



ADVANCED INTERNATIONAL JOURNAL
OF BUSINESS, ENTREPRENEURSHIP
AND SMES
(AIJBES)

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A CONCEPTUAL FRAMEWORK FOR INVENTORY FRAUD DETECTION: INTEGRATING FORENSIC CONTROLS, DIGITAL TECHNOLOGIES, AND BEHAVIORAL INDICATORS

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Article Info:

Article history:

Received date: 25.07.2026

Revised date: 23.08.2026

Accepted date: 03.09.2026

Published date: 17.09.2026

Abstract:

Digital supply chains have significantly escalated the sophistication of internal fraud schemes targeting enterprise inventory assets. While scholarship has advanced across forensic controls, digital detection tools, and human behavioral signs, these streams remain fragmented, leaving organizations without an interconnected defense mechanism. This conceptual paper addresses this gap by presenting an integrative framework that structures forensic governance, digital technologies, and behavioral indicators into a collaborative oversight system. Developed through a multidisciplinary synthesis of recent accounting, audit, and information systems literature, the study evaluates how digital tools automate transaction tracking, how forensic oversight structures verification, and how behavioral tracking captures underlying human risk patterns. The primary theoretical contribution is a three-

To cite this document:

Karim, N. A., Yahaya, N. A., Kamarudin, N. N. A. N., Shaari, S. N. M., & Raman, S. A. (2026). A Conceptual Framework For Inventory Fraud Detection: Integrating Forensic Controls, Digital Technologies, And Behavioral Indicators. *Advanced International Journal of Business Entrepreneurship and SMEs*, 8 (29), 973-986.

layer architecture anchored in the Fraud Diamond, the Technology–Organization–Environment (TOE) model, and digital forensic governance principles. This architecture maps out direct propositions linking proactive forensic verification directly to the mitigation of technology-enabled misconduct. Practically, the framework shifts focus from individual tools toward an integrated oversight package, outlining boundary constraints like system maturity while offering a strategic roadmap for empirical validation in inventory-intensive sectors.

DOI: 10.35631/AJBES.829054

Keyword:

Behavioural Indicator, Conceptual Framework, Continuous Auditing, Digital Technologies, Forensic Accounting, Fraud Diamond, Inventory Fraud Detection



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Introduction

Inventory is an important asset due to its role in sustaining a firm's business operations. Inventory cycles and movements have an impact on cash flow, supply chain activities and competitiveness. However, inventory is also susceptible to fraud given its high financial value as well as the movement of materials from the time of the purchase of raw materials to the delivery of final goods to the customer. Inventory fraud has significant financial losses and may damage the stakeholders' confidence of an organization. The most serious consequences of inventory fraud are the misstatement of financial statements, and non-compliance with applicable regulations.

As an organization increasingly adopts the use of digital technology in the supply chain, inventory fraud has become more complex, as it is not just a basic form of physical theft from a warehouse or collusion between two parties anymore. Fraud may entail system activities such as the creation of false inventory records, making unauthorized write-offs or change accounting records and manipulations of inventory quantities through digital system. Fraud now can occur in two situations either physical or through the manipulation digital system.

Traditional inventory auditing typically focuses on physical counts, reconciliations and sample testing. Auditing physical inventory counts only occurs once a year at the end of the financial period. These procedures are important, but it may fail to identify fraudulent activities that

occur continuously between audit periods. The increasing volume and speed of digital transactions also make manual monitoring more challenging.

Recent studies indicate that forensic accounting can contribute to fraud detection and prevention. In a systematic literature review, Kaur et al. (2022) revealed a positive relationship between forensic accounting practices and the detection and prevention of fraud and underlined the importance of supply-chain monitoring and inventory-management controls in facilitating the early detection of fraudulent activities (Kaur et al., 2022). Additionally, incorporating risk-based auditing into the inventory cycle allows auditors to zero in on vulnerable areas where misstatements and procedural weaknesses are most likely to arise (Zulaika et al., 2026).

Meanwhile, digital technologies offer new opportunities for fraud monitoring. Akinbowale et al. (2023), for instance, looked at the integration of forensic accounting and big-data technology for internal fraud mitigation (Akinbowale et al., 2023). Their study showed the potential of machine learning to classify fraudulent and non-fraudulent activities to identify red flags for fraud (Akinbowale et al., 2023).

