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ESTABLISHING A COMPREHENSIVE DIGITAL EVIDENCE STORAGE MANAGEMENT FRAMEWORK FOR JUDICIARY CRIMINAL INVESTIGATION AND PROSECUTION: A CASE STUDY OF ARUA CITY, UGANDA

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ABSTRACT. The growing reliance on digital evidence in judicial proceedings highlights the urgent need for a robust and effective storage management framework. This study critically assesses the shortcomings of the current digital evidence storage system within the judiciary of Arua City, Uganda specifically issues related to loss, corruption, and inadmissibility of evidence, which threaten the delivery of justice and the protection of human rights. The study adopted a quantitative approach to explore the state of digital evidence management and design a suitable model for its improvement. This involved structured surveys aimed at generating measurable data on the technical, financial, and organizational challenges hindering effective implementation. Results showed that 87% of respondents identified technical barriers, 63% cited financial constraints, and 72% emphasized the need for organizational support and training. The study concludes that addressing these challenges through scalable, secure, and user-friendly systems alongside ongoing professional training and stakeholder engagement is vital. Regular evaluations are recommended to ensure system relevance and effectiveness in line with evolving digital technologies.

KEYWORDS: *Digital Evidence, Judiciary, Criminal Investigation, Evidence Storage Management, Arua City, Uganda*

1. INTRODUCTION

Digital evidence defined as any information stored or transmitted in digital form that can be used in legal proceedings includes a broad spectrum of data types such as emails, text messages, social media content, photographs, videos, audio recordings, web pages, databases, and other electronic documents (Wamukoya & Mutula, 2005). Its growing relevance in modern criminal investigations and prosecutions has significantly transformed how justice systems operate. It is argued that digital evidence plays a crucial role in upholding the rights of both victims and suspects by offering verifiable and often indispensable information for solving crimes. Nonetheless, the management of such evidence introduces complex challenges, necessitating the formulation and implementation of comprehensive policies, standards, and technologies to ensure its quality, integrity, security, and admissibility in court (Kimuli et al., 2021).

The management of digital evidence storage in Uganda is beset by significant issues stemming from insufficient policies and ineffective standards. These deficiencies result in the loss and corruption of digital evidence, threatening its admissibility in court and ultimately undermining the delivery of justice (Nkongho, 2016). As a result, the credibility of law enforcement agencies and the judicial system is compromised, leading to a deterioration of public trust in the criminal justice process. Inadequate institutional capacity and limited resources further hinder the ability of law enforcement and judicial bodies to manage digital evidence effectively. Moreover, there is a lack of public and professional awareness concerning the reliability, legal weight, and significance of digital evidence in criminal proceedings (Kasper & Laurits, 2016). These systemic weaknesses are worsened by the rapid evolution of digital technologies, which introduce additional complexities and demands that current evidence management protocols are ill-equipped to handle.

Furthermore, the situation is compounded by Uganda's outdated legal framework most notably, the Evidence Act of 1909 which is ill-equipped to address the complex challenges introduced by modern digital technologies (National Institute of Justice,2025; Goodison et al., 2015b). This legislative gap mirrors broader institutional and technical shortcomings, such as inadequate ICT infrastructure, poorly defined digital records management policies, and a significant digital skills deficit within key public service sectors like the judiciary (Judiciary to Expand Electronic Court System - Monitor, n.d.; PAC Calls for More Judicial Reforms to Address Case Backlog - Parliament of Uganda, n.d.). These deficiencies carry serious ethical implications, particularly in relation to data privacy, information security, and the responsible management of sensitive digital evidence.

Given these complex challenges, there is a pressing need for a well-structured digital evidence storage management framework that draws on global best practices and innovative approaches. Such a framework should emphasize enforceable policies, strengthened institutional capacity, and greater awareness among legal professionals and the public about the value of digital evidence. This study aims to design a context-specific, robust model suited to Uganda's criminal justice system by addressing technical, organizational, legal, and ethical aspects of digital evidence handling.

