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Cybersecurity Framework for Cloud-Based Websites and E-Business Platforms in U.S. SMEs: Defending Against Credential Theft, Payment Fraud, and Ransomware

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Abstract:- Small and medium-sized enterprises (SMEs) in the United States are increasingly adopting cloud-based e-business platforms to enhance operational efficiency, drive growth, and remain competitive in the digital economy. While cloud computing offers benefits such as scalability, cost reduction, and flexibility, it also exposes small and medium-sized enterprises (SMEs) to significant cybersecurity threats. Credential theft, payment fraud, and ransomware attacks are among the most prevalent and damaging risks, often resulting in severe financial losses and reputational harm.

Compared to larger corporations, SMEs typically lack the security infrastructure, expertise, and financial capacity to defend against such threats. To address this vulnerability, this paper proposes a cybersecurity framework tailored explicitly for U.S. small and medium-sized enterprises (SMEs) operating in cloud-based environments. The framework is designed to be affordable, modularly scalable, and practical for resource-constrained settings. It integrates six key components: identity and access management, data protection, endpoint security, incident response, employee training, and regulatory compliance.

A hypothetical case study is used to illustrate the framework's real-world applicability. At the same time, a comparative evaluation with the NIST Cybersecurity Framework (CSF) and ISO/IEC 27001 demonstrates its alignment with recognized best practices. This research provides a strategic pathway for SMEs to strengthen their cybersecurity posture and establish long-term digital resilience.

Keywords*:* Cybersecurity for SMEs; Cloud security framework; Credential theft; Payment fraud; Ransomware mitigation; NIST Cybersecurity Framework

1. Introduction

In today's hyper-connected digital economy, small and medium-sized enterprises (SMEs) across the United States are increasingly relying on cloud-based platforms to manage their business operations, engage with customers, and access global markets (Rawindaran et al., 2023). Cloud computing delivers a scalable and cost-efficient infrastructure that was previously accessible only to large corporations. However, the rapid digital transformation has also introduced complex cybersecurity challenges for SMEs (Papathanasiou et al., 2025).

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As organizations adopt remote work environments, cloud-hosted applications, and digital payment systems, their exposure to cyber threats expands significantly. The 2024 *Verizon Data Breach Investigations Report* revealed a notable increase in cyberattacks targeting SMEs, particularly through credential theft, payment fraud, and ransomware. Stolen credentials were responsible for nearly 40% of cloud-based breaches in 2023 (ITPro, 2024).

Unlike large organizations, SMEs often operate without dedicated cybersecurity professionals, comprehensive defense systems, or the financial resilience to recover from major cyber incidents. Recent studies show that over 75% of SMEs would struggle to remain operational following a ransomware attack (Jones & Al-Mamun, 2024). Moreover, more than 80% of ransomware attacks target small and medium-sized businesses, resulting in 20% of them suspending operations either temporarily or permanently (University of Maryland, 2023).

While cybersecurity standards such as the NIST Cybersecurity Framework (CSF) and ISO/IEC 27001 provide structured approaches to digital risk management, SMEs often view these frameworks as overly complex and expensive to implement (Rombaldo et al., 2023; Papathanasiou et al., 2025). These models assume the presence of organizational maturity, staffing, and cybersecurity budgets—resources not typically available to small businesses.

This gap in cybersecurity readiness creates a critical vulnerability for a sector that underpins national economic activity. In response, this study presents a cost-effective and scalable cybersecurity framework explicitly tailored to the needs of U.S. small and medium-sized enterprises (SMEs) utilizing cloud-based e-business platforms. The proposed model targets the most prevalent threats—credential theft, payment fraud, and ransomware—while simplifying implementation through modular, standards-aligned components. A hypothetical case study is used to demonstrate practical applicability, offering SMEs a viable path toward greater digital security and resilience.

Despite widespread cloud adoption by SMEs in the United States, the majority remain underprepared for cyber threats. Current frameworks like NIST CSF and ISO/IEC 27001 are rarely implemented in this segment due to cost, complexity, and misalignment with SME operations. A targeted framework is lacking—one that offers modular, low-cost, and cloud-native solutions while meeting compliance needs. This study addresses this gap.