Technology adoption, however, cannot be viewed in isolation from organizational capabilities. Akter et al. (2024) used the Technology–Organization–Environment (TOE) framework to look at the adoption of blockchain in accounting and found that factors from technological, organizational and environmental dimensions influence blockchain adoption (Akter et al., 2024). Their findings also highlight challenges of system integration, knowledge and implementation costs (Akter et al., 2024).

Fraud is also driven by human behaviors. The Fraud Diamond framework consists of four factors, including pressure, opportunity, rationalization and capability that may be associated with asset misappropriation. For example, Kazemian et al. reported significant associations between pressure, rationalisation and capability and employee asset misappropriation (Kazemian et al., 2019). Follow-up evidence further emphasizes the importance of these factors in explaining and assessing the risk of asset misappropriation. Nonetheless, traditional frameworks such as fraud triangle and diamond are no longer adequate as standalone tools in digitized environments and necessitate an integration with more advanced digital instruments such as artificial intelligence and big data analytics (Finny & Hermansyah, 2024).

These studies highlight that forensic controls, digital technologies, and behavioral factors can serve as a basis for fraud detection. However, the literature is fragmented across these dimensions. A recent systematic review by Abderrahman and Makarem (2026) in the emergence of technologies in auditing, using literature from Scopus, ScienceDirect and SpringerLink, found that research is fragmented across technologies and that relatively little research looks at how multiple technologies can be combined in a holistic approach to audit (Abderrahman & Makarem, 2026).

Thus, there is a need for an integrated framework that combines technology, human behaviors and forensic controls, especially in the context of inventory fraud. This study attempts to address this research gap by proposing a conceptual framework that incorporates forensic controls, digital technologies and behavioural indicators.

The study addresses the following research questions:

1. How do forensic controls enhance the effectiveness of inventory fraud detection?
2. How do digital technologies enhance an organization's capacity to monitor and detect inventory fraud?
3. How can behavioural indicators be utilized to identify potential employee misconduct to avoid significant financial losses?

Literature Review

Inventory Fraud and the Limitations of Traditional Auditing

Inventory fraud incorporates intentional acts that aim to steal inventory, manipulate inventory records, or misrepresent the quantity or value of inventory (ACA et al., n.d.). Since inventory affects both the statement of financial position and cost of sales, fraudulent inventory reporting can also affect the reported financial performance (ACA et al., n.d.). Hence, the effective identification of such irregularities necessitates going beyond manual reconciliation to leverage advanced and cognitive analytics, which offers higher computational efficiency and automated data narratives (Akinbowale et al., 2023).

Traditional inventory auditing typically involves performing physical inventory counts, reconciliation between physical and accounting records, and testing a sample of inventory items (Wells, 2001). These procedures can uncover the differences between recorded and actual inventory. However, they may be less effective in the case of the fraudulent activities are deliberately embedded within large volumes of transactions (Wells, 2001).

For instance, an employee may create false inventory records, make unauthorized adjustments, record damaged goods incorrectly, or remove inventory without immediately modifying the accounting records (Wells, 2001). If the organization performs primarily periodic physical counts, such activities might remain undetected for some time.

The emergence of digital supply chains has increased the number and speed of inventory transactions. As such, organizations are in need of monitoring approaches that can process transactions continuously rather than only through periodic reviews. The rise of digital forensic tools, such as blockchain and intelligent automation, has fundamentally changed the landscape by allowing the processing of large datasets in real-time to improve the accuracy and speed of fraud identification (Aini et al., 2025).

Forensic Controls and Inventory Fraud Detection

Forensic accounting encompasses the identification, investigation, and prevention of financial fraud. Unlike the traditional approaches, forensic auditing is concerned with highlighting suspicious activities and obtaining evidence that can support further investigation. Through the integration of forensic accounting techniques, organizations can effectively detect the discrepancies between the physical inventory and accounting records, which is essential for uncovering sophisticated fraud schemes (Mejía et al., 2024).

A systematic review of forensic accounting literature by Kaur et al. (2022) revealed a positive association between forensic accounting and fraud detection and prevention (Kaur et al., 2022). Their findings suggest that forensic techniques can provide additional support for detecting and investigating fraudulent activity. The study highlights the importance of the supply-chain monitoring and inventory management controls for early fraud detection.

Forensic controls can include continuous auditing, forensic data analytics, fraud risk assessment, digital investigation, and surprise inspections (Akinbowale et al., 2023). The continuous monitoring of transactions enables organizations to review the transactions more frequently, whereas the usage of forensic analytics can help in identifying unusual patterns, which may necessitate further investigation.

