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Empirical Study of Cyber Incident Management Systems in Higher Education Institutions (HEIs) in Kenya

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Abstract

Kenyan universities are increasingly integrating digital technologies into their academic and administrative operations. However, this digital transformation has exposed institutions to escalating cybersecurity threats, including data breaches, ransomware attacks, and unauthorized access to critical information. This study evaluates the effectiveness of existing cybersecurity measures and incident management systems in Kenyan universities, aiming to identify key vulnerabilities and areas for improvement. A structured survey was conducted among IT personnel from four major Kenyan universities, gathering data on cybersecurity preparedness, existing frameworks, and incident response strategies. The sampling process ensured proportional representation across public and private universities, considering factors such as infrastructure and regional diversity. Additionally, this group was vital for the research as they possess first-hand experience and knowledge about the existing cybersecurity infrastructure, threat detection capabilities, and incident response mechanisms within their respective institutions. The study utilized descriptive statistical analysis, correlation analysis, and regression modelling to assess the effectiveness of cybersecurity frameworks such as NIST Cybersecurity Framework, MITRE ATT&CK, and the Cyber Kill Chain Framework in the university context. The findings indicate that although universities have implemented basic cybersecurity measures such as firewall protections and access controls, there are significant gaps in real-time threat detection, incident response preparedness, and cybersecurity training programs. Many institutions lack dedicated cybersecurity teams, and incident response mechanisms are largely reactive rather than proactive. Additionally, limited financial and technical resources hinder effective implementation of cybersecurity policies. This paper highlights critical deficiencies in cybersecurity frameworks currently in use and emphasizes the need for real-time monitoring systems, improved staff training, and the adoption of automated threat detection tools. The study recommends a multi-stakeholder approach involving universities, government agencies, and cybersecurity experts to enhance resilience against evolving cyber threats. Addressing these gaps will allow Kenyan universities to strengthen their cybersecurity posture, protect academic assets, and safeguard the privacy of students, staff and faculty members.

Keywords: ***Cybersecurity, Incident Management, Real-Time Threat Detection, Kenyan Universities, Cyber Threats*****.**

Introduction

In recent years, Kenyan universities have rapidly adopted digital technologies to support academic and administrative functions. The transition to cloud computing, online learning platforms, and digital libraries has significantly improved efficiency and accessibility. However, this increased digital transformation has also introduced substantial cybersecurity risks. Universities store vast amounts of sensitive student records, research data, financial transactions, and confidential administrative information, making them attractive targets for cybercriminals. The rising number of cyberattacks on higher education institutions globally and in Kenya underscores the urgent need for robust cybersecurity frameworks to protect critical academic assets, Owino (2025).

Cybersecurity threats against universities have evolved in complexity and frequency. Incidents such as data breaches, ransomware attacks, phishing scams, and denial-of-service (DoS) attacks have become more common in academic institutions worldwide. In Kenya, universities have reported cases of unauthorized access, insider threats, and theft of intellectual property, Musembi et al (2024). The consequences of these security breaches are severe, including loss of academic integrity, financial implications, reputational damage, and disruptions in learning activities. Despite the growing cyber threats, most Kenyan universities still rely on outdated security systems and lack adequate cybersecurity policies, leaving them highly vulnerable.

One of the primary challenges in Kenyan organizations is the reactive nature to staff training on cybersecurity. The level of cybersecurity awareness is low as only 15% of organizations have an established cybersecurity training program. Additionally, staff and students often have minimal awareness of cybersecurity best practices, increasing the risk of social engineering attacks such as phishing and identity theft (Serianu (2018).

Globally, institutions have adopted established cybersecurity frameworks, such as the National Institute of Standards and Technology (NIST) Cybersecurity Framework, the MITRE ATT&CK Framework, and the Cyber Kill Chain Model, to strengthen their defence mechanisms. However, Kenyan universities have been slow to integrate these frameworks, often due to limited financial resources, lack of skilled cybersecurity professionals, and inconsistent enforcement of cybersecurity policies. Without an adequate real-time cyber threat detection system, universities remain exposed to evolving cyber threats.

The Kenyan government has enacted laws and policies to promote cybersecurity, such as the Data Protection Act (2019), which mandates educational institutions to implement measures to safeguard personal data. However, enforcement remains inconsistent across universities, and many institutions struggle to comply due to insufficient resources. This situation raises concerns about data privacy, regulatory compliance, and institutional resilience against cyber threats.