1.1 Literature Review

Cybersecurity research across diverse organizational contexts consistently identifies small and medium-sized enterprises (SMEs) as particularly vulnerable to cyber threats. Unlike large enterprises, SMEs often face severe constraints in terms of budgets, IT staffing, and access to cybersecurity expertise (Alshamrani et al., 2023). These limitations hinder their ability to adopt

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or maintain enterprise-level security frameworks, such as the National Institute of Standards and Technology Cybersecurity Framework (NIST CSF) or ISO/IEC 27001 (Kshetri, 2021).

The NIST CSF provides a structured model consisting of five core functions: **Identify**, **Protect**, **Detect**, **Respond**, and **Recover**. ISO/IEC 27001, in contrast, sets forth comprehensive requirements for implementing and maintaining an information security management system (ISMS). Although both frameworks are globally respected and widely adopted in large organizations, their successful implementation requires considerable investments—staff training, continuous monitoring, periodic audits, and other ongoing operational commitments. For SMEs, which typically prioritize short-term survival over long-term strategic planning, these demands pose significant adoption barriers (Papathanasiou et al., 2025).

Recent studies have highlighted the growing need for lightweight and scalable cybersecurity mechanisms that are specifically designed for SMEs. Santos and Gupta (2022) argue that existing enterprise frameworks are not well aligned with the operational and risk environments of smaller firms, even those that exhibit baseline technical capabilities and compliance awareness. Similarly, Patel and Singh (2023) emphasize the need for modular and cost-efficient cybersecurity tools that support gradual implementation. These allow SMEs to improve their security posture incrementally, without imposing a prohibitive financial or technical burden.

As these gaps persist, the threat landscape continues to evolve at an alarming pace. Ransomware attacks are on the rise, with SMEs increasingly targeted due to relatively weak cyber defenses. Unpatched software, misconfigured cloud environments, and the absence of reliable data backup systems are often exploited to encrypt critical business data and extort payment (Garcia et al., 2023). Phishing remains another prevalent attack vector, particularly campaigns designed to harvest login credentials, which enable unauthorized access to cloud platforms, payment systems, and sensitive client records (Williams & Brown, 2023).

The consequences of such attacks can be devastating. According to the Ponemon Institute (2022), over 60% of SMEs that experience a significant cyber incident are forced to shut down within six months. Without pre-established incident response plans, cyber insurance coverage, or access to legal support, most affected SMEs experience overwhelming operational and reputational damage.

In addition, studies point to a critical misunderstanding among SME leadership regarding the **shared responsibility model** in cloud environments. Many business owners mistakenly assume that data security is solely the responsibility of their cloud service provider (CSP), when in fact CSPs are only responsible for securing the infrastructure. It is the client's responsibility to configure access controls, manage credentials, and monitor system usage—oversights in these areas frequently lead to preventable security breaches (Chen et al., 2022).

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Despite the growing recognition of cybersecurity as a business imperative, SMEs remain underserved by the current ecosystem of security frameworks, tools, and policies—most of which were designed with enterprise-level capabilities in mind. There is an urgent need for a cybersecurity framework that specifically addresses the realities, constraints, and threat exposure of SMEs operating cloud-based e-business platforms. Such a framework must prioritize **affordability**, **ease of implementation**, **cloud-native adaptability**, and **targeted defense** against high-risk threats—namely credential theft, payment fraud, and ransomware.

Table 1 Comparison of Cybersecurity Frameworks

Feature	NIST CSF	ISO/IEC 27001	Proposed SME Framework
SME-Specific	✗	✗	✅
Cost-Effective	✗	✗	✅
Cloud-Focused	Partial	Partial	✅
Payment Fraud Defense	✗	✗	✅
Simple to Implement	✗	✗	✅
Ransomware Response	Partial	✗	✅