The integration of forensic accounting and advanced analytics is receiving increasing attention. Akinbowale et al. (2023) developed an integrated forensic accounting and big-data technology framework for internal fraud mitigation. Their study demonstrated the possibility of using machine learning to categorize fraud risk and identify fraud-related red flags (Akinbowale et al., 2023).

These findings suggest that forensic controls can enhance the organization's ability to identify suspicious inventory activities and support further investigation (Ja, 2007). In addition, the implementation of real-time data analysis and reporting, facilitated by big data analytics, has revolutionized this process by enabling the detection of fraud patterns across vast transactional datasets (Singh, 2023).

Digital Technologies for Fraud Monitoring

Digital transformation has transformed the way organizations manage and monitor inventory. The utilization of technologies such as Artificial Intelligence (AI), Machine Learning (ML), Enterprise Resource Planning (ERP), blockchain, Radio-Frequency Identification (RFID), Internet of Things (IoT), and Big Data analytics can provide organizations with greater visibility over inventory and financial transactions. Specifically, the immutability of the blockchain ledger creates a tamper-proof trail of financial activity, while smart contracts enable the automated enforcement of predefined controls to minimize the possibility of human error and manipulation (Odeyemi et al., 2024).

AI and ML can analyze large sets of data and identify any unusual transaction patterns (Bakumenko & Elragal, 2022). For instance, an AI-based system may identify unusual inventory adjustments, abnormal transaction timing, repeated overrides, and differences in inventory movement and accounting records. Furthermore, these algorithms can help detect high-risk journal entries and other anomalies, which often serve as an early indicator to the material misstatement or internal fraud (Bakumenko & Elragal, 2022; Zhang et al., 2025). Through the utilization of machine learning to uncover these trends and abnormalities, organizations can help reduce the time window for potential losses (Shoetan et al., 2024).

Big Data analytics can also facilitate fraud detection by processing large sets of data from different systems (Shoetan et al., 2024). Akinbowale et al. (2023) demonstrate the potential of machine learning and big-data analytics to classify fraud-related activities and identify potential fraud indicators (Akinbowale et al., 2023). These supervised and unsupervised models allow institutions to autonomously learn from previous patterns to detect emerging

fraud schemes that traditional approaches frequently overlook (Shoetan et al., 2024). Moreover, the integration of Internet of Things sensors allows for the direct, automated verification of the physical inventory levels which can reduce or even eliminate the need for manual ledger confirmations while placing more emphasis on detecting potential management-level malfeasance (Roszkowska, 2020).

Blockchain is another promising mechanism for enhancing transaction transparency. It allows for the creation of transaction records that are highly resistant to alterations once they are recorded (Garanina et al., 2021). Nevertheless, the adoption of this technology is not necessarily automatic. Akter et al. found that blockchain adoption in the area of accounting is influenced by technological, organizational, and environmental factors (Akter et al., 2024). Their study also identified several implementation challenges, including the system integration, limited organizational knowledge, and high adoption costs (Akter et al., 2024).

This finding supports the use of the TOE framework in the proposed model (Akgül, 2021). Digital technology can enhance fraud monitoring, but its effectiveness is conditional on whether the organization has the necessary technological capability, organizational support, and external environment (Akgül, 2021).

Recent literature also confirms that emerging technologies are becoming increasingly important in auditing. Abderrahman and Makarem (2026) reviewed research on Big Data, blockchain, ML, deep learning, AI, and RPA and found that research remains fragmented across technologies (Abderrahman & Makarem, 2026). Their review also highlights the limited understanding of how multiple technologies can operate in tandem within audit processes.

Behavioural Indicators of Internal Misconduct

Technology and accounting controls can identify unusual transactions, but fraud is ultimately committed by people. As such, understanding employee behaviour is important for effective fraud detection.

The Fraud Triangle explains the phenomenon of fraud by three factors, namely pressure, opportunity, and rationalization. The Fraud Diamond extends this explanation by incorporating capability. These theories suggest that fraud is more likely to occur when an individual experiences pressure, identifies an opportunity, rationalizes the behaviour, and possesses the ability to carry out the fraud. Consequently, recent research highlights the importance of integrating digital monitoring tools with the Fraud Diamond model to enhance the identification of red flags associated with these behavioural drivers (Finny & Hermansyah, 2024).

