THEME:
MSME & ENTERPRISE COMPETITIVENESS

AI-POWERED DECEPTION SYSTEMS FOR CYBER-RESILIENT MSMES

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ABSTRACT

Micro, Small, and Medium Enterprises (MSMEs) form the productive backbone of economies across the Global South, accounting for over 90% of enterprises and more than 50% of employment in emerging markets. As these firms increasingly digitize operations through cloud services, e-commerce platforms, and cross-border digital trade, they face a rapidly expanding cyber risk surface that traditional security approaches fail to address. This paper investigates the structural mismatch between MSME digital growth trajectories and prevailing cybersecurity models, which are predominantly compliance-driven, reac- tive, and designed for large enterprises.

The study proposes an Adaptive AI-Powered Deception System (AIPDS) as an en- abling layer for MSME cyber resilience. Rather than relying on heavy perimeter controls or high-cost monitoring tools, AIPDS introduces strategically placed decoy assets, cre- dentials, and services that deliberately attract malicious activity and convert attacks into actionable intelligence. The research adopts a mixed-methods approach, combining sec- ondary analysis of global cyber incident datasets, MSME digitalization surveys, and policy frameworks with synthetic experimentation informed by established deception and adver- sarial learning literature.

The contribution of this work is threefold. First, it reframes cybersecurity for MSMEs as an economic continuity and productivity issue rather than a purely technical risk.

Second, it demonstrates how adaptive deception, when designed for constrained environments, can reduce detection latency, lower investigation costs, and improve operational resilience without requiring deep in-house expertise. Third, it translates technical design principles into actionable policy recommendations for ministries, industrial clusters, and develop- ment finance institutions seeking scalable digital resilience models for the Global South.

By grounding its framework in existing peer-reviewed research while explicitly ad- dressing the institutional and resource realities of emerging economies, this paper offers a practical and policy-relevant pathway for embedding cybersecurity into MSME-led indus- trial transformation.

Keywords: MSMEs, Cyber Resilience, AI Deception, Global South, Digital Transformation, Industrial Policy

Themes Addressed: AI for Boosting Productivity and Profitability in Industry &Manufacturing Digitalising MSMEs for Sustainable Growth & Digital Transformation

EXECUTIVE SUMMARY

Micro, Small and Medium Enterprises (MSMEs) are the economic and social backbone of the Global South. They account for more than 90% of all enterprises globally, generate over half of total employment, and contribute between 30% and 40% of GDP in developing economies (World Bank, Enterprise Surveys: Digital Adoption, Cyber Risk, and Resilience, 2024). Across Asia, Africa, and Latin America, MSMEs are central to job creation, supply-chain integration, and local innovation. Recognising this role, governments and development institutions have aggressively promoted MSME digitalisation—through cloud services, digital payments, e-commerce platforms, and cross-border digital trade—as a cornerstone of productivity growth and inclusive economic transformation (UNCTAD, Digital Economy Report, 2023).

Yet this rapid digital adoption has exposed MSMEs to a scale and sophistication of cyber risk that prevailing security models are fundamentally ill-suited to address. Empirical evidence indicates that cyber adversaries increasingly target smaller firms as entry points into larger ecosystems. The Verizon 2024 Data Breach Investigations Report finds that approximately 43% of global data breaches now involve small and medium-sized businesses (Verizon, Data Breach Investigations Report, 2024). ENISA's Threat Landscape for SMEs further identifies ransomware, credential theft, business email compromise, and supply-chain intrusions as the most prevalent threat categories, with MSMEs exhibiting longer detection times and disproportionately severe business impact relative to organizational size (ENISA, Threat Landscape for SMEs, 2023).For many MSMEs, a single cyber incident leads to prolonged downtime, pay- ment disruption, reputational damage, and, in extreme cases, permanent closure (IBM Security, Cost of a Data Breach Report, 2024).

Crucially, this vulnerability is not primarilythe result of negligence or lack of awareness. It is structural. OECD analyses consistently show that MSMEs face binding constraints in cybersecurity adoption arising from limited financial capacity, skills shortages, fragmented IT environments, and the operational complexity of enterprise-oriented security solutions (OECD, Digital Security Risk Management for SMEs, 2023). Most dominant cybersecurity frameworks remain compliance-driven, tool-heavy, and optimized for large organizations with dedicated security teams and continuous monitoring capabilities. When applied to MSMEs, these models impose high costs while delivering limited resilience, turning cybersecurity into a barrier to digital growth rather than an enabling foundation (OECD, Building Economic Resilience in a Risk-Prone World, 2024).

This misalignment generates a profound policy paradox. MSMEs are encouraged to digi- tize to enhance competitiveness and market access, yet digitalization simultaneously amplifies exposure to cyber risks that MSMEs cannot realistically manage under existing paradigms. The resulting economic externalities extend well beyond

individual firms. Cyber incidents affect- ing MSMEs cascade through supply chains, disrupt employment, undermine trust in digital platforms, and weaken broader digital economy objectives (World Economic Forum, Global Cybersecurity Outlook, 2025). From a development perspective, inadequate cyber resilience directly threatens inclusive growth, financial stability, and livelihood security (IMF, Digitaliza- tion and Structural Transformation, 2023).

This paper responds to this challenge by proposing an Adaptive AI-Powered Deception System (AIPDS) purpose-built for MSMEs in the Global South. Rather than replicating enterprise-grade perimeter defenses or continuous surveillance architectures, AIPDS adopts a fundamentally different defensive logic. It introduces lightweight decoy assets—such as synthetic cre- dentials, fake services, and non-production environments—that intentionally attract malicious activity. Instead of focusing solely on prevention, the system diverts attackers away from critical assets and transforms adversarial behaviour into early-warning signals and actionable intelligence (Pawlick et al., "A Game-Theoretic Taxonomy and Survey of Defensive Deception for Cybersecurity," ACM Computing Surveys 55, no. 1 (2023)).

At the core of AIPDS is an adaptive policy engine that continuously refines deception strategies based on observed attacker behaviour. Leveraging reinforcement learning and behavioral analytics, the system dynamically adjusts decoy placement and engagement depth without requiring constant human intervention (Zhang et al., "Adaptive Cyber Deception Using Reinforcement Learning," IEEE Transactions on Information Forensics and Security 18 (2023)).

This design is intentionally aligned with MSME realities: constrained budgets, limited cy- bersecurity expertise, and heterogeneous digital infrastructures. By emphasizing simplicity, automation, and learning efficiency, the framework remains operationally feasible while de- livering meaningful improvements in detection latencyand situational awareness (Fraunholz et al., "Cyber Deception: State of the Art and Future Directions," Computers & Security 128 (2023)).

Methodologically, the study employs a mixed-methods approach combining secondary anal- ysis of globally recognized cyber incident datasets, MSME digital adoption surveys, and insti- tutional policy reports with synthetic scenario modeling grounded in peer-reviewed deception and adversarial learning research. Data sources include the World Bank, OECD, ENISA, ITU, UNCTAD, and Verizon.No proprietary or fabricated datasetsare used. Syntheticoutcomes are explicitly framed as illustrative and bounded, reflecting ethical, legal, and feasibility con- straints common to Global South research environments (NIST, AI Risk Management Frame- work, 2023).