The rest of this paper is organized as follows: Section 2 provides a review of the relevant literature, while Section 3 outlines the methodology employed in the study. Section 4 details the research findings. Section 5 provides a comprehensive discussion of the results, and Section 6 concludes the study.

2. LITERATURE REVIEW

2.1 The role of digital evidence in criminal justice systems

Digital evidence has increasingly become a cornerstone of modern criminal investigations and judicial proceedings. With the proliferation of digital technologies, evidence derived from electronic devices and digital platforms has become indispensable in establishing facts, proving criminal intent, and ensuring the integrity of judicial processes (Casey, 2011; Yeboah-Ofori & Brown, 2020). In many jurisdictions, digital evidence is now routinely admitted in court, provided it meets standards of authenticity, integrity, and relevance (Pillai, 2016). However, the admissibility of digital evidence is often compromised due to poor storage practices, lack of chain-of-custody documentation, and limited technical expertise within the judicial sector (Premanand Narasimhan, 2024).

In Uganda, digital evidence remains underutilized due to infrastructure limitations and weak institutional capacity (Kuhimbisa, 2024). As a result, many criminal cases suffer from delays or outright dismissal, undermining public trust in the justice system. The Arua City judiciary is not immune to these challenges, and there is an urgent need to develop context-specific frameworks for secure and efficient digital evidence storage and management.

2.2 Deficiencies in digital evidence storage management

Effective digital evidence storage requires robust systems that ensure security, integrity, and accessibility. However, several studies indicate that many criminal justice institutions in low- and middle-income countries, including Uganda, lack the technical infrastructure and procedural frameworks necessary for managing digital evidence efficiently (UNODC, 2021; Efendi, 2019). Common challenges include inadequate storage capacity, lack of encryption mechanisms, insufficient backup systems, and vulnerability to cyber threats (Ruan et al., 2013).

Furthermore, the lack of standardized guidelines and inter-agency coordination often results in fragmented approaches to evidence management (Mason & Esther, 2011). In Uganda, these deficiencies are exacerbated by limited financial resources and the absence of national policies that govern the handling and storage of digital evidence (Judiciary of Uganda,2025). This situation has led to the loss, corruption, or compromise of critical digital materials, which significantly hampers the prosecution process.

3. METHODOLOGY

The study employed a quantitative research design to investigate the current state of digital evidence management and to inform the development of an appropriate improvement model. Structured surveys were utilized to generate quantifiable data critical to the formulation of a robust digital storage management framework. The target population consisted of key stakeholders within the criminal justice system of Arua City in Uganda. Using Cochran's formula, a sample size of 75 respondents was established, with equal representation across five stakeholder groups. Data collection was conducted through the administration of structured questionnaires. The collected data were analyzed using SPSS, incorporating both descriptive and inferential statistical methods.

4. RESULTS

4.1 Current practices and existing gaps in digital evidence storage

A thorough analysis was undertaken to assess existing digital evidence storage practices within Uganda's Judiciary, uncovering several significant deficiencies. The survey findings captured participants' perceptions across various key dimensions, which are detailed in the following sections

Frequent Technical Issues: A significant 50% of respondents reported frequent technical issues as a barrier to effective digital storage, corroborated by 40% who disagreed with the notion of a well-functioning system. Only 2.2% maintained a neutral stance on this issue. This consensus emphasizes the urgent need for a fortified technical infrastructure capable of mitigating these recurrent challenges.

Data Volume Concerns: A robust 62.2% of respondents indicated that the existing digital storage systems struggle to accommodate the growing volumes of data generated within Arua City's criminal justice system. In stark contrast, only 2.2% agreed that the current system performs adequately. This significant gap highlights the critical need for scalable storage solutions to ensure timely access to essential evidence, a cornerstone for the integrity of judicial processes.

Lack of Trained Personnel: Training deficits were identified as a major gap, with 75.6% of respondents agreeing and 23.3% strongly agreeing that insufficient training hampers the effective management of digital evidence systems. This shows need for targeted initiatives to enhance personnel development, ensuring the judiciary can leverage technology effectively.