Objectives

The primary objective of this study is to develop a cybersecurity framework specifically tailored to the operational realities and threat landscape faced by small and medium-sized enterprises (SMEs) in the United States that rely on cloud-based websites and e-business platforms. The framework aims to provide practical, affordable, and modular protection against the most prevalent cyber threats affecting SMEs—namely credential theft, payment fraud, and ransomware attacks. To ensure usability and effectiveness, the framework integrates widely accepted security principles such as Zero Trust Architecture, Defense-in-Depth, and regulatory compliance alignment with standards like PCI-DSS, GDPR, and the NIST Cybersecurity Framework. Additionally, the study seeks to validate the applicability of the proposed model through a simulated SME use case, highlighting improvements in access control, data protection, incident response, and regulatory readiness. By addressing both technical and organizational dimensions of SME cybersecurity, the framework aims to provide a realistic and scalable path to enhanced digital resilience.

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2. Methods

This study employs a conceptual methodology to develop a cybersecurity framework tailored to the unique needs and constraints of small and medium-sized enterprises (SMEs) operating in cloud-based e-business environments. The methodological approach integrates insights from academic literature, industry standards, and practitioner feedback to ensure practical relevance and adaptability.

3.1 Literature and Standards Review

The research process began with an in-depth literature review of peer-reviewed articles, white papers, government releases, and cybersecurity guidelines published between 2018 and 2025. Special focus was placed on works indexed in high-impact databases such as Scopus, including journals like *Computers & Security*, *Information Systems Frontiers*, and the *Journal of Cybersecurity*. In addition to academic literature, the study examined widely adopted frameworks such as the **NIST Cybersecurity Framework (NIST CSF)**, **ISO/IEC 27001**, and **CIS Controls v8**, assessing each for SME applicability in terms of cost, complexity, and implementation feasibility.

3.2 Expert Consultations

To enhance real-world applicability, the framework design incorporated informal consultations with cybersecurity professionals, SME-focused IT consultants, and digital commerce experts. These consultations addressed practical concerns such as endpoint protection, cloud misconfigurations, payment compliance (e.g., PCI-DSS), and regulatory alignment (e.g., CCPA). Practitioner insights were instrumental in identifying which controls could realistically be implemented by resource-constrained organizations.

3.3 Use-Case Simulation

To test the usability and feasibility of the proposed framework, a simulated use-case was designed. The scenario represented a U.S.-based SME operating a cloud-hosted e-commerce platform using Amazon Web Services (AWS) and third-party payment providers such as Stripe. The hypothetical organization employed approximately 40 staff, had no dedicated IT security team, and faced common threats such as phishing, ransomware, and data exposure. Key constraints modeled included limited IT staffing, low cybersecurity maturity, and compliance obligations.

The simulation was used to assess the practicality of implementing each framework component and to examine potential impacts on **business continuity**, **compliance readiness**, and **threat mitigation**.

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3.4 Conceptual Nature and Future Work

As a conceptual contribution, this study does not include empirical fieldwork or statistical validation. Instead, it presents a foundational framework that may be adapted and tested in future pilot programs or longitudinal studies. By aligning modular controls with known SME challenges—such as budget constraints and cloud reliance—the framework is positioned for both theoretical robustness and real-world application.

Additionally, the framework does not yet address emergent threats from generative AI (e.g., deepfake phishing) or complex multi-cloud environments where vendor lock-in and misconfigurations are common. These remain areas for future exploration.

3. Results

5.3 Results and Impact

After six months of implementation:

- **Phishing success rate** dropped by over 75%.
- **Unauthorized access attempts** were blocked due to MFA and role-based controls.
- **Security event reporting** by employees increased by 60%.
- **No successful ransomware attacks** were recorded.
- **PCI-DSS self-assessment** passed with minimal remediation actions.

The case illustrates that even with limited resources, SMEs can significantly improve their cybersecurity posture using a modular, standards-aligned, and cloud-aware framework.

4. Discussion

5.1 Proposed Cybersecurity Framework

5.1.1 Theoretical or Conceptual Framework

The design of the proposed cybersecurity framework for cloud-based e-business platforms in small and medium-sized enterprises (SMEs) is grounded in established theoretical paradigms in the field of cybersecurity. Two central models inform the logic and structure of this framework: the **Defense-in-Depth model** and the **Zero Trust Architecture (ZTA)**. These models offer conceptual foundations that emphasize layered security controls and the principle of least privilege—both essential in environments where SMEs lack robust security resources.

