerged as vital tools in the detection and prevention of fraud. With rapid technological advancements, traditional audit approaches are undergoing a significant transformation, incorporating innovations such as Artificial Intelligence (AI), Big Data Analytics, and Blockchain. This study aims to examine the development of technology in supporting the application of forensic accounting and investigative auditing for fraud detection and prevention in five countries: the United States, the United Kingdom, China, Indonesia, and Nigeria. A qualitative-descriptive literature study method was employed, analyzing 40 reputable international journal articles published between 2020 and 2025. The findings reveal that technologies like AI, Big Data, and Blockchain have significantly enhanced the effectiveness of fraud detection, particularly in developed countries. However, developing nations such as Indonesia and Nigeria face critical challenges, including limited infrastructure, regulatory gaps, and low technological literacy. The study concludes that the integration of technology-based forensic accounting and investigative auditing can strengthen financial oversight systems. This research contributes to the development of an adaptive anti-fraud technology framework tailored to each country's institutional context and represents the first cross-country study to integrate the Fraud Pentagon Theory with technological advancements in auditing on a global scale.

Keywords: Technology, Forensic Accounting, Investigative Audit, Fraud, Cross-Country, AI.

INTRODUCTION

The rapid advancement of digital transformation has positioned technology as a fundamental component in strengthening financial oversight systems and detecting fraudulent practices (Rosita Eberechukwu Daraojimba et al., 2023). In the context of forensic accounting

and investigative auditing, the utilization of technologies such as Artificial Intelligence (AI), Big Data Analytics, and Blockchain is considered capable of enhancing the accuracy, efficiency, and speed in identifying anomalies and suspicious transaction patterns (Lokanan et al., 2019; Zheng et al., 2024; Imjai et al., 2024). Technology is no longer viewed merely as a technical support tool but rather as a strategic instrument in uncovering complex fraud schemes (Nikkel, 2020). However, the effectiveness of implementing such technologies largely depends on several contextual factors, including regulatory readiness, availability of digital infrastructure, the level of technological literacy among professionals, and the prevailing institutional dynamics in each country (Popoola et al., 2015; Oyerogba, 2021). Therefore, the application of technology in this field requires an adaptive and holistic approach to optimally contribute to cross-country fraud detection and prevention systems (Gwenzi et al., 2023).

On the other hand, rapid technological advancements have also created new avenues for the emergence of increasingly complex and cross-border digital financial crimes (Rosita Eberechukwu Daraojimba et al., 2023; Nikkel, 2020). Online financial fraud, accounting data manipulation, and cyberattacks targeting financial systems have become global challenges faced by both public and private sectors (Oyerogba, 2021; Gwenzi et al., 2023). These crimes not only result in significant economic losses but also compromise the integrity of financial reporting and erode public trust in financial institutions. Although several countries have adopted advanced technologies in auditing and forensic accounting, numerous challenges remain (Akinbowale et al., 2020; Rosita Eberechukwu Daraojimba et al., 2023).

The United States and the United Kingdom, as pioneers in digital audit innovation, have demonstrated significant progress in integrating technologies such as Artificial Intelligence (AI), Blockchain, and predictive analytics into their financial oversight systems (Rosita Eberechukwu Daraojimba et al., 2023; Imjai et al., 2024; Lokanan et al., 2019). In the U.S., institutions like the PCAOB reported a decline in problematic audit findings from 46% in 2023 to 39% in 2024, indicating the effectiveness of implementing advanced audit technologies. The UK has also promoted real-time auditing approaches by equipping forensic auditors with technology-based training. Nevertheless, high-profile cases such as the financial reporting manipulations involving FTX and Wirecard reveal that fraud can still occur—even within highly advanced oversight systems when perpetrators possess significant competence and occupy strategic positions. These instances reflect the “arrogance” and “opportunity” elements of the Fraud Pentagon Theory (Popoola et al., 2015).

