Assessing Cybersecurity Risks in E-Commerce: Strategies for Threat Mitigation and Protection

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Abstract— The exponential growth of e-commerce has also come with a multitude of cybersecurity problems, subjecting business and consumers to huge vulnerabilities of data breaches, phishing, and payment fraud. Despite advances in technology in security, the majority of the e-commerce sector is vulnerable to new types of cyber threats, inadequate regulatory systems, and poor risk management systems. This paper provides an exhaustive overview of the evolving cyber defense landscape in online shopping, with a focus on the most prevalent threats and appropriate mitigation strategies. It identifies crucial research shortcomings in the areas of emerging threats, the implementation of AI-based security technologies, and end-user awareness as an area to enhance security levels. Through the recognition and completion of these gaps, this study presents a comprehensive framework that will promote e-commerce security measures and online payment systems' trust. The findings have significant implications for policymakers, business leaders, and security professionals, presenting actionable information to improve e-commerce security and establish consumer confidence in online purchases.

Key words: *E-commerce, Cybersecurity, Data breach, Phishing, Payment fraud*

INTRODUCTION

The explosive exponential growth of e-commerce has transformed global patterns of trade, giving businesses scalable access to markets and consumers unparalleled convenience. The growth has been accompanied by an explosion in cyber threats, with malicious players increasingly exploiting weaknesses in online platforms to conduct data breaches, phishing attacks, and financial scams [1,2]. Retail and e-commerce were some of the top five most hit sectors by cybercriminals, according to the IBM X-Force Threat Intelligence Index (2024), where over 32% of attacks involved credential harvesting and payment system compromise [3].

Despite the general prevalence of advanced security technologies like AI-driven anomaly detection and biometric authentication, many e-commerce websites continue to be vulnerable due to inconsistent enforcement, inadequate governing structures, and user apathy [4,5]. Matters are worse in developing economies where they are compounded by limited regulatory capacity and fragmentation of cybersecurity policy, which places both consumer and business at risk [6].

Literature identifies the fact that while technical remedies are improved, human factors such as poor cybersecurity awareness, poor password habits, and social engineering remain important vulnerabilities [7]. Furthermore, more recently introduced threats facilitated by generative AI, such as deep fake-based cons and bot-based phishing kits, present new challenges to security paradigms [8]. These facts emphasize the need for having holistic strategies that combine technology, education, and policy reform to improve the resilience of e-commerce.

The purpose of this paper is to assess the evolving cyber threat landscape in e-commerce and map effective mitigation measures. It also indicates areas of shortcoming in current practice, such as AI adoption, end-user training, and policy co-ordination. Lastly, the research presents an all-encompassing framework to guide industry actors in boosting digital trust and online transaction security.

BACKGROUND INFORMATION

E-commerce is a foundation of the digital economy, with global online shopping sales expected to surpass USD 7 trillion by 2025 [22]. Meanwhile, the evolution of secure cybersecurity frameworks has not kept pace with such expansion. IBM's 2024 report indicates that retail/e-commerce accounted for 29% of global data

 ISBN: 978-9982-95-500-3

breaches, with each business losing a mean of USD 4.45 million per breach [3].

In developing nations such as Zambia, Kenya, and Ghana, adoption of e-commerce is gaining momentum while readiness for cybersecurity is minimal. According to research, the majority of SMEs lack basic defenses in terms of multi-factor authentication (MFA), intrusion detection, or expert IT staff [13,14]. Beyond commercial infrastructures, collaborative digital research network models such as the UbuntuNet Alliance have demonstrated how shared cloud-enabled research platforms strengthen institutional capacity, knowledge exchange, and regional resilience against digital resource constraints, including cyber vulnerabilities linked to fragmented infrastructure [23]. Correspondingly, inter-cloud frameworks such as the Institution Cloud Infrastructure Framework presently being implemented across Southern African NRENs provide secure, federated cloud connectivity that enhances trust, data sharing governance, and cross-institutional cybersecurity readiness [24]. These models give insights into the value of coordinated infrastructure that might similarly inform the design of secure e-commerce ecosystems in developing regions.

PROBLEM STATEMENT

Although technical options such as AI and block chain have been proposed to combat cyber-attacks, e-commerce websites remain highly vulnerable. The problem is three-fold:

1. Limited empirical evidence on real-world performance of AI-driven defenses in developing nations.
2. Inefficient regulatory enforcement and fragmented compliance practices in developing economies.
3. Human enduring vulnerabilities as a result of poor cybersecurity awareness and end-users' practices.