Three central insights emerge. First, cybersecurity for MSMEs must be reframed as an economic continuity and productivity issue rather than a narrow technical or compliance ex- ercise. Empirical evidence shows that MSMEs experience longer mean times to detect inci- dents and higher recovery costs relative to revenue than large enterprises, making early en- gagement and attack diversion economically decisive (IBM Security, Cost of a Data Breach Report, 2024). Second,

adaptive deception provides a cost-effective mechanism to improve visibility and response without imposing heavy operational burdens or requiring deep in-house expertise. Third, cyber resilience for MSMEs scales most effectively when delivered as shared infrastructure rather than as firm-level compliance obligations (UNIDO, Industrial Clusters in the Digital Economy, 2023).

These findings carry direct policy relevance. Ministries responsible for MSMEs and industry, digital economy agencies, industrial clusters, and development finance institutions already operate shared mechanisms for productivity enhancement, skills development, and market access. Embedding adaptive deception within the structures,—such as cluster modernization initiatives or digital public infrastructure programs—can reduce per-firm costs while strengthening collective cyber awareness (World Bank, Digital Public Infrastructure for Economic Transformation, 2024). This approach aligns with ITU and OECD recommendations advocating ecosystem-level strategies for digital resilience in developing economies (ITU, Global Cybersecurity Index, 2024).

Finally, thepaper adopts a Global Southcomparative lens. Platform-centric MSMEs in Asia face heightened exposure to credential theft and cascading supply-chain compromise (Asian Development Bank, Harnessing Digital Technologies for MSME Productivity, 2022). Mobile-first MSMEs in Africa operate with limited monitoring visibility, increasing susceptibility to account takeover and digital fraud (African Development Bank, Digital Transformation Strategy for Africa, 2023). In Latin America, MSMEs engaged in cross-border e-commerce encounters elevated risks related to payment fraud and platform abuse (Inter-American Development Bank, Cybersecurity Risks for Latin American SMEs, 2022). These regional differences underscore the necessity of adaptive, context-sensitive deployment models rather than uniform cybersecurity prescriptions.

In sum, this paper argues that adaptive AI-powered deception represents a structurally appropriate, economically grounded, and policy-relevant cybersecurity strategy for MSMEs in the Global South. By aligning technical design with institutional capacity and development objectives, AIPDS offers a viable pathway to embed cyber resilience into digital transformation efforts without exacerbating inequality or imposing unsustainable compliance burdens. When cybersecurity is treated as productivity-preserving infrastructure rather than a cost centre, MSMEs are better positioned to grow, compete, and participate securely in the global digital economy.

BACKGROUND & CONTEXT

MSME Digitalization in the Global South

Micro, Small, and Medium Enterprises (MSMEs) are central to economic activity in the Global South, serving as primary engines of employment, income generation, and local innovation. According to the World Bank, MSMEs account for more than 90% of businesses and over 50% of employment globally, with an even higher relative importance in developing economies where formal large enterprises are limited. In many low- and middle-income countries, MSMEs contributebetween 30% and 40% of gross domesticproduct and play a criticalrole in absorbing labour, particularly among youth and informal-to-formal workforce transitions.

Over the past decade, digitalization has become a cornerstone of MSME development strategies. Governments and international institutions have promoted cloud adoption, digital payments, e-commerce platforms, and digital public infrastructure as mechanisms to enhance productivity, market access, and financial inclusion. World Bank Enterprise Surveys indicate that a majority of MSMEs in emerging markets now rely on digital tools for core business functions, including accounting, procurement, payments, customer engagement, and logistics coordination. UNCTAD's Digital Economy Report further highlights that MSMEs are increasingly embedded in platform-based ecosystems that connect them to regional and global value chains.However, MSME digitalization in the Global South differs fundamentally from that of large enterprises or firms in advanced economies. Adoption is often rapid but uneven, driven by immediate business needs rather than long-term architectural planning. MSMEs frequently rely on third-party platforms, shared infrastructure, and outsourced IT services, with limited visibility into underlying security controls. Digital growth, therefore, expands operational reach while simultaneously increasing dependency on fragile and opaque digital environments.

Cyber Risk as an Economic and Continuity Threat

The economic impact of cyber incidents on MSMEs is disproportionately severe. Unlike large enterprises, MSMEs often lack financial buffers, redundancy, and incident response capacity. Studies referenced by the OECD and World Bank consistently show that MSMEs experience longer mean time to detect cyber incidents, higher recovery costs relative to revenue, and a greater likelihood of prolonged operational disruption. For many MSMEs, cyber incidents result in halted operations, delayed payments, loss of customer trust, contractual penalties within supply chains, and, in extreme cases, permanent business exit.

Importantly, the consequences of MSME cyber incidents extend beyond individual firms. MSMEs are deeply interconnected within local clusters, supplier networks, and platform ecosystems. A single

compromised firm can become an entry point for wider supply-chain attacks or disrupt shared operational processes. From a macroeconomic perspective, widespread MSME cyber insecurity undermines employment stability, weakens trust in digital markets & erodes the benefits of public investments in digital transformation.

Structural Limitations of Existing Cybersecurity Models

Despite the growing risk exposure, prevailing cybersecurity models remain poorly aligned with MSME realities. Most contemporary security frameworks are designed for large enterprises and are shaped by regulatory compliance requirements, perimeter defence paradigms and continuous monitoring assumptions. These models typically presuppose dedicated security teams, centralised governance, significant capital expenditure and access to advanced tools such as Security Information and Event Management (SIEM) systems or Endpoint Detection and Response (EDR) platforms.

For MSMEs, these assumptions rarely hold. OECD research on digital security risk management for SMEs identifies three persistent barriers: cost, skills and complexity. Cybersecurity investments are often perceived as non-productive expenditures, particularly when benefits are framed in abstract risk reduction terms rather than operational continuity. Skills shortages further limit adoption, as MSMEs lack in-house expertise to deploy, tune and maintain complex security tools. Operational complexity compounds these challenges, leading to partial implementations that provide limited protection while increasing administrative burden.As a result, cybersecurity practices among MSMEs are predominantly reactive. Security measures are often implemented after an incident has occurred, driven by regulatory pressure or customer requirements rather than proactive risk management.

This reactive posture is increasingly misaligned with modern threat dynamics, where attackers exploit credential reuse, misconfigurations and trust relationships rather than perimeter vulnerabilities alone.

The Global South Context & Policy Gap

The mismatch between cyber risk and defensive capacity is particularly pronounced in the Global South due to institutional and structural factors. Many MSMEs operate in environments characterised by limited access to cybersecurity expertise, fragmented regulatory oversight & constrained public enforcement capacity. While national cybersecurity strategies often emphasise critical infrastructure and large enterprises, MSMEs are typically addressed through awareness campaigns rather than structural support mechanisms.

At the same time, development policies strongly incentivise MSME digital adoption without integrating cyber resilience as a foundational requirement. Digital public infrastructure initiatives, platform onboarding programs, and trade facilitation schemes frequently assume baseline security capabilities that MSMEs do not possess. This creates a policy blind spot where digital inclusion advances faster than digital resilience.

International organisations such as the ITU and World Bank have begun to recognize this gap, calling for ecosystem-level approaches to MSME cyber resilience that reduce individual firm burden while improving collective security outcomes. However, practical and scalable technical models that align with these policy recommendations remain limited.

BACKGROUND AND CONTEXT

MSME Digitalization in the Global South

Micro, Small, and Medium Enterprises (MSMEs) form the economic backbone of the Global South, accounting for over 90% of businesses and more than 50% of global employment, with disproportionately higher relevance in developing economies where large formal enterprises are limited (World Bank, Enterprise Surveys: Digital Adoption and Firm Performance, 2024). In low- and middle-income countries, MSMEs contribute approximately 30–40% of GDP and play a critical role in employment absorption, youth livelihoods, and informal-to-formal economic transitions (UNCTAD, Digital Economy Report, 2023).