This study seeks to assess the current cybersecurity measures and incident management strategies in Kenyan universities, focusing on identifying gaps in existing frameworks and providing valuable insights that can help universities enhance their cybersecurity posture, adopt real-time threat detection technologies, and implement effective incident response strategies.

The Problem

Kenyan universities face heightened vulnerability to cyberattacks due to the lack of effective real-time threat detection and rapid response capabilities, despite efforts to improve cybersecurity awareness. This gap exposes institutions to risks such as data breaches, intellectual property theft, and reputational harm. The Kenyan Data Protection Act underscores the need for robust security measures to protect personal data, highlighting the urgency of developing tailored incident management frameworks to address these unique challenges.

Literature Review

The rise in cyber threats has led to an increased focus on cybersecurity in academic institutions. Universities worldwide have been targeted by cybercriminals due to the vast amounts of sensitive data they store, including student records, research findings, and financial information, (Miller 2021). Various studies have examined cybersecurity challenges in higher education, highlighting weaknesses in threat detection, incident management, and policy enforcement. In the context of Kenyan universities, several empirical studies have identified significant gaps in cybersecurity preparedness, emphasizing the urgent need for improved security measures.

Njoroge et al. (2021) conducted a study on cybersecurity awareness in Kenyan universities, revealing that a majority of faculty members and students lack basic knowledge of cybersecurity best practices. The study found that over 60% of cybersecurity incidents in universities result from human error, such as falling for phishing scams or using weak passwords. Despite the increasing number of cyberattacks targeting higher education institutions, most universities have not integrated cybersecurity training into their academic programs or staff development initiatives. The study concluded that improving cybersecurity awareness through regular training sessions could significantly reduce vulnerability to cyber threats.

Chizanga et al. (2022) investigated the impact of financial constraints on cybersecurity infrastructure in African universities. Their study found that limited budgets prevent universities from investing in critical security technologies such as firewalls, intrusion detection systems, and real-time threat monitoring tools. The researchers surveyed IT administrators from multiple institutions and discovered that only 30% of universities had dedicated cybersecurity budgets, while the rest relied on general IT funding, which often prioritized hardware and software procurement over security enhancements. The study emphasized that without adequate financial investment, universities remain highly exposed to cyber threats and are unable to implement comprehensive security frameworks.

Serem (2021) examined incident response mechanisms in Kenyan universities, assessing how institutions handle cybersecurity breaches. The study revealed that most universities lack structured incident response teams, and when security incidents occur, responses are often delayed or ineffective. Only 25% of universities surveyed had documented cybersecurity policies that outlined incident response procedures. The absence of dedicated response teams means that IT personnel often struggle to contain cyber threats, leading to prolonged system downtimes and potential data breaches. The study recommended the establishment of dedicated

cybersecurity units within universities to improve response times and mitigate the impact of cyber incidents.

A study by Kaibiru et al. (2023) explored the role of policy enforcement in cybersecurity management. The researchers found that while many Kenyan universities have formal cybersecurity policies, enforcement remains weak due to a lack of accountability. Their findings indicated that universities often adopt generic cybersecurity policies without adapting them to their specific institutional needs. As a result, compliance levels are low, and security policies are rarely updated to reflect emerging threats. The study suggested that universities should establish independent cybersecurity oversight bodies to monitor compliance and ensure that security policies are effectively implemented and regularly reviewed.

In another study, Maranga and Nelson (2019) compared cybersecurity practices in African and Western universities. Their research highlighted that universities in developed countries allocate significantly more resources to cybersecurity, leading to better preparedness and lower incident rates. For instance, institutions in the United States and Europe often have 24/7 security operations centers, dedicated cybersecurity teams, and advanced threat detection systems. In contrast, African universities, including those in Kenya, rely on outdated security tools and lack the human expertise needed to combat sophisticated cyber threats. The study emphasized that adopting global best practices, such as real-time threat intelligence sharing and continuous cybersecurity training, could help African universities strengthen their security posture.

Strom et al. (2018) analyzed the effectiveness of cybersecurity frameworks such as MITRE ATT&CK and the Cyber Kill Chain in higher education institutions. Their findings indicated that universities that implemented structured cybersecurity frameworks experienced fewer security breaches compared to those without formalized security strategies. However, in Kenya, the adoption of these frameworks remains low, with most universities lacking the technical expertise required for implementation. The study recommended collaboration between universities and industry experts to develop customized cybersecurity frameworks that align with the specific challenges faced by academic institutions.