In contrast, developing countries such as China and Indonesia face dual challenges. On one hand, both nations are actively promoting the adoption of AI-based auditing and big data analytics (Haddad et al., 2024; Suryani et al., 2021). In China, approaches such as data clustering have begun to be applied in the internal audits of large corporations; however, regulatory frameworks are still in a developmental phase (Faccia et al., 2022). Meanwhile, in Indonesia, major obstacles to effective fraud detection include limited technological infrastructure, low digital literacy among auditors, and a financial oversight system that has yet to be fully integrated digitally (Prasetiyo et al., 2023; Piter et al., 2024). This situation creates significant room for the "opportunity" and "competence" elements of the Fraud Pentagon to thrive with minimal resistance (Anthony et al., 2023).

Nigeria presents an even more extreme condition, marked by a high incidence of online fraud with global reach. The country has gained international attention due to the emergence of cybercrime groups such as SilverTerrier, which have conducted thousands of cross-border business email compromise (BEC) attacks (Cook & Cook, 2025). In December 2024, hundreds of individuals involved in "crypto-romance scams" were arrested in Lagos; however, the wave of financial crime continues to persist (Al Natour et al., 2023). The low level of trust in digital evidence, lack of training for forensic auditors, and the continued reliance on manual audit methods reflect the weakness of internal control mechanisms and the dominance of "pressure"

and "rationalization" elements within the local fraud context (Hassan et al., 2023; Haddad et al., 2024).

Therefore, technological advancement does not automatically guarantee the strengthening of financial oversight systems unless it is accompanied by regulatory readiness, the reinforcement of professional ethics, and the enhancement of human resource competencies (Suryani et al., 2021; Prayitno & Sinosi, 2024). Cross-country studies reveal that the effectiveness of technology in fraud detection is heavily influenced by the five elements of the Fraud Pentagon Theory pressure, opportunity, rationalization, competence, and arrogance which manifest in varying proportions depending on the institutional context of each country.

In this context, the implementation of forensic accounting and investigative auditing supported by technology has become increasingly crucial. Technologies such as Artificial Intelligence (AI), Blockchain, and Big Data Analytics can significantly enhance the speed and accuracy of detecting financial anomalies (Kecurangan & Teknologi, 2025; Haddad et al., 2024; Huang et al., 2022). Consequently, there is a need for cross-country studies that compare how both developed and developing nations adopt technology to prevent and address modern financial crimes (Al Natour et al., 2023; Haddad et al., 2024). However, despite numerous studies highlighting the importance of technology in forensic accounting and investigative auditing, there remains a lack of comparative research that examines the effectiveness of audit technologies across different economic contexts (Piter et al., 2024). Existing studies tend to focus on general technological applications without adequately considering institutional differences, infrastructure readiness, and unique implementation challenges faced by each country group (Kecurangan & Teknologi, 2025). This indicates a significant gap in the literature regarding how contextual factors influence the successful integration of technology in cross-jurisdictional fraud detection and investigation (Al Natour et al., 2023). Therefore, this study is designed to systematically review the literature related to the role of technology in supporting forensic accounting and investigative auditing across countries (Kecurangan & Teknologi, 2025).

Based on the aforementioned background, the research questions proposed in this study are as follows:

1. **RQ1**: How are technologies implemented to support forensic accounting and investigative auditing across different countries, and how do the five elements of the Fraud Pentagon Theory manifest in these implementation contexts?
2. **RQ2**: What institutional challenges and strategic opportunities influence the effectiveness of audit technology in identifying the elements of pressure, opportunity, rationalization, competence, and arrogance in fraud perpetrators?
3. **RQ3**: What is the relationship between technological readiness, regulatory frameworks, and human resource capacity with the five elements of the Fraud Pentagon in mitigating fraud risks across countries?

METHODS

This study adopts a qualitative descriptive approach using a literature review method. This approach was chosen to explore in depth the phenomenon of technological advancement in supporting forensic accounting and investigative auditing for fraud detection, as well as to compare its implementation across five countries: the United States, the United Kingdom, China, Indonesia, and Nigeria (Sekaran & Bougie, 2020). The research utilizes secondary data obtained from the following sources:

1. International journal articles indexed by Scopus and SINTA (from the period 2020–2025),
2. Official reports from audit and anti-fraud institutions such as the Association of Certified Fraud Examiners (ACFE), the Organisation for Economic Co-operation and Development (OECD), and the Public Company Accounting Oversight Board (PCAOB),

3. Regulatory documents and policy papers related to audit technologies in each country,
4. Relevant case studies and investigative news reports.