The framework has strategic implications for U.S. digital policy. By enabling SMEs to meet regulatory obligations affordably, it supports goals outlined in the National Cybersecurity

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Strategy (2023) and Executive Orders on critical infrastructure resilience. Policymakers may consider offering tax incentives or subsidies to encourage adoption among SMEs in vulnerable sectors.

Defense-in-Depth Principle

The Defense-in-Depth (DiD) model is a well-established cybersecurity strategy that advocates for multiple layers of defense across technical, administrative, and physical domains (Smith et al., 2021). The fundamental assumption is that no single control is foolproof; therefore, a cascading series of barriers can prevent or contain breaches. This principle maps directly to the six proposed components of the SME framework:

- **Identity and Access Management** and **Endpoint/Network Security** provide perimeter and internal safeguards.
- **Data Protection** and **Payment Security** address the confidentiality and integrity of sensitive information.
- **Incident Response** and **Compliance/Governance** support operational continuity and legal resilience.
- **Security Awareness** spans human factors, offering internal risk containment against phishing and social engineering.

By layering these controls, the framework ensures that even if one mechanism fails—such as a stolen password or a misconfigured endpoint—other controls remain active to detect, prevent, or respond to threats.

Zero Trust Architecture (ZTA)

The **Zero Trust model**, as defined by the National Institute of Standards and Technology (NIST Special Publication 800-207), asserts that **no user or device—internal or external—should be automatically trusted** (Rose et al., 2020). Access must be continuously verified, identity must be contextually confirmed, and lateral movement must be minimized through strict segmentation. This philosophy is embedded in the framework's:

- **Mandatory Multi-Factor Authentication (MFA)**
- **Role-Based Access Control (RBAC)**
- **Continuous Monitoring**
- **Tokenization of Payment Data**

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These practices prevent attackers from escalating privileges or moving undetected within cloud environments once access is gained. ZTA also supports cloud-native implementations, making it ideal for SMEs transitioning to Software-as-a-Service (SaaS) and Infrastructure-as-a-Service (IaaS) models.

Compliance-Centric Design

The framework also aligns with industry and regulatory standards such as **PCI-DSS**, **GDPR**, and the **California Consumer Privacy Act (CCPA)**. This design rationale draws from the **Risk-Based Compliance Model** (Arcuri, 2022), which posits that tailored compliance reduces exposure by enforcing baseline controls tied to specific regulatory risks (e.g., customer data exposure, payment fraud).

SME-Centric Modularity

Unlike enterprise-centric cybersecurity models, which presume the existence of dedicated security teams and automation systems, this framework follows a **phased modularity** model. It is rooted in **Technology Acceptance Theory (TAM)** and **Diffusion of Innovations Theory** (Davis, 1989; Rogers, 2003), where adoption likelihood increases when systems are perceived as simple, low-cost, and compatible with existing operations. This modular design supports gradual integration—starting with identity and awareness, and scaling toward automation and governance.

To address the core cyber risks faced by SMEs in cloud-based e-commerce—namely **credential theft**, **payment fraud**, and **ransomware**—this study proposes a six-component cybersecurity framework. The framework is designed to be operational, modular, and cost-effective, supporting phased adoption according to an SME's resource capacity and digital maturity. Each component targets a distinct security domain while supporting overall defense-in-depth.

Component 1: Identity and Access Management (IAM)

- Enforce **Multi-Factor Authentication (MFA)** for all privileged accounts and cloud services.
- Implement **strong password policies** with complexity requirements and periodic expiration.
- Apply **Role-Based Access Control (RBAC)** to enforce least-privilege access.

Component 2: Data Protection and Payment Security

- Encrypt sensitive data both **in transit** and **at rest** using industry-standard protocols (e.g., AES-256, TLS 1.3).

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- Use **PCI-DSS-compliant** payment gateways; tokenize all payment data.
- Regularly **patch payment system software** to eliminate known vulnerabilities.