A survey by Hutchins et al. (2011) assessed the application of the Cyber Kill Chain model in detecting cyber threats in universities. Their study found that institutions that actively mapped cyberattacks using this framework were able to identify threats earlier and respond more effectively. However, the study noted that most universities in Africa, including Kenya, do not use advanced threat detection models, instead relying on outdated security approaches. The researchers recommended that universities integrate real-time threat detection tools into their cybersecurity strategies to improve their ability to counter evolving cyber threats.

The review of these empirical studies highlights several critical challenges facing Kenyan universities in cybersecurity management. First, there is a widespread lack of cybersecurity awareness among students and staff, making institutions vulnerable to phishing, ransomware, and other cyber threats. Second, financial limitations hinder the adoption of advanced security technologies, leaving universities reliant on outdated systems. Third, weak policy enforcement and a lack of dedicated cybersecurity personnel contribute to slow incident response times and ineffective threat mitigation strategies. Finally, the limited adoption of cybersecurity frameworks in Kenyan universities means that institutions do not benefit from structured approaches to managing cyber risks.

This empirical review underscores the urgency of improving cybersecurity in Kenyan universities. With increasing cyber threats targeting academic institutions, there is a critical need for comprehensive security measures that address vulnerabilities in awareness, funding, policy enforcement, and incident management. This study presents results from an empirical analysis that is structured into key thematic areas targeted at filling in gaps identified in cybersecurity strategies used in Higher Education Institutions (HEIs). These include; Cybersecurity Awareness and Awareness and Training; Resource Constraints and Infrastructure Gaps; Incident Management and Response Systems; Policy Enforcement and Institutional Oversight; and Adoption of Cybersecurity Frameworks.

Methodology

The study adopted a descriptive research design to evaluate cybersecurity practices in Kenyan universities, focusing on the effectiveness of real-time threat detection and incident management systems. This approach allowed for detailed observation and analysis of the existing state of cybersecurity frameworks in higher education institutions. A quantitative method was employed, enabling precise measurement of variables such as framework adoption, incident response effectiveness, and correlations between detection tools and management practices. Data were gathered through structured online questionnaires distributed to IT staff at four universities: United States International University – Africa (USIU), Strathmore University, University of Nairobi (UoN), and Jomo Kenyatta University of Agriculture and Technology (JKUAT). Secondary data from relevant literature and reports further enriched the study.

The sampling process ensured proportional representation across public and private universities, considering factors such as infrastructure and regional diversity. Stratified random sampling was used to achieve this, with a sample size of 55 participants determined using Cochran's formula. This robust sampling method ensured the reliability and generalizability of the findings. Participants included IT professionals such as cybersecurity analysts, system administrators, and network engineers, who provided key insights into the state of cybersecurity in their institutions.

Data analysis was conducted using IBM SPSS Statistics, employing descriptive statistics to summarize data and inferential techniques, such as correlation and regression analysis, to explore relationships among variables. Structural Equation Modeling (SEM) and Analysis of Variance (ANOVA) were used to validate hypotheses and assess the effects of various cybersecurity factors on incident management outcomes. These methods offered a nuanced understanding of how cybersecurity measures influence institutional readiness and response capabilities.

The study adhered to strict ethical standards. Permissions were obtained from university authorities, and ethical clearance was secured from review boards. Informed consent was obtained from all participants, who were assured of their rights, including voluntary participation and withdrawal without consequences. Data confidentiality was maintained through encrypted storage and restricted access. This comprehensive methodology provided a

reliable foundation for identifying gaps in cybersecurity practices and informing the development of a tailored incident management framework for Kenyan universities.

Findings

The findings of this study provided critical insights into the cybersecurity practices of Kenyan universities, shedding light on both the existing efforts and the substantial gaps that undermine the institutions' ability to protect themselves against evolving cyber threats.

Incident Management Practices

The study revealed that while most universities had documented incident response plans, only 35% of respondents indicated that these plans were regularly tested and updated. This demonstrated a predominantly reactive approach to incident management rather than a proactive strategy. Regular testing and updates are vital to ensure that the response plans remain effective and adaptable to new types of threats. Institutions that lacked this rigor in maintaining their plans faced delays and inefficiencies during actual incidents, increasing the potential for operational disruptions and data breaches.