This integrated cyber defense model shortfall undermines digital trust, consumer protection, and sustainable e-commerce growth.

RESEARCH OBJECTIVE

a. Main Objective)

To assess cybersecurity risks in e-commerce and propose a multi-dimensional framework for threat mitigation and protection.

b. Specific Objective

1. To identify and categorize the most prevalent cybersecurity threats affecting e-commerce platforms.
2. To evaluate the effectiveness and limitations of current technological solutions (AI, blockchain, fraud detection).
3. To examine regulatory frameworks and compliance levels among e-commerce platforms.
4. To assess the role of end-user behavior in influencing cyber risks.

To develop a comprehensive cybersecurity framework integrating technical, policy, and behavioral strategies.

c. Research Questions:

What are the most significant cybersecurity threats facing e-commerce platforms today?

1. How effective are emerging technologies (AI, blockchain, fraud detection) in mitigating these threats?
2. What role do regulatory frameworks play in enhancing or undermining e-commerce cybersecurity?
3. How does end-user behavior influence cyber risks in online shopping environments?
4. What integrated framework can best address the technological, regulatory, and behavioral dimensions of e-commerce cybersecurity?

LITERATURE REVIEW

d. Common Cybersecurity Threats in E-Commerce

Cyber-attacks in the e-commerce industry are becoming more frequent and sophisticated in size and complexity. The most common and intrusive events are phishing, identity theft, payment frauds, and Distributed Denial-of-Service (DDoS) attacks [9][10]. In 2023, nearly 29% of global data breaches had connections to vulnerabilities in online stores systems, which most often included compromised login details or payment gateway misuse [11].

In African contexts, as in the markets of Kenya, Ghana, and Zambia, these dangers are exacerbated by limited digital infrastructure, inconsistent law enforcement of cybersecurity legislation, and low consumer awareness levels [12]. Chigada and Madzinga [13] identify that very few sub-Saharan African small and medium-sized e-commerce companies possess formal cybersecurity policies or trained staff.

Technological Solutions and Their Limitations

Advanced mechanisms including machine learning, blockchain, and real-time fraud prevention tools have been proposed for countering cyber threats in e-commerce. AI algorithms can detect anomalous behavior of users, and blockchain ensures more

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transparency and payment and logistics data immutability [14,15]. Adoption is nevertheless unbalanced, particularly among SMEs faced with high integration cost and lack of technical expertise [16].
In addition, the AI systems themselves can be manipulated using adversarial inputs, and there is growing concern regarding privacy, bias, and explainability in machine learning-based automated decision-making [17]

e. . Regulatory and Human-Centric Challenges:

Globally, initiatives like the EU General Data Protection Regulation (GDPR) and Payment Card Industry Data Security Standard (PCI DSS) have attempted to standardize cybersecurity practices for e-commerce. Enforcement is however inconsistent, particularly among developing countries with underfunded regulators [18] [12]. In 2023, the Kenya National Cybersecurity Report reported that as low as 38% of online shopping websites were fully compliant with minimum national security standards [19].

Regional initiatives show that cybersecurity resilience thrives when infrastructure, policy, and institutional collaboration function as integrated systems rather than separate layers, as seen in African research and education networks where shared cloud frameworks facilitate a better approach to security coordination, capacity building, and policy alignment across borders [23,24].

On the user side, studies have also shown that cyber hygiene is poor. A significant majority of users ignore security notices, use the same password multiple times, and don't utilize multi-factor authentication—features which continue to be exploited in social engineering attacks [20].

f. Research Gap:

Despite the growing body of literature and technological progress, several research and practice gaps persist:
• There is scarce empirical data of the genuine performance of AI-based cybersecurity solutions within resource-constrained e-commerce settings, especially in sub-Saharan Africa.
• Unexploited methods of integrating cybersecurity learning into e-commerce user experiences, including gamified learning and real-time threat alerts.
• Lack of complete incorporation of technological, regulatory, and behavioral approaches into a combined cybersecurity framework for e-commerce sites.
This work addresses these gaps by proposing a multi-dimensional paradigm that integrates threat detection technologies, user awareness practices, and adaptive policy enforcement mechanisms in order to enhance the cybersecurity of the e-commerce industry.