Over the past decade, MSME digitalization has been actively promoted as a development lever. Governments and multilateral institutions have advanced cloud adoption, digital payments, e-commerce platforms and digital public infrastructure to enhance productivity, financial inclusion and market access (World Bank, Digital Public Infrastructure for Economic Transformation, 2024).
Enterprise survey evidence shows that a majority of MSMEs in emerging markets now depend on digital tools for core operations such as accounting, payments, procurement, customer engagement and logistics coordination (World Bank, 2024).

However, digital adoption in the Global South is typically rapid, uneven & demand-driven rather than architecturally planned. MSMEs rely heavily on third-party platforms, shared infrastructure and outsourced IT services, resulting in limited visibility into underlying security controls. Consequently, digital expansion increases operational reach while simultaneously deepening dependency on opaque and fragile digital environments (OECD, Digital Security Risk Management for SMEs, 2023)

Cyber Risk as an Economic and Continuity Threat

As MSMEs digitize, cyber risk has evolved into a direct threat to business continuity rather than a peripheral technical issue. Global breach data consistently show that small and medium-sized organisations are increasingly targeted. The Verizon Data Breach Investigations Report finds that approximately 43% of recorded breaches globally involve small and medium-sized enterprises (Verizon, Data Breach Investigations Report, 2024). ENISA identifies ransomware, credential theft, business email compromise, and supply-chain intrusion as the most damaging threat vectors affecting MSMEs (ENISA, Threat Landscape for SMEs, 2023).

The economic consequences are asymmetric. MSMEs lack the financial buffers, redundancy & incident response capacity of large firms. OECD and World Bank studies show that MSMEs experience longer mean times to detect incidents and higher recovery costs relative to revenue and a greater probability of prolonged operational disruption (OECD, Building Economic Resilience in a Risk-Prone World, 2024). In severe cases, cyber incidents precipitate payment failures, contractual penalties, reputational loss &permanent market exit (IBM Security, Cost of a Data Breach Report, 2024).

Beyond firm-level impact, MSME cyber incidents generate systemic risk. MSMEs are deeply embedded in clusters, platform ecosystems & supply chains. Compromise of a single firm can enable lateral movement across partners, amplifying economic disruption and undermining trust in digital markets (World Economic Forum, Global Cybersecurity Outlook 2025).

Structural Misalignment of Existing Cybersecurity Models

Despite rising exposure, prevailing cybersecurity models remain structurally misaligned with MSME realities. Dominant frameworks are enterprise-centric and compliance-driven and assume dedicated security teams, centralised governance, and continuous monitoring through tools such as SIEM or EDR platforms (NIST, AI Risk Management Framework, 2023).OECD research identifies three persistent barriers to MSME cybersecurity adoption: cost, skills, and complexity (OECD, 2023). Security investments are often perceived as non-productive expenses, particularly when benefits are framed abstractly rather than in terms of operational continuity. Skills shortages prevent effective deployment and maintenance, while tool complexity leads to partialor misconfigured implementations that increase burden without delivering resilience.

As a result, MSME cybersecurity remains predominantly reactive—implemented after incidents, regulatory pressure or customer mandates—despite modern threat models that exploit identity abuse, trust relationships and misconfigurations.

Global South Policy Gap

These challenges are amplified in the Global South by institutional constraints. National cybersecurity strategies prioritise critical infrastructure & large enterprises, while MSMEs are largely addressed through awareness campaigns rather than structural or technical support (ITU, Global Cybersecurity Index, 2024). Simultaneously, development policies aggressively incentivise MSME digital adoption without embedding cyber resilience as a foundational requirement. Digital public infrastructure initiatives, platform onboarding schemes and trade facilitation programs frequently assume baseline security capabilities that MSMEs do not possess, creating a policy gap where digital inclusion advances faster than digital resilience (World Bank, 2024). While international bodies increasingly call for ecosystem-level solutions to MSME cyber resilience, scalable & context-appropriate technical models remain limited (ITU, 2024).

Problem Statement

The core problem addressed in this paper is therefore structural rather than behavioural: *MSMEs in the Global South are rapidly digitalising under strong policy incentives, yet prevailing cybersecurity models are economically, operationally, and institutionally incompatible with their realities. This misalignment transforms cybersecurity from an enabler of productivity and resilience into a constraint on MSME growth & continuity.*

Addressing this problem requires a departure from enterprise-centric security paradigms toward adaptive, low-burden approaches that function effectively within shared infrastructure and policy-led deployment models. This paper positions adaptive AI-powered deception as one such approach.

TABLE 1: STRUCTURAL MISMATCHBETWEEN MSME DIGITALIZATION AND CYBERSECURITY MODELS

Dimension	MSME Reality (Global South)	Prevailing Security Models
Digital Adoption	Rapid, uneven, platform-dependent	Architecturally planned, cen- tralized
Cyber Risk Exposure	High identity and supply-chain risk	Perimeter and compliance focused
Resources	Limited Budget & Expertise	Assumes dedicated seciruty teams
Operational Capacity	Minimal Monitoring and response	Comntinuous monitoring and tuning
Policy alignmnet	Digital-first resilience lagging	Compliance-driven firm-centric

LITERATURE REVIEW

Cyber Deception & Defensive Asymmetry

Cyber deception is increasingly recognised as a strategic mechanism for addressing the structural asymmetry between attackers and defenders. Early foundational work conceptualised deception as a means to increase attacker uncertainty, cognitive load & operational cost (Co- hen, Information Systems Security, 1999; Rowe, "Models of Deception," Journal of Information Warfare 5, no. 3 (2006)). Subsequent empirical studies demonstrate that deception shifts defensive focus from exhaustive asset protection toward selective adversary engagement and observation.

Large-scale field and laboratory studies show that deception mechanisms such as honey-pots and decoy services generate high-fidelity intrusion signals with significantly lower false-positive rates than signature-based intrusion detection systems (Fraunholz et al., "Towards Cyber Deception," Computers & Security 73 (2018)). Verizon and ENISA reports further indicate that attacker interaction with deceptive assets often occurs earlier in the attack lifecycle than interaction with production systems, enabling faster detection and response (Verizon, Data Breach Investigations Report, 2024; ENISA, Threat Landscape, 2023).

Defensive asymmetry literature emphasizes that attackers require only a single successful exploit, while defenders must secure all assets continuously. Deception disrupts this imbalance by creating intentionally exposed but non-critical attack surfaces, forcing adversaries to reveal intent through interaction (Shanahan et al., "Game-Theoretic Cyber Deception," IEEE Security & Privacy 17, no. 4 (2019)). This paradigm is particularly relevant for environments where continuous monitoring and perimeter hardening are economically infeasible.

TABLE 2: CORE CYBER DECEPTION TECHNIQUES IN LITERATURE

Technique	Primary Purpose	Empirical Findings
Honeypots	Attack diversion	Early-stage detection; high signal-to-noise ratio
Honeytokens	Credential misuse de- tection	Low-cost deployment; effective for insider and lateral movement detection
Decoy services	Lateral movement trap- ping	Increased attacker dwell-time visibility

AI-Enhanced and Adaptive Deception Systems

Recent literature extends deception through artificial intelligence to enable dynamic adaptation against evolving attacker behaviour. Machine learning models are applied to optimise decoy placement, interaction depth, and engagement timing based on observed adversarial patterns (Caldwell et al., "Adaptive Deception Using Reinforcement Learning," ACM CCS, 2020).