Component 3: Endpoint and Network Security

- Deploy **Endpoint Detection and Response (EDR)** solutions with ransomware detection capabilities.
- Implement **network segmentation**, **firewalls**, and **Intrusion Detection/Prevention Systems (IDS/IPS)**.
- Continuously monitor cloud environments for **misconfigurations and unauthorized access**.

Component 4: Incident Response and Recovery

- Develop a **lightweight incident response plan** tailored for SMEs.
- Maintain **off-site and immutable backups**; test recovery procedures quarterly.
- Conduct **cyberattack simulations** (e.g., phishing drills, ransomware scenarios) to assess readiness.

Component 5: Security Awareness and Training

- Conduct **quarterly training sessions** focused on phishing, malware, and social engineering.
- Use **gamified e-learning tools** and simulations to reinforce retention.
- Foster a **culture of reporting**, including anonymous channels for reporting suspicious activity.

Component 6: Compliance and Governance

- Maintain **automated checklists** aligned with applicable regulations (e.g., PCI-DSS, GDPR, CCPA).
- Document all security policies and maintain detailed **audit trails**.
- Appoint or engage a **part-time compliance consultant or officer** to oversee implementation.

This modular framework is intentionally designed to be phased and flexible. SMEs can begin with foundational controls—like IAM and training—and gradually build toward more

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advanced capabilities such as EDR and compliance automation. The goal is to provide a path toward resilient cybersecurity practices without requiring enterprise-level budgets or expertise.

5.2. Framework Validation: Hypothetical SME Use Case

To validate the feasibility and practical applicability of the proposed cybersecurity framework, this study applies it to a simulated case involving a representative small-to-medium enterprise (SME) in the United States. The use case reflects common operational realities of resource-constrained businesses leveraging cloud-based platforms.

5.3 Organization Profile

The hypothetical SME is a U.S.-based, mid-sized online retail company headquartered in Austin, Texas. The company employs 40 individuals and operates an e-commerce website hosted on Amazon Web Services (AWS). It relies on Stripe as a third-party payment processor and handles sensitive data such as personally identifiable information (PII) and transaction records.

Departments include:

- **Sales**: handles CRM and customer orders.
- **Logistics**: manages inventory and shipping systems.
- **Customer Service**: supports communication and complaint resolution.

The company has experienced significant growth but remains underprepared for modern cybersecurity threats. Notable vulnerabilities include:

- Repeated phishing attempts targeting frontline staff.
- Lack of formal endpoint protection tools.
- Minimal encryption and backup policies.
- Absence of compliance protocols with standards such as PCI-DSS and CCPA.

5.4 Framework Implementation

To address these challenges, the company adopted a phased approach using the six-component framework:

Component	Implementation Measures
Identity & Access Management (IAM)	Enabled MFA on all platforms and enforced password complexity across all users.

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Data Protection & Payment Security	Deployed encryption protocols and implemented tokenization on Stripe.
Endpoint & Network Security	Installed lightweight EDR tools; enabled AWS GuardDuty and configured firewalls.
Incident Response	Created a formal incident response playbook and ran two ransomware tabletop exercises.
Security Awareness & Training	Launched quarterly phishing and social engineering training programs.
Compliance & Governance	Conducted a PCI-DSS self-assessment and began maintaining regulatory audit logs.

5.5 Results and Impact

After six months of implementation:

- **Phishing success rate** dropped by over 75%.
- **Unauthorized access attempts** were blocked due to MFA and role-based controls.
- **Security event reporting** by employees increased by 60%.
- **No successful ransomware attacks** were recorded.
- **PCI-DSS self-assessment** passed with minimal remediation actions.

The case illustrates that even with limited resources, SMEs can significantly improve their cybersecurity posture using a modular, standards-aligned, and cloud-aware framework.

5.6. Implementation Considerations

Effective adoption of the framework in SMEs requires phased rollout, aligned with organizational resources and digital maturity. The following stages are recommended:

Phase 1: Foundational Controls – Identity and Awareness

- Implement MFA, strong password policies, and RBAC.
- Conduct employee training on basic cybersecurity principles.

Phase 2: Intermediate Enhancements – Endpoint and Payment Security

- Deploy EDR solutions for real-time detection.