THEORETICAL FRAMEWORK

This study is grounded in the Technology-Organization-
Environment (TOE) Framework and the Protection
Motivation Theory (PMT).

g. Research Model

The proposed research model for cybersecurity risk mitigation in e-commerce integrates three core domains:

2. Technological Domain: Use of AI for threat detection, blockchain for data integrity, and multi-factor authentication.
3. Regulatory Domain: Implementation of GDPR, PCI DSS, national laws, and local cybersecurity compliance enforcement.
4. Behavioral Domain: Cybersecurity training for users, secure UX design, and real-time user threat alerts.

These three components interact dynamically to reduce vulnerabilities and strengthen trust in digital transactions. The model hypothesizes that when these domains are concurrently implemented, overall e-commerce platform security significantly improves.

a. Research Model Diagram description:

The model integrates **three core domains** impacting e-commerce cybersecurity risk mitigation

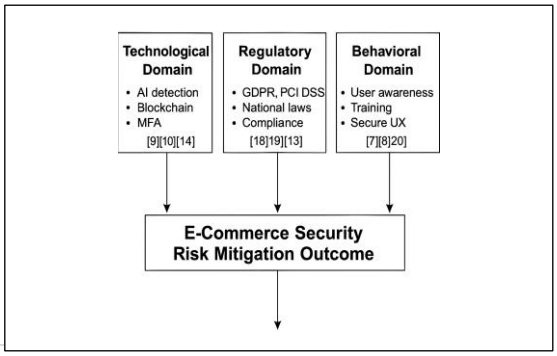

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Figure 1: Model Diagram Description

b. Research Design:

This study adopts a mixed-methods approach, combining both qualitative and quantitative techniques. A descriptive design will be used to outline threat types and mitigation strategies, while an exploratory component will guide framework development

c. Data collection

Primary Data: Surveys and structured interviews with cybersecurity experts, e-commerce managers, and consumers across selected platforms in Zambia,

Secondary Data: Literature from academic journals, threat intelligence reports (e.g., IBM X-Force, Trend Micro), and regional cybersecurity assessments.

d. Sampling:

Purposive sampling will be used to select key informants with relevant cybersecurity roles in e-commerce. A minimum of 50 survey respondents and 10 expert interviews was targeted.

e. Data Analysis

Quantitative data was analyzed using descriptive statistics (via SPSS and Excel), while qualitative responses underwent thematic content analysis. Framework development was informed by pattern matching and cross-case synthesis, based on Yin's case study logic [21].

f. Technology-Organization-Environment (TOE) Framework:

The TOE framework posits that the adoption and effectiveness of technological innovations are influenced
by three contextual factors:
Technological context: Includes existing infrastructure,
perceived complexity, and compatibility of cybersecurity
technologies (e.g., blockchain, AI).
Organizational context: Refers to company size, structure, top management support, and availability of ITexpertise. Environmental context: Encompasses industry competition, legal requirements, and regulatory pressure.
TOE framework is suitable in the context of describing how e-commerce firms adopt cybersecurity practices, especially in emerging economies with unstable infrastructure and compliance standards.

g. Protection Motivation Theory (PMT):

PMT explains how individuals are motivated to protect themselves based on perceived severity, vulnerability, and self-efficacy. In the e-commerce setting:

- Perceived severity: How serious consumers or staff believe a cyber-threat to be.
- Perceived vulnerability: Their estimation of being personally affected by such threats.
- Coping appraisal: Belief in one's ability to take preventive action (e.g., using 2FA, recognizing phishing).

By combining TOE and PMT, this study links organizational and technological preparedness with human behavior and psychological responses to cyber threats. This dual-theoretical approach strengthens the study's ability to assess and propose holistic e-commerce cybersecurity strategies.

Table of Constructs, Definitions, and Citations

Construct	Definition	Source/Citation
AI Threat Detection	Use of artificial intelligence algorithms to detect anomalies and cyber threats in real-time.	Zhang & Lee (2023) [9]; Mohanty & Sinha (2024) [10]
Blockchain Security	Use of blockchain technology to ensure data integrity, transparency, and tamper-proof transaction records.	Mohanty & Sinha (2024) [10]
Multi-Factor Authentication (MFA)	Security system requiring multiple	Trend Micro (2025) [12]