Kazemian et al. (2019) examined the Fraud Diamond in relation to asset misappropriation and found that pressure, opportunity, rationalization, and capability significantly influenced employee asset misappropriation (Kazemian et al., 2019). This provides support for the consideration of behavioural factors when examining fraud risk. Through the integration of these theoretical foundations with modern digital forensics, organizations can identify fraud-related behaviour and technology indicators (Wulandari et al., 2026).

More recent research has continued to support the relevance of Fraud Diamond factors (Serrano et al., 2025). For instance, the Fraud Star model further refines these constructs by incorporating integrity as a critical fifth dimension, acknowledging that ethical character serves as a fundamental deterrent against illicit acts (Jonas, 2026).

In an inventory environment, behavioural indicators may include repeated violations of procedures, excessive system overrides, attempts to bypass controls, unauthorized access to inventory areas, refusal to take mandatory leave, and unusual changes in work behaviour. These indicators should not be automatically treated as evidence of fraud. Instead, they can be used as warning signs that necessitate further investigation.

Therefore, behavioural indicators can provide an important human perspective that can complement information obtained from digital monitoring systems. Specifically, when organizations recognize that perpetrators are attempting to justify their illicit activities via self-rationalization or exploiting weak internal control cultures, they can appropriately target their preventative interventions (Setiawan & Cholili, 2023).

Methodological Approach

This study adopts a conceptual research design that combines the theoretical and methodological foundations of existing literature. This study does not involve the collection of primary data. Instead, it synthesizes the existing theories and research findings in the fields of forensic accounting, information systems, auditing, and organizational behaviour.

The rationale for using a conceptual research design is to formulate a conceptual framework that elucidates how forensic controls, digital technologies, and behavioural indicators can be utilized to prevent and detect fraud. In particular, the framework will demonstrate how forensic controls and digital technologies can be combined with the assessment of organizational behavioural indicators to reduce inventory fraud. Additionally, personnel integrity and organizational culture play a key role when evaluating fraud risk (Siahaan et al., 2019).

The proposed framework is intended to be testable in future empirical research. Quantitative researchers could examine the proposed relationships using techniques such as Partial Least Squares Structural Equation Modeling (PLS-SEM) or Covariance-Based Structural Equation Modeling (CB-SEM).

Theoretical Framework

Fraud Triangle and Fraud Diamond Theories

The Fraud Triangle and Fraud Diamond provide the behavioral foundations of the proposed framework. These theories explain the potential motivations and behavioral manifestations of fraudulent activities and offer avenues to explore behavioral indicators associated with fraud risk.

The empirical validation of these theories has been demonstrated by Kazemian et al. (2019), who found that these factors continue to be relevant in explaining asset misappropriation (Kazemian et al., 2019).

In the proposed framework, Fraud Triangle and Fraud Diamond therefore explain the potential motivations and behavioral indicators of fraud.

Technology–Organization–Environment Framework

The TOE framework explains how firms adopt and implement technological innovations, based on three key dimensions: technology, organization, and environment.

The three dimensions of the TOE framework consider diverse factors, from technological compatibility and complexity to technological capability, and management support and organizational readiness, and resources. The environmental dimension considers factors such as regulation, competition, and industry conditions. In the context of the current work, the TOE framework aims to frame the deployment of forensic technologies to ensure the organizational environment is appropriate to support the investigations of behavioral drivers (Mvunabandi, 2024).

Akter et al. (2024) demonstrate the relevance of TOE for accounting, through an investigation of blockchain adoption (Akter et al., 2024). Their findings reveal that accounting technology adoption is influenced by diverse organizational and environmental factors, rather than being driven by technology alone. Furthermore, the Technology-Organization-Environment framework, when combined with Diffusion of Innovation theory, allows researchers to develop a comprehensive model, which captures the interplay between organizational readiness and environmental pressures in technology implementation (Rawashdeh et al., 2023).

In the current work, the TOE framework offers the theoretical foundation for how firms adopt and implement digital technologies for inventory fraud monitoring. By categorizing these drivers into technological, organizational, and environmental contexts, the framework effectively captures the multifaceted requirements of implementing forensic tools in existing operational architectures (Akter et al., 2024; Seshadrinathan & Chandra, 2021).

Forensic Accounting Governance Principles

Forensic accounting governance provides the control dimension of the framework. It refers to several mechanisms, which enable fraud prevention, detection, investigation, and response. These mechanisms range from continuous monitoring and fraud risk assessment, forensic analytics and evidence collection, investigation procedures and management oversight.