Disparate Storage Systems: Integration challenges due to varied storage systems were acknowledged by 43.3% of respondents, indicating a clear need for standardization within the justice framework. This aligns with contemporary technological demands for interoperability and efficient integration.

Budget for Upgrades and Maintenance: Opinions regarding financial resources were mixed. While 55.6% disagreed that budget constraints hinder effective implementation, 28.9% affirmed the existence of financial challenges that require attention. This mixed feedback suggests a need for clearer communication and optimization of funding mechanisms to support the proposed technological advancements.

4.2 Key performance metrics for digital evidence storage management

Accessibility: Notably, 62.2% of respondents emphasized that system accessibility is crucial for effective functionality, reaffirming the established best practices that prioritize timely access to judicial resources.

Efficiency: Over half (53.3%) underscored the importance of efficiency, indicating a prevalent understanding that optimizing operational workflows is critical to enhancing service delivery in the judicial system.

Sufficiency of Current Security Measures: Concerns regarding security were pronounced, with 48.9% of respondents disagreeing that the current security measures are adequate. This suggests that existing security protocols may be inadequate in safeguarding sensitive information.

Scalability: Acknowledged by 55.6%, scalability is deemed vital to manage increasing data demands, highlighting the need for systems that can expand in line with growth.
Need for User-Friendly Interface: An overwhelming 86.7% of respondents emphasized the necessity of a user-friendly interface, which significantly impacts user engagement and operational effectiveness.

4.3 Relationships among key factors influencing digital evidence storage management

Pearson correlation analysis was employed to examine the relationships among the key factors affecting digital evidence storage management. The results are summarized in Table 1 below.

Tab.1. Pearson correlation coefficients among key factors

Factor	Technical Issues	User Training	Data Volume Concerns	System Efficiency	Integration Readiness
Technical Issues	1.00	-0.67**	0.45*	-0.75**	0.29
User Training	-0.67**	1.00	-0.55*	0.50*	0.60**
Data Volume Concerns	0.45*	-0.55*	1.00	-0.70**	0.35
System Efficiency	-0.75**	0.50*	-0.70**	1.00	0.42*
Integration Readiness	0.29	0.60**	0.35	0.42*	1.00

Note: p < 0.05 (*) indicates a significant correlation.

p < 0.01 ()** indicates a strong significant correlation.

As seen in Table 1 above, the findings reveal a strong negative correlation between technical issues and user training (-0.67), indicating that increased technical challenges are associated with perceived deficiencies in training.
The Findings further establish a significant negative correlation between data volume concerns and system efficiency (-0.75), suggesting that as concerns about data volume management rise, perceptions of system efficacy diminish.
Conversely, user training positively correlated with integration readiness (0.60), implying that improved training is associated with a greater readiness to adopt new storage solutions. These relationships underscore the interconnected nature of training, technical infrastructure, and system efficacy in digital evidence management.

4.4 Satisfaction levels with digital evidence storage systems across different educational backgrounds

An Analysis of Variance (ANOVA) was performed to evaluate differences in satisfaction with digital evidence storage systems among respondents with varying educational backgrounds. The findings are presented in Table 2 below.

Tab. 2. ANOVA results for satisfaction levels by education level

Source of Variation	SS	df	MS	F	p-value
Between Groups	28.55	2	14.27	5.43	0.007
Within Groups	239.45	74	2.75		
Total	268.00	74			

The findings revealed a significant effect of educational background on satisfaction levels ($F(2, 72) = 5.43$, $p < 0.01$), illustrating that perceptions regarding the effectiveness of digital storage solutions vary significantly based on educational qualifications. This suggests that tailored training and resource distribution may be necessary to address varying needs across different educational levels within the judiciary.

4.5 Framework development

The proposed framework is organized into five essential components, each targeting a critical dimension of the study's focus. To enhance clarity and visualization, the framework was graphically illustrated using Microsoft Visio software.

Technology Infrastructure:

i. Emphasizes the use of scalable cloud platforms that allow secure access and flexible resource allocation for managing increasing volumes of digital evidence.
ii. Stresses the need for compatibility standards to enable seamless data sharing and integration, alongside robust security measures like encryption and access controls.