The lack of clarity in assigning roles and responsibilities during incident management was another critical finding. Many universities did not have clearly defined teams or personnel specifically tasked with managing cybersecurity incidents. This gap led to confusion and uncoordinated efforts during cybersecurity breaches, further exacerbating the response time and the extent of damage.

Moreover, respondents highlighted that existing incident response protocols were often outdated, having been developed several years ago without subsequent reviews. This stagnation left universities ill-prepared to deal with contemporary challenges such as ransomware and advanced persistent threats (APTs). Universities that conducted regular drills or simulations to test their response capabilities reported significantly better outcomes when managing real-world incidents, underscoring the importance of operational preparedness.

Threat Detection Systems

Over 60% of the surveyed institutions had implemented some form of threat detection system. However, the study found that many of these systems relied on outdated technologies, which limited their effectiveness in detecting and mitigating modern cyber threats. Institutions relying on signature-based detection methods struggled to identify novel or evolving threats, such as zero-day vulnerabilities, which do not match known patterns.

Additionally, less than half of the universities had integrated their threat detection systems with more advanced tools, such as artificial intelligence (AI)-based anomaly detection systems. AI and machine learning tools have become essential in modern cybersecurity frameworks due to their ability to analyze patterns and detect subtle deviations indicative of malicious activity. The lack of integration with such tools left many universities unable to respond effectively to sophisticated attack vectors.

The study also revealed that institutions with updated threat detection systems experienced fewer successful breaches and shorter recovery times. Universities that had invested in real-

time monitoring systems reported a significantly higher capacity to prevent data exfiltration and service disruptions, demonstrating the value of modernizing their threat detection infrastructure.

Cybersecurity Training and Awareness

A significant gap was identified in the area of cybersecurity training and awareness. Less than 45% of respondents reported that their institutions provided regular training programs for staff and students on identifying and responding to cybersecurity threats. This shortfall left the majority of the university community vulnerable to common attack methods, including phishing and social engineering.

The study found that most existing training initiatives, where they existed, were not tailored to address the specific threats faced by the universities. For example, while ransomware attacks have been on the rise globally, only a few training sessions covered the steps to recognize and mitigate such threats. Moreover, many respondents noted that the training sessions were infrequent and overly theoretical, failing to engage participants or equip them with practical skills.

The lack of awareness was further evidenced by the high prevalence of successful phishing attempts reported by respondents. These attacks often targeted staff and students, exploiting their lack of knowledge about recognizing fraudulent emails or securing sensitive information. Institutions that conducted regular, scenario-based training programs reported higher levels of preparedness and a marked reduction in such incidents.

Correlation Analysis

Statistical analysis revealed strong correlations between certain cybersecurity practices and their effectiveness (See table 1). For instance, institutions with dedicated incident response teams demonstrated significantly better outcomes in terms of threat mitigation and recovery times. The presence of such teams was strongly correlated with the effectiveness of threat detection systems ($r=0.76$, $p<0.05$). This finding underscored the importance of having specialized personnel to oversee and implement cybersecurity protocols.

Similarly, universities that provided regular training programs exhibited higher levels of confidence among staff and students in their ability to respond to cyber threats ($r=0.71$, $p<0.05$). This correlation highlighted the critical role of education and awareness in strengthening an institution's cybersecurity posture. Additionally, the study found that institutions with integrated and modernized threat detection systems were better equipped to prevent and manage security breaches, showcasing the tangible benefits of investing in advanced technologies.

Table 1. Correlation Summary of Key Cybersecurity Measures

Variable	Real-Time Detection	Updates Performed	Integrated Systems	Awareness Training
Effective real-time detection systems	1	0.776**	0.475**	0.837**
Regular updates performed	0.776**	1	0.548**	0.582**
Integrated with other systems	0.475**	0.548**	1	0.292*
Regular awareness training	0.837**	0.582**	0.292*	1

Impact on Institutional Operations

The deficiencies in cybersecurity practices identified in the study had significant implications for the operational integrity of Kenyan universities. Several respondents cited incidents where cyberattacks had led to disruptions in essential services, such as online learning platforms, financial systems, and research databases. One notable case involved a ransomware attack that forced a major university to suspend its online services for over two weeks, resulting in academic delays and reputational damage.

The exposure of sensitive data, including student records and research findings, was another recurrent issue. Data breaches not only jeopardized the privacy of individuals but also exposed institutions to legal liabilities under the Kenyan Data Protection Act. These incidents highlighted the pressing need for universities to adopt more robust cybersecurity measures to protect their critical assets and maintain stakeholder trust.