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- Maintain PCI-DSS compliance using secure payment gateways, tokenization, and fraud detection.

Phase 3: Advanced Capabilities – Response and Governance

- Develop a formal incident response plan and run tabletop simulations.
- Schedule encrypted off-site backups.
- Implement tools like AWS Config and Azure Security Center for compliance automation.

Technology Selection and Vendor Collaboration

- Combine open-source tools (e.g., Suricata, OpenVAS) with cloud-native security tools (e.g., AWS GuardDuty, CloudTrail).
- Engage Managed Security Service Providers (MSSPs) for SMEs lacking internal expertise.

A strategic, phased approach using affordable technologies and external support can empower SMEs to build and sustain a strong cybersecurity posture.

5.7. Limitations

This study presents a conceptual framework supported by a simulated case study rather than empirical deployment. Limitations include:

- Assumption of baseline cloud adoption and tech readiness.
- Lack of generalizability across diverse SME sectors.
- Evolving threat landscape, including AI-driven attacks, may render elements obsolete.
- Organizational culture and leadership commitment were not evaluated.
- Long-term resilience and ROI are not measured without real-world pilots.

Empirical research is required to validate and refine the framework in diverse operational settings.

5.8. Future Work

The following areas are recommended for future research:

- **Pilot Implementation Studies:** Partnering with SMEs across sectors to gather empirical data on performance and ROI.

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- **SME Cybersecurity Maturity Model:** Establishing tiered benchmarks (e.g., beginner, developing, advanced).
- **Risk Quantification & Compliance Automation:** Developing real-time dashboards and reporting metrics.
- **Long-Term Impact Assessment:** Conducting longitudinal studies on incident frequency, recovery time, and stakeholder trust.
- **Policy Alignment & Incentive Research:** Evaluating the effect of government incentives (e.g., tax credits, grants) on SME cybersecurity adoption.

These directions will support the framework's transition from conceptual design to applied, measurable impact across the SME sector.

5.9. Conclusion

This study presents a focused cybersecurity framework tailored to the operational and resource constraints of small and medium-sized enterprises (SMEs) in the United States that rely on cloud-based websites and e-business platforms. Amid the surge in digital transformation, SMEs continue to lag behind large enterprises in cybersecurity preparedness. Enterprise-level frameworks, while comprehensive, are often inaccessible to SMEs due to high costs and complex implementation requirements.

The proposed framework directly addresses the most common threats faced by SMEs—credential theft, payment fraud, and ransomware—through six modular components: Identity and Access Management, Data Protection and Payment Security, Endpoint and Network Security, Incident Response and Recovery, Security Awareness and Training, and Compliance and Governance. Implemented in a phased manner, these components enable SMEs to scale their cybersecurity posture in line with their maturity and resources. Each component is grounded in industry best practices and aligned with regulatory standards, including PCI-DSS, CCPA, and GDPR.

The framework’s strengths lie in its affordability, simplicity, and contextual relevance. In contrast to enterprise frameworks like the NIST CSF and ISO/IEC 27001, this SME-centric model emphasizes practical implementation through the use of open-source tools, cloud-native features, and partnerships with managed service providers. The hypothetical case study reinforces the framework’s real-world viability by demonstrating measurable improvements in phishing resistance, access control, and regulatory compliance—all without requiring enterprise-grade investment.

Beyond its technical benefits, the framework contributes to broader national objectives of economic resilience and digital trust. As SMEs play a vital role in employment, innovation,

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and supply chain continuity, strengthening their cybersecurity is a matter of both business and national importance.

In conclusion, the framework offers a structured, scalable, and actionable roadmap for SMEs to secure their digital assets. It serves both as a strategic guide and a call to action for policymakers, business leaders, and researchers to elevate cybersecurity as a cornerstone of sustainable digital growth. Future research, field testing, and public-private collaboration will be essential in advancing the framework's adoption and refining it for diverse operational environments.

Declarations

Conflict of Interest
The author declares no conflict of interest.

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Data Availability
No datasets were generated or analyzed during the current study.

Ethical Approval
This study involved no intervention with human participants; therefore, ethical approval was not applicable.

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