User-Centric Design:

i. Advocates for intuitive user interfaces that cater to varying technical proficiencies to enhance user experience.
ii. Ensures compliance with accessibility standards, promoting inclusivity for all users.

Training and Development:

i. Highlights the importance of ongoing training programs to keep personnel updated on emerging technologies and best practices.
ii. Recommends providing accessible manuals and online resources, fostering self-sufficiency among users.

Data Management Practices:

i. Calls for standardized protocols for data entry and retrieval to maintain consistency and accuracy in digital evidence management.
ii. Establishes clear policies for data retention, archiving, and destruction, ensuring compliance with legal requirements.

Stakeholder Engagement:

i. Encourages active feedback collection from users and stakeholders to continuously improve the framework.
ii. Fosters collaboration with technology and legal experts to maintain the framework's relevance in addressing evolving challenges in digital evidence management.

The conceptual structure of the proposed framework, encompassing the five fundamental components, is visually represented in Figure 1 below.

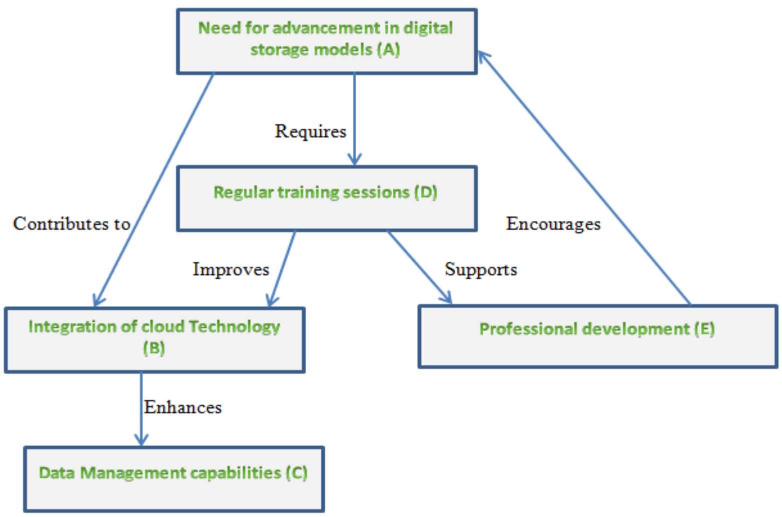

Fig.1. A comprehensive digital evidence storage management framework for judiciary criminal investigation and prosecution

The flowchart representing the proposed framework for digital evidence storage management visually encapsulates the interrelationships among its key components.

Need for Advancement in Digital Storage Models (A): This foundational component emphasizes the necessity for continuous improvement in digital storage technologies, with 60% of respondents highlighting its importance.

Integration of Cloud Technology (B): This element illustrates the direct contribution of advancements in storage models toward integrating cloud technology, recognized by 56.66% of respondents for enhancing data management capabilities.

Data Management Capabilities (C): This component signifies improved storage, retrieval, and analysis capabilities resulting from the integration of cloud technology, vital for efficient evidence management.

Regular Training Sessions (D): Highlighting the importance of staff staying updated, with 52.22% of respondents recognizing ongoing training as essential for adapting to technological advancements.

Professional Development (E): Regular training supports professional growth, enhancing workforce competence in navigating digital evidence complexities.

4.6 EVALUATION OF THE FRAMEWORK

Evaluation in information systems refers to the systematic assessment of an artifact's effectiveness, efficiency, and relevance within its intended context, often employing both quantitative and qualitative methods to ensure comprehensive validation (Hevner et al., 2004; Venable et al., 2016).

The evaluation of the proposed digital evidence storage management framework was conducted using a multi-method approach to ensure its robustness, usability, and alignment with judicial requirements. User surveys were deployed anonymously to a diverse participant group, assessing dimensions such as ease of use, training adequacy, accessibility, and overall satisfaction, thereby identifying recurring challenges and gauging user perceptions. Expert reviews, involving technology and legal professionals, provided critical external assessments of the framework's architecture and security protocols. The evaluation results are presented in Table 3 below.