Data collection was carried out through systematic keyword searches using terms such as: *"forensic accounting", "investigative audit", "fraud detection technology", "AI in auditing", "financial fraud case",* along with the names of the respective countries. Sources were retrieved using databases such as Scopus, Google Scholar, the Directory of Open Access Journals (DOAJ), and official documents from international institutions.

The data were analyzed using content analysis. Each piece of literature was examined to identify:

1. The role of technology in auditing and forensic accounting,
2. Institutional factors including regulatory frameworks, infrastructure, and human resources,
3. Patterns of technological application in actual fraud cases,
4. Cross-country comparisons in terms of effectiveness, challenges, and prevention strategies.

The findings are presented in a narrative format, supported by comparative tables and thematic conclusions. These results highlight differences in national characteristics and help identify best practices that could be adapted for Indonesia and other developing countries.

RESULTS AND DISCUSSION

The study examines the implementation of technology in supporting forensic accounting and investigative auditing for fraud detection across five countries with distinct institutional characteristics: the United States, the United Kingdom, China, Indonesia, and Nigeria. Based on the literature review, several key findings emerged, highlighting significant differences in technological readiness, implementation strategies, and the effectiveness of the tools employed.

The United States and the United Kingdom: Models of Innovation and High-Level Technology Integration

Both the United States and the United Kingdom demonstrate a high level of technological readiness in the field of forensic accounting. These countries have successfully integrated advanced technologies such as Artificial Intelligence (AI), Blockchain, and predictive analytics into their forensic audit processes. According to Daraojimba et al. (2023), forensic accounting in the U.S. has shifted towards big data–driven systems that can analyze large volumes of transactions with high accuracy. Similarly, in the UK, the training and certification of forensic auditors place strong emphasis on the mastery of digital tools. As a result, fraud detection has become more rapid and is supported by robust digital evidence.

The United States, in particular, showcases the highest degree of technological integration in forensic auditing. As reported by PCAOB (2024), U.S. audit systems utilize AI and big data algorithms to process millions of transaction entries in a short period, significantly enhancing oversight capabilities (Bisnis, 2017). AI is used for pattern recognition, outlier detection, and fraud risk modeling. Blockchain technology has also been incorporated into several public audit platforms, providing immutable audit trails aligned with the principles of transparency and integrity (Piter et al., 2024).

Meanwhile, the United Kingdom promotes real-time auditing approaches supported by forensic audit software that enables continuous monitoring systems (CMS). Professional training in the UK emphasizes digital proficiency as a core element of auditor certification, reflecting a systemic approach to developing a tech-savvy, anti-fraud workforce. This strengthening of auditor competence and integrity also illustrates a holistic application of the Fraud Pentagon elements (Oyerogba, 2021).

In general, both countries have successfully reduced fraud levels by implementing detection systems that are not only reactive but also predictive. Nevertheless, challenges remain, particularly related to data ethics, potential algorithmic bias, and resistance from senior practitioners toward digital transformation (Faccia et al., 2022).

China and Indonesia: Transition Toward Technology-Based Auditing

China has taken early steps toward integrating data mining systems into its auditing practices. According to Zheng et al. (2024), the use of algorithms such as K-Means Clustering has proven effective in categorizing financial data and detecting anomalies, although its implementation remains limited to specific sectors. China is recognized as a pioneer in Asia for adopting big data and machine learning in internal auditing, particularly within large state-owned financial institutions. However, this adoption has not been uniformly applied across all public sectors, especially at the regional level. The regulatory framework is still in development, creating oversight gaps that reduce the system's overall effectiveness (Oyerogba, 2021).