Evidence suggests that forensic accounting practices contribute to fraud detection and prevention, thereby justifying its inclusion as a control component in the proposed framework. By incorporating forensic accounting governance, firms can systematically address the systematic gaps often exploited by internal actors (Akinbowale et al., 2023).

Thus, forensic accounting governance indicates how firms can investigate and respond to potential frauds detected via the behavioural and digital monitoring dimensions. Furthermore, the fusion of forensic accounting and existing control architectures, including the COSO framework, enables firms to enhance fraud detection processes, by facilitating pattern identification and anomaly recognition through real-time data analysis (Mardjono et al., 2024).

Integrated Conceptual Framework and Propositions

The proposed framework brings together three complementary aspects:

1. Behavioural indicators – inform potential human misconduct;
2. Digital technologies – enable continuous monitoring and identification on unusual transactions;
3. Forensic control - provide investigations, verifications and responses.

The three aspects are therefore not seen as separate solutions, which operate independently. Instead, they are complementary components of an integrated framework for fraud monitoring of inventory fraud. This synergy reflects the need to transition from reactive, historical analysis to forward-looking decision-support architectures, which utilize real-time risk predictions (Sekinobe et al., 2026).

Forensic Controls and Inventory Fraud Detection

Forensic controls can enhance the organization's ability to detect and investigate suspicious inventory activities. Continuous auditing and forensic analytics enable the firm to review transactions more frequently and identify unusual patterns.

(Kaur et al., 2022). provide systematic evidence that forensic accounting positively influences fraud detection and prevention. (Akinbowale et al., 2023) further demonstrate the feasibility of combining forensic accounting with big-data analytics for fraud identification.

Based on this evidence:

- Proposition 1 (P1): The use of proactive forensic controls positively influences the speed and accuracy of inventory fraud detection (Kaur et al., 2022).

Digital Technologies and Inventory Fraud Detection

Digital technologies can enable the firm to continuously monitor a large volume of inventory and transaction data (Impact of Digital Transformation on Inventory Management: An Exploration of Supply Chain Practices, n.d.).

AI and ML can detect unusual patterns, ERP systems can integrate inventory and accounting information, blockchain can ensure transaction traceability, while RFID and IoT can provide information on physical inventory movement.

However, technology adoption in accounting is influenced by several technological, organizational, and environmental factors. Recent systematic evidence also suggests that emerging technologies are increasingly relevant to auditing, but the application of these technologies remains fragmented across individual technologies. Therefore:

- Proposition 2 (P2): The use of digital monitoring technologies positively influences real-time identification of unusual activities and inventory fraud detection effectiveness.

Behavioural Indicators and Early Fraud Detection

Behavioural indicators can enable the firm to gain information on potential employee misconduct that is not apparent in the accounting records.

Fraud Diamond research suggests that pressure, opportunity, rationalization, and capability are important factors in explaining asset misappropriation. Evidence from (Kazemian et al., 2019) supports the relationship between these factors and asset misappropriation.

Behavioural indicators can therefore serve as early warning signals of fraud but should be regarded as risk indicators and not evidence of fraud.

- Proposition 3 (P3): Systematic monitoring of employee behavioral indicators positively influences the early detection of inventory fraud.

Integrated Effect of the Three Dimensions

The main contribution of the framework is the integration of the three dimensions.

Digital technologies can identify unusual transactions, but the human motivations behind these transactions are not explained. Behavioural indicators can provide information on potential employee misconduct, but the actual inventory or financial transaction of concern may not be identified. Forensic controls can investigate and connect the information from both sources together.

(Akinbowale et al., 2023) demonstrate the values of integrating forensic accounting with big-data technologies, and Abderrahman and Makarem (2026) identify the ongoing fragmentation of research across emerging audit technologies.

Therefore, the three dimensions can collectively offer a more integrated fraud detection approach.

- Proposition 4 (P4): An integrated approach combining forensic controls, digital technologies, and behavioural indicators provides greater inventory fraud detection effectiveness than relying on any single dimension.

Discussion and Contributions

Main Contributions

The main contribution of the paper is the development of an integrated conceptual framework, which combines forensic controls, digital technologies, and behavioural indicators for inventory fraud detection.

The contribution does not lie in introducing a new fraud theory or a new technology. Rather, the contribution is in connecting concepts from different bodies of literature and applying them in the context of inventory fraud. This synthesis is important, as current literature has become fragmented, with research on fraud schemes, detection procedures, and auditor characteristics existing in isolation, with limited synthesis in practice (Habibi, 2025).