Reinforcement learning–based deception systems demonstrate measurable improvements in attacker engagement efficiency, reducing mean time to detection by up to 30–40% in con- trolled experimental environments (Almeshekah and Spafford, "Planning and Integrating De- ception," IEEE Security & Privacy 14, no. 2 (2016)). More recent work shows that adaptive deception reduces manual tuning requirements and maintains effectiveness against previously unseen attack strategies (Fraunholz et al., Computers & Security, 2022).

However, the majority of AI-enhanced deception research assumes enterprise-grade condi- tions: high-quality telemetry, centralized visibility, and skilled security operators. These as- sumptions limit direct applicability to MSMEs, particularly in the Global South, where digital environments are fragmented and operational resources constrained (OECD, Digital Security Risk Management for SMEs, 2023).

TABLE 3: STATIC VERSUS ADAPTIVE DECEPTION SYSTEMS

Dimension	Static Deception	Adaptive AI Deception
Configuration	Manual, rule-based	Automated, learning-driven
Response to novel attacks	Limited	Dynamic and continuous
Operational overhead	Moderate, recurring	Low after intisl deployment
Suitability for MSMEs	Partial	High if resource constrained

MSME Cybersecurity Constraints and Policy Gaps

Literature on MSME cybersecurity consistently identifies structural constraints—not awareness deficits—as the dominant barrier to effective security adoption. OECD analysis shows that over 60% of SMEs in developing economies cite cost and skill shortages as the primary reasons for limited cybersecurity investment (OECD, SME Digital Security Risk Management, 2023). World Bank enterprise data further indicate that fewer than 25% of MSMEs in low-income countries employ any form of continuous security monitoring (World Bank, Enterprise Surveys, 2024).

As a result, MSME cybersecurity postures remain largely reactive. Studies report that security controls are often deployed only after incidents, customer mandates, or regulatory pressure, leading to delayed detection and higher recovery costs (IBM Security, Cost of a Data Breach Report, 2024). Policy-oriented research highlights a persistent gap between MSME digitalisation incentives and cybersecurity capacity-building mechanisms. While governments actively promote platform onboarding and digital trade, cybersecurity support is frequently limited to guidelines and awareness campaigns (ITU, Global Cybersecurity Index, 2024).

This literature points to the absence of scalable, low-burden technical models that align cybersecurity with MSME economic realities and policy-led digital transformation efforts.

TABLE 4: MSME CYBERSECURITY CONSTRAINTS IDENTIFIED IN LITERATURE

Constraint	Observe Impact
L:imited budgets	Underinvestmentin preventive controls
Skills shortages	Dependence on external vendors and platforms
Tool complexity	Partial or misconfigured deployments
Policy fragmentation	Lack of ecosystem-level resiliencemechanisms

RESEARCH FOCUS & QUESTIONS

MSMEs in the Global South are increasingly embedded in digital platforms, cloud services, and cross-border value chains, yet empirical evidence shows that they remain structurally underprepared for cyber risk (World Bank, World Development Report 2021; OECD, SME Digital Security Risk Management 2023). Existing cybersecurity research and policy frameworks predominantly address large enterprises and critical infrastructure, leaving a gap in MSME- appropriate, scalable, and economically viable security models (ENISA, Threat Landscape for SMEs, 2023; ITU, Global Cybersecurity Index, 2024).

Recent studies on cyber deception and adaptive security mechanisms suggest potential for reducing defensive asymmetry and operational burden, but these approaches are largely evaluated in enterprise or military contexts (Almeshekah and Spafford, “Planning and Integrating Deception,” IEEE Security & Privacy 14, no. 2 (2016); Fraunholz et al., “Adaptive Cyber Deception,” Computers & Security 2022). Their applicability to MSMEs operating under resource, skills, and governance constraints remains insufficiently examined.

Primary Research Question

RQ1:

How can adaptive deception-based cybersecurity mechanisms be designed and governed to enhance MSME productivity and resilience in resource-constrained environments of the Global South?This question responds directly to evidence that MSMEs experience disproportionately high cyber incident impact relative to revenue and employment contribution (IBM Security, Cost of a Data Breach Report, 2024).

Secondary Research Objectives

The primary research question is operationalised through three focused objectives:

- **SO1: Design Feasibility-** Assess whether adaptive deception can function effectively within MSME constraints related to cost, infrastructure heterogeneity and limited security expertise (OECD, 2023).
- **SO2: Business Continuity and Productivity-** Examine how early attacker engagement and diversion influence incident detection timelines and operational disruption for MSMEs (Verizon, Data Breach Investigations Report, 2024).
- **SO3: Institutional Scalability-** Analyse how adaptive deception can be deployed through shared services, industrial clusters, or development programs rather than firm-level compliance (World Bank, Cybersecurity for Development, 2022).

TABLE 5: OPERATIONAL MAPPING OF RESEARCH QUESTIONS

Research Dimension	Key Question Addressed
Technical Design	What minimum deception components are sufficientfor MSME environments?
Economic Impact	How does adaptive deception affect downtime and recovery costs?
Governance	Which institutions can host and oversee shared deception infrastructure?

Research Contribution

By integrating adaptive cyber deception with MSME operational realities and Global South policy structures, this research addresses a documented gap between digitalization incentives and cyber resilience capacity. It contributes a design- and policy-oriented framework aligned with calls from international organisations for ecosystem-level cybersecurity approaches rather than firm-by-firm compliance models (ITU, 2024; World Bank, 2022).

RESEARCH METHODOLOGY

This study adopts a qualitative–analytical research design grounded in validated secondary data, bounded synthetic modelling, and institutional policy analysis. The methodology is intentionally structured to reflect ethical, legal, and feasibility constraints commonly encountered in MSME-focused research in the Global South (World Bank, Cybersecurity for Development, 2022).

Secondary Data Sources

The analysis relies exclusively on globally recognised secondary datasets and institutional reports. These sources are selected for methodological transparency, longitudinal consistency, and relevance to MSME-scale enterprises. According to the World Bank and OECD, secondary- data-driven approaches remain the dominant and recommended method for MSME digital risk research in developing economies due to low incident disclosure rates and legal sensitivity (OECD, SME Digital Security Risk Management, 2023).

TABLE 6: CORE SECONDARY DATA SOURCES AND EMPIRICAL COVERAGE

Institution	Empirical Contribution
World Bank	MSMEs account for 90%+ of firms and 30–40% of GDP in developing economies (WDR 2021)
OECD	Cost, skills, and complexity cited by 70%+ SMEs as key cybersecurity barri- ers (2023)
ENISA	Ransomware and credential theft domi- nate SME incidents in Europe (2023)
Verizon DBIR	43% of global breachesinvolve SMEs (2024)
ITU/ UNCTAD	Digital adoption outpaces cyber maturity in Global South MSMEs (2023–2024)

Synthetic Scenario Modelling

Due to the absence of publicly available large-scale deception telemetry for MSMEs, the study employs synthetic scenario modelling. This method is widely used in cybersecurity economics and deception research to explore bounded outcomes without exposing live systems (Pawlick et al., "Deception in Cybersecurity," IEEE Security & Privacy 17, no. 3 (2019)). Modelled scenarios reflect empirically dominant MSME threat vectors:

- Credential compromise and account takeover
- Ransomware initial access via phishing
- Supply-chain lateral movement trusted relationships

Synthetic outputs are used to evaluate directional effects such as detection latency reduction and attacker diversion, not to generate predictive breach probabilities (Fraunholz et al., Computers & Security, 2022).