Tab.3. Results for evaluation of the framework's feasibility and impact

Evaluation Criteria	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Recognition of technical challenges as a significant issue	0%	20%	0%	0%	80%
Concerns over funding issues impacting implementation	0%	55.56%	0%	0%	44.44%
Importance of scalability	0%	0%	44.44%	55.56%	0%
Importance of regular training sessions	0%	6.67%	31.11%	62.22%	0%

As seen from Table 3 above, the key findings from this evaluation indicated that 80% of respondents recognized technical challenges as a significant issue, underscoring the need for targeted solutions. Perceptions regarding funding limitations varied, with 55.6% disagreeing that financial constraints hinder implementation. The importance of scalability was affirmed by 55.6%, and 62.2% stressed the critical role of regular training for long-term system effectiveness.

5. DISCUSSION

The study revealed significant gaps in the current digital evidence storage practices within Uganda's judiciary system, aligning with existing literature that underscores the complexities and infrastructural inadequacies in digital transformation efforts in judicial systems (Cunningham,2008; Ruan et al., 2013). The most prevalent issue identified was the frequent occurrence of technical problems, with 50% of respondents highlighting this as a major impediment. This finding supports Ruan and Carthy's (2012) assertion that sustainable digital evidence management requires robust technical frameworks that can withstand operational pressures.

Furthermore, concerns over data volume were widespread, as over 62% of respondents indicated that current systems were insufficient to manage the growing data loads. This aligns with Quick and Kim-Kwang (2014), who emphasizes the need for scalable and flexible infrastructures in forensic and legal data management. The lack of trained personnel also emerged as a key challenge, with nearly 99% of participants affirming the deficiency. This reflects similar concerns noted by Mason and Esther (2011), who stressed the importance of continuous professional training in digital evidence handling to ensure competence and compliance with evolving legal standards.

Integration issues due to disparate storage systems were noted by 43.3% of participants, indicating an urgent need for interoperability a view supported by Casey (2011), who argues that fragmented systems impede effective digital forensics and judicial processes. Interestingly, opinions on budget constraints were mixed, suggesting that financial limitations may be more perceptual than systemic, or that communication regarding resource allocation is inconsistent.

From a performance metrics perspective, most respondents emphasized accessibility (62.2%), efficiency (53.3%), and user-friendly interfaces (86.7%) as crucial to effective system performance. These priorities are consistent with Hevner et al. (2004), who argue that usability and system performance are vital for artifact acceptance in design science research.

The correlation analysis further illustrated critical interdependencies: technical issues were negatively associated with training levels, and data volume concerns were inversely related to system efficiency. Conversely, a strong positive relationship was noted between user training and integration readiness. This affirms literature advocating for user capacity-building as a lever for improved technology adoption and system interoperability (Venable et al., 2016).

Finally, educational background significantly influenced satisfaction levels with digital evidence systems, as evidenced by the ANOVA results. This suggests the necessity for differentiated training strategies that consider users' educational diversity, reinforcing Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT), which identifies education and experience as moderating variables in technology adoption.

6. CONCLUSION

This study examined the existing challenges in storing digital evidence in Uganda's judiciary, focusing on Arua City, and developed a framework to address these gaps. The findings highlighted key limitations, including inadequate infrastructure, technical challenges, limited skilled personnel, and disjointed systems. The proposed framework has five parts: technology, user design, training, data management, and stakeholder engagement. The implementation of this framework is expected to significantly enhance the efficiency of criminal investigations and prosecutions by promoting reliable, secure, and streamlined digital evidence management in Arua City. Its integration of cloud technologies and standardized protocols facilitates faster data retrieval, while robust security measures protect sensitive information, thereby reinforcing public trust as well as the integrity of judicial processes in Uganda. Future research should investigate the effects of specific training programs on the effectiveness of digital evidence handling. Furthermore, the framework has the potential to be adapted for application in other regions facing similar challenges.

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