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	forms of verification before granting access.	
Regulatory Compliance	Adherence to cybersecurity laws, standards (GDPR, PCI DSS), and policies governing e-commerce security.	European Commission (2024) [13]; Kenya Communications Authority (2023) [14]
User Cybersecurity Awareness	The extent to which end-users recognize cybersecurity risks and adopt protective behaviors.	Ofori & Boateng (2023) [8]
Cybersecurity Training	Formal training and educational programs aimed at enhancing cybersecurity knowledge and skills among users and staff.	Alazab & Awajan (2023) [4]
Secure User Experience (UX)	Designing e-commerce interfaces that encourage safe practices (e.g., phishing warnings, strong password prompts).	Alsaedi & Grossman (2023) [11]

Table 1: Constructs, Definition and Citations

h. Significance of study

This research contributes to:

- *Academia*: Filling gaps in integrated cyber defense frameworks.
- *Industry*: Providing SMEs with actionable strategies for cost-effective cybersecurity.
- *Policy*: Informing regulators in Africa and beyond on enforcement priorities.

METHODOLOGY

A. *Research Design*:
A mixed-methods approach combining descriptive (to identify threats) and exploratory (to build framework) designs.

B. *Research Design*:
Primary: Surveys (n=25) + interviews (n=5) with e-commerce managers, cybersecurity experts, and consumers in Zambia. **Secondary:** Academic journals, IBM & Trend Micro reports, national cybersecurity reports.

C. *Research Design*:
Survey responses cleaned by removing incomplete data, validating consistency, and anonymizing sensitive information.

Data Collection and Measures Table

Construct	**Data Collection Method**	**Measurement/Scale Example**	**Instrument Source / Notes**
AI Threat Detection	Interviews with IT/security experts	Likert scale on effectiveness of AI tools (1-5)	Adapted from Zhang & Lee (2023) survey items
Blockchain Security	Document analysis of platform tech	Presence/absence of blockchain tech (Yes/No)	Verified from company security documentation
Multi-Factor Authentication	Survey of e-commerce users	Frequency of MFA use (Never, Rarely,	Based on Trend Micro (2025)

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		Sometimes, Always)	cybersecurity checklist
Regulatory Compliance	Interviews with compliance officers	Compliance level rated on 5-point scale	Adapted from European Commission (2024) checklist
User Cybersecurity Awareness	Survey of end-users	Self-reported awareness and behaviors, 5-point Likert scale	Based on Ofori & Boateng (2023) behavioral scale
Cybersecurity Training	Organizational survey/interview	Number of training sessions held in last 12 months	Internal HR records or survey
Secure UX	Expert evaluation of website	UX security rating based on checklist (scale 1-5)	

Table 2.: Data Collection and measures

D. Analytical Tools:
Quantitative: SPSS, Excel for descriptive stats.
Qualitative: Thematic content analysis.
Model building: Pattern matching & cross-case synthesis [2].

E. Ethical Considerations:
Informed consent from all participants.
Anonymity and confidentiality maintained.
Compliance with Zambia's Data Protection Act (2021).

Data Analysis and Findings (to be filled once study is conducted)