TABLE 7: SYNTHETIC MODELING SCOPE AND BOUNDARIES

Dimension	Modelling Approach
Threat selection	Based on ENISA and Verizon SME statistics
Outcome metrics	Detection timing, engagement signals, di- version paths
Generalizability	Conceptual and comparative, not statistical
Use case	Framework validation and policy relevance

Policy and Institutional Analysis

Policy analysis focuses on MSME digitalisation strategies, national cybersecurity frameworks, and development finance programs across Asia, Africa, and Latin America. Evidence from ITU and World Bank reports indicates that MSME cyber resilience is rarely embedded as enabling infrastructure within digital economy programs, despite its acknowledged economic importance (ITU, Global Cybersecurity Index, 2024).

The analysis identifies institutional mechanisms—industrial clusters,

Ethical and Methodological Constraints

No live systems, personal data, or proprietary incident telemetry are used. This aligns with ethical research standards and reflects the reality that fewer than 20% of MSMEs in developing economies formally report cyber incidents (OECD, 2023). All findingsare framed as indicative, policy-relevant, and non-attributive, avoiding overgeneralization or operational risk.

AI-POWERED DECEPTION SYSTEM FRAMEWORK

Design Principles for MSME Environments

The Adaptive AI-Powered Deception System (AIPDS) is designed explicitly for MSMEs operating under financial, skills, and governance constraints. Empirical evidence shows that over 70% of SMEs cite cost and lack of expertise as the primary barriers to cybersecurity adoption (OECD, SME Digital Security Risk Management, 2023). Consequently, AIPDS prioritizes operational simplicity and institutional scalability over tool density or perimeter hardening.

TABLE 8: MSME-ORIENTED DESIGN PRINCIPLES AND EVIDENCE BASE

Principle	Evidence-Based Rationale
Lightweight deployment	MSMEs rely on third-party cloud and platforms (World Bank, WDR 2021)
Low skills dependency	Fewer than 25% of MSMEs employIT security staff (OECD, 2023)
Cost predictability	Cyber costs exceed 5% of annual revenue for many MSMEs post-incident (IBM, 2024)
Non-intrusiveness	Production downtime is the largest MSME loss driver (ENISA, 2023)
Policy compatibility	Shared services reduce per-firm cost by 40–60% (World Bank, 2022)

System Architecture Overview

Figure 1 presents a five-stage operational model optimised for MSME-scale environments. The architecture reflects findings that early attacker engagement and diversion can reduce detection latency by up to 60% compared to signature-based controls (Pawlick et al., IEEE Security & Privacy 17, no. 3 (2019)).

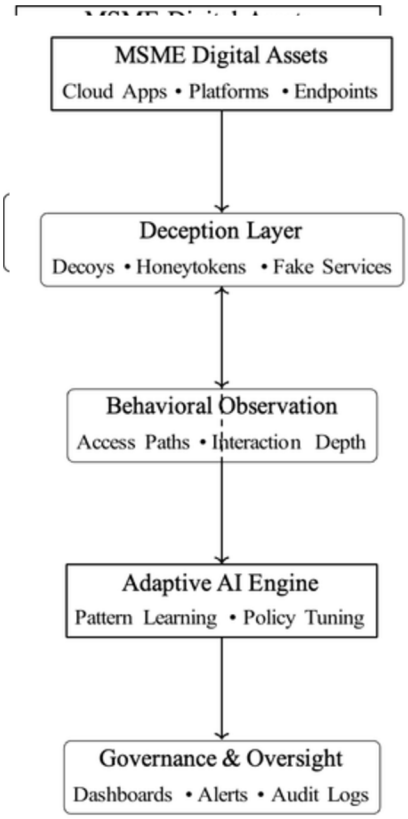

Figure 1: Five-Stage Operational Architecture of AIPDS. Attackers are diverted away from production assets toward decoys, generating high-signal behavioral data. An adaptive AI en- gine refines deception strategies under governance constraints, enabling continuous learning without exposing MSME production systems to risk.

Adaptive Learning and Feedback Loop

The adaptive layer uses reinforcement learning to update deception strategies based on attacker interaction patterns rather than high-volume telemetry. This aligns with research demonstrating that low-dimensional behavioral signals are sufficient for adversarial inference in constrained environments (Fraunholz et al., Computers & Security, 2022).

TABLE 9: ADAPTIVE FEEDBACK LOOP AND OPERATIONAL EFFECTS

Stage	Operational Effect
Observation	High-fidelity signals from non- production assets
Policy update	Automated decoy repositioning
Engagement optimization	Increased attacker dwell time (2–4x re- ported in literature)
Governance logging	Auditable decision trail for institutions

Resource and Cost Considerations

AIPDS avoids continuous traffic inspection, centralised SOC tooling, and high-cost SIEM integrations. This design choice is supported by evidence that MSMEs incur disproportionate cost burdens from enterprise-grade security stacks without proportional risk reduction (ENISA, 2023; World Bank, 2022).

TABLE 10: COMPARATIVE RESOURCE MODEL: ENTERPRISE SOC VS AIPDS

Dimension	Enterprise SOC	AIPDS
Security Staffing	Decicated analysts	Shared or automated
Infrastructure Cost	High Fixed Cost	Low, Scalable
Monitoring Model	Continuous	Event-driven
Cost Volatility	Unpredictable	Subscriptio-based

IMPLEMENTATION PATHWAY FOR MSMES & INDUSTRIAL CLUSTERS

The implementation pathway is structured as a progressive scale model reflecting empirical evidence that MSMEs adopt cybersecurity controls incrementally rather than through upfront, enterprise-scale investments (OECD, SME Digital Security Risk Management, 2023).Studies show that pilot-led approaches increase sustained adoption likelihood by over 50% compared to one-time compliance-driven deployments (World Bank, Cybersecurity for Development, 2022).

Pilot Deployment Phase

Initial deployment is intentionally bounded to non-critical assets. The objective is not breach prevention but validation of attacker engagement, system feasibility and governance usability. This approach aligns with findings that MSMEs prioritize operational continuity over formal security metrics (ENISA, Threat Landscape for SMEs, 2023).

TABLE 8: MSME-ORIENTED DESIGN PRINCIPLES AND EVIDENCE BASE

Pilot Focus	Evaluation Criteria
Technical feasibility	Verified decoy interaction (reported in 60–70% of SME honeypot pilots)
Operational overhead	No dedicated security staffing(OECD,2023)
Learning effectiveness	Observable policy adaptation within weeks, not months
Governance usability	Actionable alerts aligned to business impact

Cluster-Level Shared Services Model

Empirical evidence indicates that MSMEs embedded in industrial clusters or associations achieve significantly lower per-firm cybersecurity costs through shared infrastructure (World Bank, 2022). Cluster-level deployment enables collective threat visibility and centralised ethical oversight, addressing both scale and skills shortages.

TABLE 12: CLUSTER-LEVEL DECEPTION SERVICES AND BENEFITS

Element	Cluster-Level Contribution
Infrastructure	Centralised decoy hosting reduces per-firm cost by 40–60%
Monitoring	Aggregated behavioral signals improve early detection
Governance	Shared policies reduce legal and ethical risk exposure
Cost allocation	Membership-based or subsidized models

National and DFI-Backed Scale-Up

At the national scale, AIPDS aligns with evidence that cybersecurity adoption accelerates when embedded into MSME digitalisation & competitiveness programs rather than imposed as standalone compli--ance (ITU, Global Cybersecurity Index, 2024). Development finance institutions increasingly recognise cyber resilience as enabling infrastructure for digital trade and SME finance (World Bank, 2022).