Discussion

The findings of this study reveal both progress and critical gaps in cybersecurity preparedness within Kenyan universities. While institutions have made strides in documenting incident response plans and implementing threat detection systems, these efforts remain largely inadequate in mitigating evolving cyber threats.

One of the most significant issues identified is the reactive approach to incident management. Although most universities had documented incident response plans, only 35% of them regularly tested and updated these protocols. This aligns with findings from prior research, such

as Njoroge et al. (2021), which emphasize the vulnerability of institutions that fail to proactively refine their cybersecurity strategies. The lack of frequent testing leaves universities unprepared to respond effectively to contemporary threats such as ransomware and advanced persistent threats (APTs). Institutions that conduct regular incident response drills reported significantly improved handling of cyber threats, underscoring the need for continuous testing and updating of security protocols.

Another critical challenge is the lack of clear role assignments in cybersecurity incident management. Many universities have not designated specific personnel or teams to oversee incident response, leading to confusion and delays when breaches occur. This supports the argument made by Serem (2021), who found that most universities in Kenya struggle with cyber threat containment due to the absence of specialized cybersecurity units. Establishing well-defined roles within incident response teams is essential for reducing response times and minimizing damage during security breaches.

While 60% of surveyed universities had some form of threat detection system, the study found that many of these systems relied on outdated technologies that struggle to detect and mitigate modern cyber threats. Universities relying solely on signature-based detection methods faced challenges in identifying emerging threats such as zero-day vulnerabilities. These findings align with Hutchins et al. (2011), who demonstrated that institutions with real-time monitoring and AI-driven security tools experience significantly lower cyberattack success rates.

A notable concern in this study is the inadequate focus on cybersecurity training and awareness. Only 45% of respondents indicated that their institutions provided regular training for staff and students. This aligns with findings from Kaibiru et al. (2023), who noted that many universities lack structured training programs, leaving their communities vulnerable to phishing, social engineering, and other cyber threats.

The study also found that most existing training initiatives were not tailored to address institution-specific threats. For example, while ransomware attacks have become more frequent, few universities incorporated ransomware mitigation into their training programs. Furthermore, training sessions were often theoretical rather than practical, reducing their effectiveness. The high prevalence of phishing attacks reported by respondents further highlights the need for practical, scenario-based training programs.

Financial constraints remain a major barrier to cybersecurity advancement. Only 30% of universities had dedicated cybersecurity budgets, aligning with Chizanga et al. (2022), who found that African universities allocate less than 2% of their IT budgets to cybersecurity. This lack of funding limits universities from acquiring advanced security technologies such as intrusion detection systems (IDS), AI-driven threat detection, and real-time monitoring tools.

Moreover, the study found that while 60% of universities had cybersecurity policies in place, only 35% enforced them effectively. This lack of enforcement stems from weak accountability mechanisms and the absence of compliance monitoring bodies, as previously observed by Kaibiru et al. (2023). Without regular policy reviews and strict enforcement, universities remain vulnerable to preventable security breaches.

Conclusion

This study evaluated cybersecurity measures and incident management strategies in Kenyan universities, identifying critical gaps that expose institutions to cyber threats. While many universities have cybersecurity policies and basic security measures in place, they lack real-time threat detection, dedicated cybersecurity personnel, and structured incident management processes. These weaknesses put sensitive student data, academic records, and research information at risk.

One of the key findings is that cybersecurity awareness among university staff and students remains low. Most institutions do not conduct regular cybersecurity training, increasing the likelihood of successful phishing, malware, and social engineering attacks. To mitigate these risks, universities must implement structured cybersecurity education programs tailored to their specific threat environments.

Additionally, the study highlights the lack of dedicated cybersecurity teams in most universities. Many institutions rely on general IT staff, who often lack the expertise required for effective cyber threat management. Establishing specialized cybersecurity departments with trained personnel is crucial for improving institutional security.

Furthermore, outdated threat detection systems and weak policy enforcement further expose universities to cyber risks. Institutions that fail to modernize their security infrastructure remain vulnerable to emerging cyber threats. Investing in AI-driven security tools and enforcing cybersecurity policies through regular audits and compliance monitoring will be critical steps in addressing these gaps.

This study recommends development of a holistic cybersecurity framework for Kenyan universities, integrating AI-driven threat detection, dedicated cybersecurity teams, strict policy enforcement, and structured training programs to enhance institutional resilience against evolving cyber threats.

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