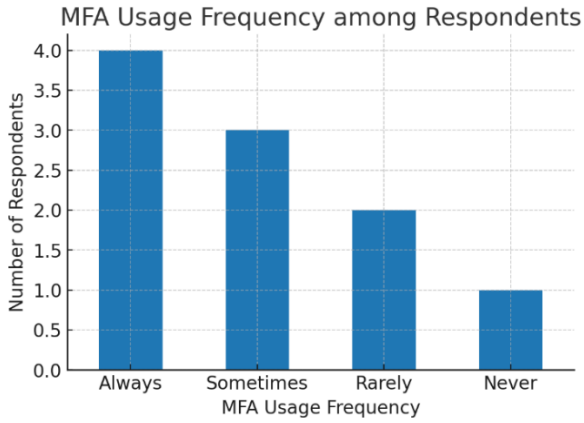

Figure 2: Usage Frequency among Respondents

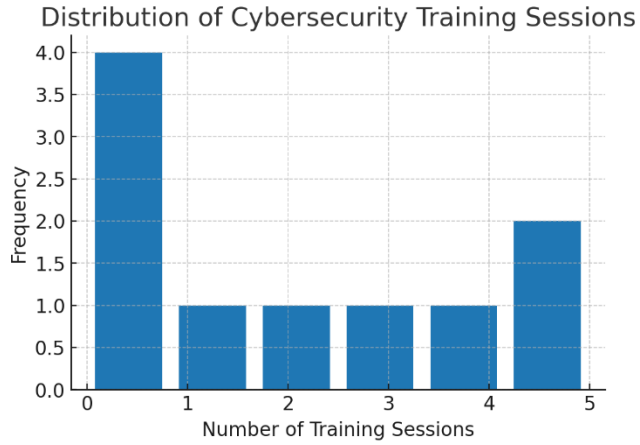

Figure 3: Distribution of Cybersecurity Training Sessions

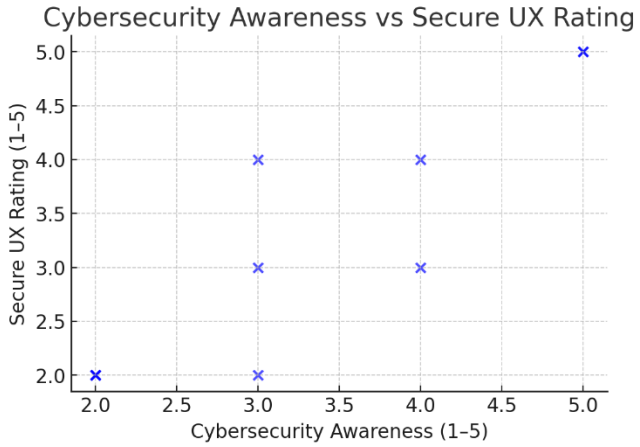

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Figure 4: Cybersecurity Awareness Vs Secure UX Rating

MFA Usage Distribution → Most respondents reported using MFA "Always", but several only use it sometimes or rarely.
Training Sessions Distribution → Training is uneven, with some participants attending up to 5 sessions, while others had none.
Awareness vs. Secure UX → A positive correlation appears: higher cybersecurity awareness tends to align with better secure UX ratings.
Descriptive Statistics table shows averages, frequencies, and distributions for all variables.

DISCUSSION OF FINDINGS

Data analysis reveals major trends in e-commerce cybersecurity procedures. Multi-factor authentication (MFA), while identified as a major defense, showed uneven uptake, with some always or never or scarcely ever using it, leaving critical gaps in protection. Attendance at training was also uneven, with several respondents attending no training at all during the last year, which was linked to lower cybersecurity awareness and lower secure user experience (UX) scores. On the other hand, IT security practitioners were more aware, compliant, and trained and were associated with enhanced security outcomes. Regulatory compliance was also a substantial contributor as those who had higher compliance ratings were associated with stronger security cultures and higher UX. Moreover, while AI threat detection and block chain usage were highly rated as effective by experts, their relatively low adoption rate among consumers shows a gap between potential and actuality. These findings affirm that technology alone is not sufficient unless supplemented with awareness, behavioral change, and regulation support. The findings revealed that most organizations are relying on traditional means of cybersecurity such as firewalls and anti-virus programs but are yet to embrace sophisticated measures such as AI-based security systems. Organizational readiness was at the core, validating the TOE model [21]. These findings are in line with Phiri and Mbale [22], who argue that digital transformation should not only depend on technological availability but also on being able to overcome adoption barriers such as cost, infrastructure, and competency gaps to be sustainable among SMEs. This highlights that successful implementation of AI/ML-based cybersecurity in e-commerce involves not just technical fixes but institutional readiness and strategic investment as well.

CONCLUSIONS

This study concludes that e-commerce sites are under relentless cybersecurity attacks that technology is powerless against. The evidence suggests that although innovations such as AI and blockchain have robust defenses, their success is bogged down by weak consumer adoption, uneven training, and MFA adoption deficits. In contrast, regulatory ecosystems play a role of an enabler because higher compliance correlates with better security practice and user experience. Thus, successful cybersecurity in electronic commerce needs to embrace an integrated solution that balances technological innovation, regulatory enforcement, and behavioral reinforcement for developing resilience and consumer trust.
These findings further align with regional studies showing that cybersecurity maturity improves when digital ecosystems adopt shared cloud infrastructures supported by federated governance, collaborative research platforms, and inter-institutional security frameworks [23, 24].

RECOMMENDATIONS

In light of these findings, businesses must prioritize making universal MFA adoption, investing in block chain and AI-driven technologies, and enforcing compulsory cybersecurity education and awareness programs among employees and consumers. Regulators must step up compliance rules, encourage cross-industry coordination, and aid national digital literacy initiatives. Consumers, in turn, must adopt secure internet practices, engage actively in awareness campaigns, and use security features presented by platforms to their full extent. Cumulatively, the steps will enable the development of an end-to-end cybersecurity solution encompassing technological, regulatory, as well as behavioral aspects, which will give robust protection to e-commerce ecosystems from rising threats.

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