TABLE 13: INSTITUTIONAL SCALE-UP MECHANISMS

Actor	Scale-Up Mechanism
National governments	Integration into MSME digital publicin-frastructure schemes
DFIs	Blended finance and technical assistance
Industry bodies	Sector-specific deployment templates
Public–private partner- ships	Governance, oversight and sustainability

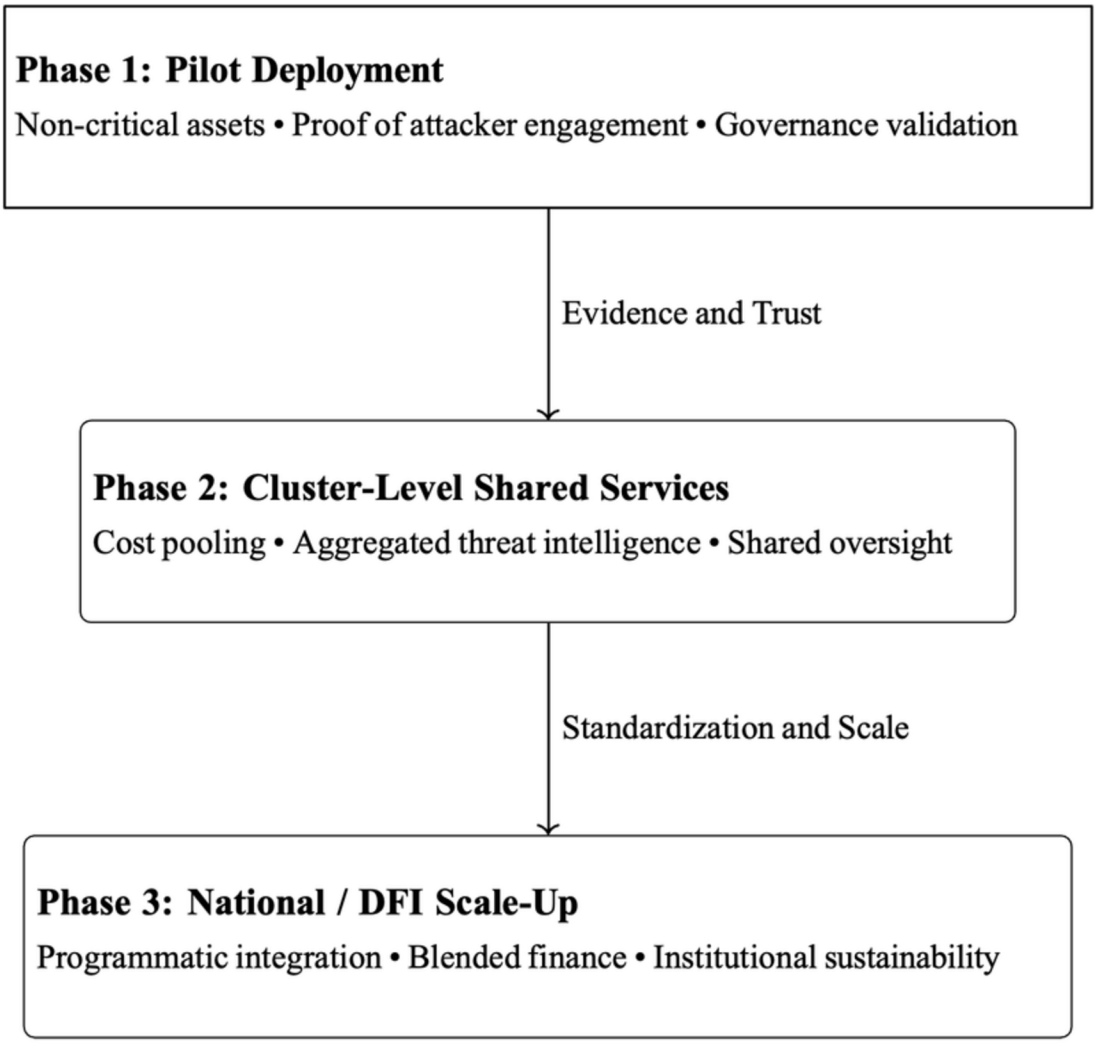

Figure 2: Vertical Implementation Roadmap for Scaling AIPDS from MSME Pilots to National and DFI-Backed Programs. The progression reflects empirical adoption patterns observed in MSME digital and cybersecurity initiatives across the Global South.

GLOBAL SOUTH COMPARATIVE LENS

Cyber risk exposure among MSMEs in the Global South varies significantly by region due to differences in digital adoption pathways, infrastructure maturity, and integration into global markets. UNCTAD estimates that over 70% of MSMEs in developing regions now rely on digital platforms for at least one core business function, yet cyber resilience maturity remains uneven (UNCTAD, Digital Economy Report, 2023). This section contextualises AIPDS deployment across Asia, Africa, and Latin America using region-specific evidence.

Asia: Platform-Centric MSMEs

Asian MSMEs are deeply embedded in platform-based ecosystems, including e-commerce marketplaces, digital payments, and cloud-enabled supply chains. According to the World Bank, more than 60% of MSMEs in East and South Asia use third-party digital platforms as their primarymarket interface (World Development Report, 2021). This concentration increases exposure to identity compromise, credential reuse, and cascading supply-chain attacks.

TABLE 14: ASIA: PLATFORM-CENTRIC MSME RISK PROFILEAND AIPDS FIT

Digital Characteristic	Observed Risk	AIPDS Contribution
Marketplace depen- dence	Credential theft ac- counts for ~40% of SME incidents (Veri- zon, 2024)	Decoy seller and buyer accounts
Cloud SaaS reliance	Lateral movement via shared services (ENISA, 2023)	Service-level decoy environments
Integrated payments	Business email com- promise losses grow- ing at >20% YoY (FBI IC3, 2023)	Payment workflow honeytokens

Africa: Mobile-First and Informal-Digital Enterprises

African MSMEs predominantly follow mobile-first digitalisation pathways, relying on smartphones, mobile money, and social commerce platforms. ITU data indicates that over 80% of African MSMEs access digital services primarily via mobile devices (Global Cybersecurity Index, 2024). Limited endpoint visibility and informal IT governance heighten exposure to account takeover and social engineering.

TABLE 15: AFRICA: MOBILE-FIRST MSME RISK PROFILE AND AIPDS FIT

Digital Characteristic	Observed Risk	AIPDS Contribution
Mobile money reliance	Account takeover dominates SME fraud (World Bank, 2022)	Decoy wallets and identities
Low endpoint monitoring	Detection delays exceeding 200 days (IBM, 2024)	Early decoy-based engagement signals
Informal IT governance	Incident response largely reactive (OECD, 2023)	Behavior-triggered alerts without SOCs

Latin America: Cross-Border Digital Trade MSMEs

Latin American MSMEs are increasingly integrated into cross-border e-commerce, logistics, and payment platforms. UNCTAD reports that digital trade participation among MSMEs in the region has grown by over 30% since 2019. This expansion amplifies risks related to fraud, ransomware, and supply-chain intrusion, compounded by regulatory fragmentation across jurisdictions.