Indonesia, meanwhile, faces more complex challenges in adopting technology-based auditing. While institutions such as the Audit Board of Indonesia (BPK) and Government Internal Supervisory Apparatus (APIP) have started implementing basic audit technologies, major obstacles include low levels of digital literacy among auditors and the underdeveloped integration of local financial information systems (Faccia et al., 2022). Infrastructural instability and limited investment in forensic audit software further hinder progress. Nevertheless, Indonesia has shown a growing awareness of the importance of forensic accounting, evidenced by the emergence of audit technology training programs initiated by government institutions and universities (Anthony et al., 2023).

Theoretically, both countries are still in a transitional phase where the *opportunity* element of the Fraud Pentagon Theory cannot be effectively minimized due to weak early detection systems and inadequate internal controls. Moreover, the *competence* of fraud perpetrators who are increasingly able to exploit loopholes in digital systems lacking sufficient controls remains a critical factor driving high fraud risk in both contexts.

Nigeria: An Extreme Representation of High Fraud Incidence and Weak Digital Detection

Nigeria presents an extreme case characterized by a high incidence of fraud alongside an underdeveloped digital audit and oversight system. Despite the growing complexity of financial crimes, the country's forensic auditing practices remain largely reliant on traditional methods. According to Oyerogba (2021), approximately 77% of forensic auditors in Nigeria still depend on manual evaluations and interviews, with minimal adoption of advanced audit technologies. This limited use of technology contributes to the low effectiveness of fraud detection systems, compounded by the lack of auditor training and a pervasive distrust of digital evidence.

Nigeria represents one of the most challenging environments for the integration of forensic technology. As reported by Oyerogba (2021), over 77% of audit institutions continue to rely on manual techniques such as interviews and financial statement reconciliation. Within the framework of the Fraud Pentagon Theory, Nigeria exhibits heightened risk across all five elements particularly *opportunity*, *competence*, and *arrogance*. Fraud perpetrators often operate with a sense of impunity, facilitated by weak oversight mechanisms and low legal consequences.

Although there have been efforts to initiate technology adoption through collaborations with international organizations, progress remains slow due to limited human resource training and persistent skepticism toward the reliability of digital evidence. On a more positive note,

public awareness and media scrutiny surrounding fraud cases have increased, generating pressure on government institutions to invest in digital monitoring systems.

Nigeria exemplifies a context in which fraud has outpaced the development of audit systems. As such, the integration of technology is not only necessary but urgent, if the country is to restore the credibility and integrity of its financial governance.

Synergy of Forensic Accounting, Investigative Auditing, and Technology

This study emphasizes that the synergy between forensic accounting, investigative auditing, and digital technology significantly accelerates the process of fraud detection and verification. In developed countries, collaboration among forensic analysts, investigative auditors, and IT experts has become a common practice. In contrast, in countries like Indonesia and Nigeria, such collaboration remains largely sectoral and sporadic (Faccia et al., 2022).

Across all cases reviewed, the studies consistently conclude that technology plays a crucial role in enhancing the effectiveness of fraud detection. The use of machine learning, cyber-forensic accounting, and data-driven investigations enables the identification of new fraud patterns that are often beyond the reach of manual audits. However, the implementation of technology must be accompanied by improvements in policy, human resource training, and the strengthening of legal frameworks to ensure sustainability and effectiveness (Faccia et al., 2022).

By applying the Fraud Pentagon Theory, this research identifies that the success of fraud detection and prevention strategies largely depends on how comprehensively a country addresses the five core elements of the model: pressure, opportunity, rationalization, competence, and arrogance (Piter et al., 2024). Countries such as the United States and the United Kingdom, which have systematically developed mitigation policies that address all five dimensions, have shown more resilient and adaptive fraud detection systems in response to technological advancements. Their approach involves not only the implementation of sophisticated digital tools but also the reinforcement of internal control systems, organizational culture reform, and the enhancement of human capital through education, certification, and continuous training in both forensic auditing and information technology (Rosita Eberechukwu Daraojimba et al., 2023).