The framework recognizes that inventory fraud involves technical and human risks: digital technologies can identify unusual patterns, behavioural indicators can provide information on potential human misconduct, and forensic controls enable investigation and response (Sofyan et al., 2026). Furthermore, the efficacy of this synergy is enhanced by organizational enablers, such as competent audit committees and robust internal control systems, which mediate the overall effect on investigative outcomes (Ramadhan et al., 2025).

Theoretical Contributions

The framework integrates three theoretical perspectives. First, the Fraud Triangle and Fraud Diamond theories provide the behavioural perspective, explaining the potential motives or enablers for fraud.

Second, the TOE framework explains the technological and organizational aspects of the problem, by investigating how technological capabilities, organizational readiness, and environmental conditions influence technology adoption.

Third, forensic accounting governance principles provide the control perspective by explaining how organizations can monitor, investigate, and respond to fraud.

Practical Contributions

For internal auditors and forensic accountants, the framework encourages a shift from traditional periodic inventory checking practices. Audit teams can combine ERP data, digital analytics, and behavioural indicators to detect suspicious activities at an earlier stage.

For management and governance boards, the framework emphasizes the need to ensure that investments in technologies such as AI, ERP, blockchain, RFID, and IoT are accompanied by appropriate organizational capabilities, internal controls, and governance mechanisms.

For policymakers and regulators, the framework provides a basis for considering technology-enabled fraud and human behavioural risks in the development of inventory auditing and fraud prevention guidance.

Conclusion

Inventory fraud remains a significant problem despite the advances of digital technologies (Afrizka et al., 2026). While modern inventory systems have enhanced operational efficiency and informational availability, they have also created new opportunities for technology-enabled fraud. Traditional periodic auditing therefore needs to be supplemented by more continuous and integrated approaches (Fotoh, 2025).

This conceptual paper proposes an integrated framework, which brings together forensic controls, digital technologies, and behavioural indicators to improve inventory fraud detection. The framework is informed by the Fraud Triangle and Fraud Diamond theories, the Technology–Organization–Environment framework, and forensic accounting governance principles. Four propositions are proposed: P1 suggests that proactive forensic controls improve the speed and accuracy of inventory fraud detection; P2 indicates that digital monitoring technologies improve the real-time identification of unusual activities; P3 is

concerned with behavioural indicators' role in supporting early fraud detection; and P4 suggests that an integrated approach combining forensic controls, digital technologies, and behavioural indicators provides greater fraud detection effectiveness.

The framework contributes to the literature by connecting human behaviours, digital monitoring, and forensic investigation to form an integrated model of fraud detection in the inventory context. It also responds to the fragmented nature of current research on emerging audit technologies and fraud detection.

Future studies should aim to test the four propositions using data from organizations spanning different industries, sizes, and geographical locations. Future research could also investigate whether organizational readiness, digital capability, ethical culture, or management support moderates the relationships. Structured internal audits, robust internal controls, and technology to identify suspicious activities, understand potential misconduct, and investigate fraud effectively (Febriyanti et al., 2025). Detection requires more than technology alone (Afrizka et al., 2026). Organizations need to combine people, technology, and forensic controls to identify suspicious activities, understand potential misconduct, and investigate fraud effectively (Kaur et al., 2022).

Acknowledgements: The authors would like to express their sincere gratitude to Universiti Teknologi MARA for providing the necessary resources and support throughout the course of this research. Special appreciation is extended to colleagues and peers who contributed valuable insights and constructive feedback, which greatly enhanced the quality of this paper.

Funding Statement: No Funding

Conflict of Interest Statement: The authors declare that there is no conflict of interest regarding the publication of this paper. All authors have contributed to this work and approved the final version of the manuscript for submission to the Advanced International Journal of Business, Entrepreneurship and SME's (AIJBES)

Ethics Statement: This study did not involve any human participants, animals, or sensitive data requiring ethical approval. The authors confirm that the research was conducted in accordance with accepted academic integrity and ethical publishing standards.

Author Contribution Statement: All authors contributed significantly to the development of this manuscript. Norazira Abd Karim was responsible for the conceptualization, methodology, and overall supervision of the study. Naimah Ahmad Yahya and Nik Nurul Aswani Nik Kamarudin handled data collection, analysis, and interpretation of results. Siti Nabilah Mohd Shaari and Suryani Abdul Raman contributed to the literature review, drafting, and critical revision of the manuscript. All authors read and approved the final version of the manuscript prior to submission.

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