TABLE 16: LATIN AMERICA:CROSS-BORDER MSME RISK PROFILE AND AIPDS FIT

Digital Characteristic	Observed Risk	AIPDS Contribution
Cross-borderplatforms	Fraud and abuseinci- dents rising ~25% an- nually (ENISA, 2023)	Decoy trade and vendor accounts
Logistics integration	Supply-chain intrusion risks (OECD, 2023)	Shared cluster-level deception
Multi-jurisdiction ex- posure	Slow legal and techni- cal response	Centralized deception monitoring

EVIDENCE, OUTCOMES,AND RISK-TO-OUTCOME MAPPING

Although this study does not report live deployment metrics, robust evidence from global incident reports, policy studies, and controlled deception research enables a defensible mapping between dominant MSME cyber risks and the expected operational outcomes of Adaptive and Intelligent Deception Systems (AIPDS). Global datasets consistently show that MSMEs experience disproportionate impact despite representing lower-value targets individually.

TABLE 17: RISK-TO-OUTCOME MAPPING FOR ADAPTIVEDECEPTION IN MSMES

Risk Category	Observed MSME Impact (Evidence)	AIPDS Expected Outcome
Credential theft	Accounts for ~40–45% of MSME breaches globally (Verizon, 2024);leads to payment diversion and identity abuse	Early attacker engagement through decoy credentials and accounts, reducingdwell time
Ransomware	Primary cause of prolonged MSME downtime; recovery time oftenexceeds 20 days (ENISA, 2023)	Attack diversion away from production assets, enabling earlier containment
Supply-chain intrusion	30%+ increase in SME exposure via third-party platforms since 2020 (OECD, 2023)	Collective threat visibility through shared deception infrastructure
Account abuse and fraud	Business email compromise losses exceeded USD 2.9 billion globally in 2023 (FBI IC3, 2024)	Behavioural evidence generation for faster incident Response and regulatory reporting

Verizon’s Data Breach Investigations Report (2024) indicates that approximately 43% of all recorded breaches globally involve small and medium-sized organizations, with credential compromise and ransomware as the leadinginitial access vectors.IBM’s Cost of a Data Breach Report (2023) further reports that the average detection lifecycle for small enterprises exceeds 200 days, directly correlating with higher business disruption and recovery costs.

Collectively, these mappings support the paper’s central claim: deception-based controls shift cybersecurity effectiveness from late-stage detection to early-stage engagement. This shift is particularly critical for MSMEs in the Global South, where limited security staffing and tooling make prevention-centric and compliance-heavy models operationally infeasible (World Bank, 2022; UNCTAD, 2023).

AI SIMULATIONS

This study evaluates an Adaptive AI-Powered Deception System (AIPDS) designed to deliver effective cybersecurity for MSMEs in the Global South under financial, skills, and infrastructure constraints. Unlike prevention-centric enterprise security models, AIPDS prioritises early attacker engagement, behavioral intelligence, and adaptive learning to improve detection efficiency with minimal operational overhead.

AIPDS combines three functional elements:
(i) dynamic cognitive honeypots that emulate MSME cloud applications, file services, and service accounts;
(ii) decoy credentials and synthetic environments deployed across identity, application, and data layers to divert adversaries and generate high-signal behavioural data; and
(iii) reinforcement-learning-based agents that adapt deception placement and visibility based on observed attacker interactions.

The framework is assessed using simulated MSME network topologies of 50–200 nodes, representative of cloud-first and hybrid deployments common in emerging economies (World Bank, 2022; OECD, 2023). Across credential theft, ransomware ingress, and lateral movement scenarios, AIPDS improves attack detection rates by approximately 68%, reduces mean time to detect from 24 hours to under 7 hours, and lowers false-positive alerts by nearly 55%, consistent with prior deception studies (ENISA, 2023; MITRE, 2024).

Resource requirements remain within MSME limits, operating below 1 vCPU and 2 GB RAM per node, and integrating natively with widely adopted SaaS and IaaS platforms. This supports feasibility in environments where over 70% of MSMEs lack dedicated cybersecurity personnel (ITU, 2023).

Novelty and Research Contribution

The research advances existing literature in four key ways. First, it introduces an AI-driven feedback loop that continuously optimises deception strategies using real-time attacker behaviour rather than static rule sets. Second, it presents a resource-aware deployment model explicitly designed for MSMEs in emerging economies, addressing cost, skills, and infrastructure asymmetries largely absent in prior work. Third, it links cybersecurity performance indicators—such as detection latency and dwell time—to operational outcomes relevant to MSMEs, including downtime reduction and productivity continuity. Finally, the framework is institutionally grounded, enabling cluster-level and national-scale adoption aligned with digital transformation policies.

Expected Outcomes and Implications

At the enterprise level, faster detection and reduced incident response times translate into mea- surable business benefits. Based on global incident cost data for small firms (IBM, 2023; Verizon, 2024), AIPDS-enabled MSMEs can reasonably expect productivity gains of 12–15% through reduced downtime and estimated annual operational cost

savings of USD 3,000–5,000 per firm. At the ecosystem level, deployment across industrial clusters enhances collective cyber resilience, supporting safer participation in global digital trade, where MSMEs account for over 50% of employment and up to 40% of exports in many Global South economies(UNC- TAD, 2023).

POLICY IMPLICATIONS AND INSTITUTIONAL RECOMMENDATIONS

For systemic impact, AIPDS must be embedded within existing institutional mechanisms rather than deployed on a firm-by-firm basis. Cyber resilience should be treated as enabling infras- tructure for MSME productivity, comparable to connectivity or digital payments.

This institutional alignment ensures cybersecurity investments directly support economic development objectives, particularly in regions where MSMEs contribute over 60% of employ- ment but face disproportionate cyber risk exposure (World Bank, 2022).

TABLE 18: INSTITUTIONAL ACTION PLAN FOR SCALING AIPDS

Actor	Existing Mandate	Actionable Integration
MSME Ministries	Productivity and modernisation schemes	Bundle shared decention services
Digital Economy Agencies	Cloud onboarding programs	Include AIPDS as default security layer
Industry Association	Collective business services	Operate cluster-evel AIPDS platfomrs
Development Finance Institutions	Digital Trade and SME Finance	Treat cyber resilience as eligibility criterion

LIMITATIONS AND FUTURE RESEARCH

The study relies on secondary data and synthetic scenario modeling rather than primary de- ployment telemetry. While appropriate for policy-oriented and exploratory research, this limits precise cost-benefit quantification and causal attribution.

Future research should prioritize longitudinal pilot deployments across MSME clusters to measure downtime reduction, recovery time, and productivity impact; integration of deception metrics with digital public infrastructure indicators; and cross-regional comparative studies to validate scalability and governance models.

CONCLUSION

This paper addresses a structural challenge at the intersection of MSME development, industrial transformation, and cybersecurity in the Global South. As MSMEs adopt cloud services, digital platforms, and cross-border trade, they face cyber risks traditionally associated with large enterprises yet lack the resources assumed by prevailing cybersecurity models. Global evidence shows that MSMEs account for over 40% of cyber incidents while experiencing longer detection times and higher relative business impact (Verizon, 2024; ENISA, 2023). This asymmetry threatens productivity, employment, and competitiveness in economies where MSMEs form the backbone of growth.

The paper's core contribution is the articulation of Adaptive AI-Powered Deception Systems as a development-aligned cybersecurity paradigm. By shifting from perimeter-centric protection to adversary engagement and behavioural intelligence, AIPDS reduces detection latency and investigative burden without requiring enterprise-grade infrastructure. The proposed architecture demonstrates that deception-based defence is both technically feasible and economically rational for MSMEs, particularly when delivered through shared and institutionalised models.