In contrast, developing countries that focus solely on the technical aspects—such as adopting audit software or digital reporting systems—without strengthening institutional capacity and professional ethics, tend to be more vulnerable to systemic, technology-driven fraud (Rosita Eberechukwu Daraojimba et al., 2023). For instance, low technical competence among auditors in operating advanced analytics tools and weak accountability mechanisms often allow fraud to go undetected for extended periods. Furthermore, unchecked cultures of rationalization and arrogance among management or public officials pose significant obstacles to establishing an effective oversight system.

Thus, the Fraud Pentagon Theory proves not only relevant as a framework for analyzing fraud motives but also serves as a diagnostic tool for evaluating structural weaknesses in national fraud detection systems (Faccia et al., 2022). This study confirms that technology-based fraud prevention strategies must be supported by strong institutional and human capital approaches to effectively respond to the increasingly complex, borderless, and digital nature of modern financial crimes (Nikkel, 2020).

Best Practices and Cross-Country Policy Implications: A Descriptive Narrative

This study highlights several best practices and policy recommendations that can be drawn from cross-country comparisons. The United States and the United Kingdom emerge as strong benchmarks, particularly in their continuous training of auditors and the integration of

cutting-edge audit technologies. Their experience underscores the importance of aligning technological tools with structured capacity-building programs and robust institutional support.

Conversely, countries like Indonesia and Nigeria face more complex challenges and require tailored strategies. For Indonesia, strengthening inter-agency collaboration, revising forensic accounting curricula in higher education, and adopting audit systems that are locally adaptive are critical. Nigeria, on the other hand, needs a more fundamental reform, particularly in the digitization of public financial systems and in providing technology-based training for investigators.

The findings indicate that the success of anti-fraud technology implementation is not solely determined by the availability of advanced tools. Instead, institutional readiness, human resource development, and cross-sectoral synergy play a central role. The U.S. and the UK serve as effective models for designing AI-based auditor training and predictive audit systems, integrating data science into routine auditing practices.

In Indonesia's case, the enhancement of auditor competencies through AI-integrated forensic audit training programs, as well as improvements in the national financial information system, are strategic priorities. For Nigeria, urgent reforms are required in public sector oversight, with a focus on digital infrastructure and restoring trust in digital evidence through formal, technology-driven forensic education and certification.

Through this comparative approach, the study contributes to the development of an anti-fraud technology framework that is adaptive to the institutional and cultural context of each country.

The United States and the United Kingdom

Zheng et al. (2024) reveal that smart city–based data mining technologies in the U.S. provide significantly higher fraud detection accuracy than traditional methods. In tests across three large audit datasets (AAR, CAQ, IIA), K-means clustering algorithms achieved accuracy rates above 88%, outperforming models like SVM and Random Forest. These results reinforce the United States' position as a leader in integrating advanced technologies into forensic investigation and auditing. Similarly, the UK promotes predictive auditing, supported by real-time monitoring systems and mandatory technological proficiency for certified forensic auditors.

China

China has made notable progress in integrating data mining into internal audit systems. Zheng et al. (2024) tested 641 financial statements from fraud and non-fraud companies and found that clustering algorithms effectively grouped fraud patterns, reducing classification errors by 3% compared to conventional methods. This capability facilitates earlier detection of anomalies without significant manual intervention, showing China's potential in adopting scalable, automated fraud detection solutions.

Indonesia

According to Haddad et al. (2024), Indonesia has begun incorporating big data approaches and internal control frameworks to combat fraud. However, the country continues to face major challenges, particularly the uneven distribution of IT infrastructure and insufficient training among public sector auditors. The integration of forensic accounting into higher education remains inconsistent and underdeveloped, slowing progress in professionalizing the field.

Nigeria

Nigeria continues to face critical challenges in applying technology-based forensic audits. Research by Modugu & Anyaduba (2021) shows that 77% of forensic auditors still rely on traditional methods, such as manual financial evaluations and suspect interviews. This overreliance on individual expertise, coupled with weak internal controls and low trust in digital evidence, hampers the development of a credible, technology-driven audit system. The lack of formal forensic audit training further widens the gap between expectations and actual auditor competence.