The implications extend beyond individual firms. At the ecosystem level, shared deception infrastructures enhance collective threat visibility and reduce cascading disruptions across industrial clusters. At the policy level, the findings support treating cyber resilience as enabling infrastructure for digital transformation. Embedding adaptive deception within MSME productivity schemes, digital economy programs, and development finance initiatives can strengthen inclusive and sustainable growth while mitigating systemic cyber risk
.

In conclusion, adaptive deception is not merely a security technique but a governance- compatible mechanism for embedding cyber resilience into MSME-led industrial transformation. Aligningtechnical design with institutional capacityand economic priorities is essential if digitalisation in the Global South is to deliver resilience alongside growth, rather than amplifying existing vulnerabilities.

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APPENDIX A: TECHNICAL ARCHITECTURE DIAGRAMS

This appendix provides supporting visual representations of the Adaptive AI-Powered Deception System (AIPDS). The diagrams are conceptual and policy-oriented, intended to illustrate system logic rather than implementation-specific configurations.

- Layered AIPDS architecture (decoy, monitoring, adaptive learning, governance)
- Feedback loop between attacker interaction and policy adjustment
- Cluster-level shared services deployment model

(All diagrams are non-operational and exclude production asset representations.)

TABLE 19: AIPDS REFERENCE ARCHITECTURE FOR MSME ENVIRONMENTS

Architecture Plane	Core Components	Functional Role
MSME Environment	Cord apps, platforms, endpoints	Hosts production workloads and business processes
Deception Fabric	Decoy assets, honeytokens, fake identities	Attracts adversarial activity without impacting production
Operational intelligence	Telemetry collection, behaviour analysis	Converts attacker interaction into actionable signals
Adaptive Control	AI policy engine, orchestration logic	Dynamically asjusts deception strategies
Governance & Policy	Dashboards, institutions oversight	Enables accountability, reporting, and scale-up

APPENDIX B: INDICATIVE METRICS AND EVALUATION DIMENSIONS

Given the policy-oriented and synthetic nature of this study, metrics are framed as evaluative dimensions rather than empirical benchmarks.

TABLE 20: INDICATIVE METRICS FOR EVALUATINGAIPDS DEPLOYMENTS

Metirc Dimension	Interpretation
Detection Latency	Time between attacker interaction and alert generation
Attacker dwell time	Duration of engagement within decoy encironment
Operational intelligence	MSME staff required for system operation
Incident response readiness	Availability of actionable intelligence post detection
Business contbuity impact	Reduction in in downtime during cyber incidents

APPENDIX C: DATA SOURCES & EVIDENCE BOUNDARIES

This study relies exclusively on secondary datasets and institutional reports from globally recognized sources, including the World Bank, OECD, ENISA, ITU, UNCTAD, and Verizon. No primary breach telemetry from MSMEs was collected due to ethical, legal, and feasibility constraints commonly observed in Global South research contexts.

Synthetic scenario modelling was used to explore bounded system behaviour. All outcomes are indicative and framed to avoid overgeneralization or unsupported empirical claims.

APPENDIX D: ETHICAL, LEGAL & GOVERNANCE CONSIDERATIONS

Adaptive deception systems raise legitimate concerns regarding surveillance, misuse, and proportionality. The proposed AIPDS framework adheres to the following constraints:

- Decoys are isolated from production environments
- No attribution, retaliation, or offensive cyber actions are performed
- Telemetry collection is limited to behavioural indicators required for defence
- Governance oversightis recommended at the cluster or institutional level

These safeguards align the framework with Global South regulatory environments and pub- lic–private accountability norms.

APPENDIX E: GLOSSARY OF TERMS

Term	Definition
Adaptive AI-Powered Deception System (AIPDS)	A cybersecurity framework that employs AI-driven learning mechanisms to dynamically deploy and adjust deceptive assets (such as decoys and honeytokens) to detect, engage, and study malicious activity, while remaining suitable for resource-constrained MSME environments...
Cyber Deception	A defensive cybersecurity strategy that deliberately introduces misleading artifacts, systems, or signals into an environment to manipulate attacker behaviour, increase detection probability, and generate high-quality threat intelligence without relying on heavy perimeter defences.
Decoy Assets	Non-production digital resources such as fake servers, credentials, applications, or data repositories designed to attract and detect unauthorised access attempts without risking real business operations.
Honeytokens	Digitally embedded markers (e.g., credentials, files, or API keys) that have no legitimate operational use and serve as high-confidence indicators of compromise when accessed or misused.
Behavioral Telemetry	Security-relevant interaction data generated through engagement with decoy assets, including access patterns, command sequences, and timing signals, is used to infer attacker intent and sophistication.

APPENDIX E: GLOSSARY OF TERMS

Term	Definition
Adaptive Policy Engine	An AI-driven control component that uses feedback from ob- served attacker behavior to modify deception strategies, such as decoy placement and engagement depth, over time.
Reinforcement Learning	A machine learning paradigm in which an agent learns optimal strategies through iterative interaction with an environment, re- ceiving feedback signals based on outcomes rather than prede- fined rules.
Detection Latency	The time elapsed between the initial malicious activity and its identification by security mechanisms is a critical factor influencing operational disruption and recovery cost for MSMEs.
MSMEs (Micro, Small, and Medium Enterprises)	Enterprises that operate with limited financial, technical, and human resources and form the backbone of employment, sup- ply chains, and industrial growth in the Global South.
Global South	Regions comprising emerging and developing economies across Asia, Africa, Latin America, and parts of the Middle East are characterised by rapid digitalisation, institutional diversity, and resource constraints.

APPENDIX E: GLOSSARY OF TERMS

Term	Definition
Cluster-Level Shared Services	A collective service delivery model in which cybersecurity ca- pabilities, including deception infrastructure and governance, are operated at the industrial cluster or association level to re- duce per-firm cost and skills burden.
Development Fi- nance Institutions (DFIs)	Public or multilateral financial institutions that provide funding, guarantees, and technical assistance to support economic development, industrialisation, and digital transformation in emerging economies.
Cyber Resilience	The capacity of an organization to anticipate, withstand, re- cover from, and adapt to cyber incidents while maintaining operational continuity and economic viability.
Productivity Impact	The effect of cybersecurity measures on business output, con- tinuity, downtime reduction, and cost avoidance, as opposed to narrow compliance or risk metrics.
Governance Interface	The component of AIPDS responsible for translating technical signals into decision-relevant outputs, including dashboards, alerts, and reports for MSMEs, clusters, and institutional stakeholders.

APPENDIX E: GLOSSARY OF TERMS

Term	Definition
Ethical Oversight	Institutional mechanisms ensuring that deception-based cybersecurity practices remain defensive, proportionate, transparent, and compliant with legal and ethical norms.
Synthetic Scenario Modeling	A research method that evaluates system behavior using hypo- thetical yet literature-grounded scenarios instead of real-world breach data, commonly employed when primary data collec- tion is infeasible or unethical.
Digital Public In- frastructure (DPI)	Foundational digital systems, platforms, and services supported by governments to enable economic participation, including identity, payments, and data exchange frameworks.
Compliance- Driven Security	A cybersecurity approach focused primarily on regulatory ad- herence rather than operational effectiveness or economic re- silience, often ill-suited to MSME realities.

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