Theoretical Implications: Fraud Pentagon Theory

Using the Fraud Pentagon Theory as an analytical lens, the study finds that countries that actively address all five fraud elements pressure, opportunity, rationalization, competence, and arrogance tend to exhibit higher fraud detection effectiveness. In contrast, countries that focus narrowly on technical tools (such as AI or audit software) while neglecting human capital development (competence) and ethical culture (arrogance) are more vulnerable to detection failures. For instance, Nigeria's lack of formal training programs in forensic auditing has led to a substantial gap between policy ambitions and actual auditor performance.

In conclusion, this cross-national analysis reinforces the idea that technology must be embedded within a broader institutional and ethical ecosystem. Fraud prevention in the digital age demands not only sophisticated tools, but also systemic investment in people, policies, and cultural transformation.

Table 1. Comparative Overview of Forensic Audit Technology Implementation in Five Countries

Country	Level of Technology Adoption	Key Technologies Used	Main Challenges	Successes / Best Practices
United States	High	AI, Blockchain, Predictive Analytics	Data ethics, resistance from senior professionals	Utilization of Big Data in complex investigative audits
United Kingdom	High	AI, Forensic Software, Real-Time Audit Tools	Rapidly evolving digital fraud threats	Advanced technology-based auditor training
China	Moderate	AI, K-Means Clustering, Data Mining	Regulatory immaturity, centralized decision-making	Algorithm innovation in internal audits within the financial sector
Indonesia	Low to Moderate	Limited AI, Basic Audit Tools	Low digital literacy, weak infrastructure	Initial integration of technology in APIP and BPK audits
Nigeria	Low	Manual Audits, Spreadsheets	Limited HR capacity, low trust in digital evidence	Growing awareness of audit technology through high-profile cases

CONCLUSION

This study demonstrates that the adoption of technologies such as Artificial Intelligence, Blockchain, and Big Data Analytics contributes significantly to the effectiveness of forensic accounting and investigative auditing in fraud detection. Developed countries like the United States and the United Kingdom have proven that comprehensive integration of technology, institutional policies, and auditor competence development can result in highly accurate, predictive, and digitally evidence-based fraud detection systems. The use of real-time audit tools, continuous monitoring systems, and advanced algorithmic data mining has strengthened the resilience of their financial oversight frameworks.

In contrast, developing nations such as China and Indonesia are still in a transitional phase. While there have been initial efforts to implement technologies like K-Means clustering and electronic audit systems, challenges such as low digital literacy, weak infrastructure, and underdeveloped regulatory frameworks hinder optimal fraud detection outcomes. These findings highlight that technological adoption must be supported by institutional reform and human capital development to be effective.

Nigeria presents an extreme case where high fraud risk is met with weak technological implementation. The country's reliance on traditional audit methods, lack of trust in digital evidence, and minimal professional training are key obstacles. Although public awareness of the importance of forensic accounting is growing, the integration of audit technology systems remains minimal. Moreover, cross-country findings reveal that investigative auditing in many contexts has yet to be fully integrated with digital tools, despite the fact that modern fraud is increasingly cross-border, real-time, and complex. A lack of inter-agency and cross-sector collaboration continues to hinder the full optimization of technology-based fraud detection systems. Referring to the Fraud Pentagon Theory, the study finds that effective fraud mitigation requires more than just technological tools. Countries that implement comprehensive strategies addressing the five elements of fraud pressure, opportunity, rationalization, competence, and arrogance demonstrate stronger capacity in building resilient oversight systems. In contrast, countries focusing solely on technical aspects often remain ill-equipped to deal with modern, hidden, and systemic forms of fraud.

Therefore, this study emphasizes the necessity of a multidimensional approach in constructing effective fraud detection systems: integrating advanced technologies, strengthening institutional capacity, enhancing human capital, and fostering a strong ethical culture. These findings are not only relevant for theoretical and practical discussions but also serve as a foundation for formulating national and regional policies aimed at reinforcing technology-based forensic accounting systems.

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