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Forward

It is with great pleasure and enthusiasm that I welcome you to the fifth volume of the African Journal of Science, Technology, and Engineering (AJSTE) for the year 2024. As Chief Editor, it is both an honor and a privilege to present to you the latest advancements, research findings, and insights within the diverse realms of science, technology, and engineering from across the African continent and beyond.

In this volume, we continue our commitment to fostering a platform for the exchange of knowledge, ideas, and innovations that are driving progress and development in various fields. Our goal remains steadfast: to showcase the rich tapestry of scientific endeavors and technological innovations emerging from Africa, while also facilitating collaboration and dialogue among researchers, academics, practitioners, and policymakers worldwide.

The articles featured in this volume represent a broad spectrum of disciplines, ranging from fundamental scientific research to applied engineering solutions. From groundbreaking discoveries in biomedical sciences to cutting-edge developments in renewable energy technologies, each contribution reflects the ingenuity and dedication of researchers striving to address the complex challenges facing our societies today.

As we navigate through an era defined by rapid technological advancements and global interconnectedness, the role of science, technology, and engineering in driving sustainable development and promoting socio-economic prosperity has never been more critical. Through AJSTE, we aim to amplify the voices of African scientists, engineers, and innovators, highlighting their contributions to the global scientific community and advocating for greater investment in research and development across the continent.

I extend my sincere gratitude to the authors, reviewers, editorial board members, and staff whose unwavering dedication and expertise have contributed to the success of this journal. It is through your collective efforts that AJSTE continues to uphold its commitment to excellence and integrity in scholarly publishing.

I invite you to explore the diverse array of articles presented in this volume and engage with the latest advancements shaping the landscape of science, technology, and engineering in Africa and beyond.

Thank you for your continued support and readership.

Chief Editor

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EVALUATING THE LEVEL OF PERSONAL RESILIENCE AMONG HEALTHCARE WORKERS AT KCRH, KIRINYAGA COUNTY, IN KENYA.

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Abstract

Personal resilience, a multifaceted concept encompassing determination, endurance, adaptability, and recuperability, is crucial for healthcare workers who frequently encounter high-stress and traumatic events. Resilience enables individuals to not only endure but also thrive in adversity, protecting against burnout and fostering psychological well-being. This study investigates the level of personal resilience among healthcare workers at Kerugoya County Referral Hospital (KCRH) in Kirinyaga County, Kenya, focusing on vicarious trauma and its effects. A descriptive research design was employed, involving a sample of 149 healthcare workers at KCRH. Data was collected using the Adult Personal Resilience Questionnaire (APRQ). There was moderate vicarious trauma levels (score of 33.3) and substantial resilience across four dimensions: determination (4.42), endurance (4.18), adaptability (4.06), and recuperability (3.93). Healthcare workers at KCRH exhibited substantial resilience across all dimensions, with determination and endurance scoring the highest. Thus, despite facing significant challenges, including high stress levels and exposure to traumatic events, the workers demonstrated strong determination, perseverance, adaptability, and ability to recover from setbacks. However, the moderate level of vicarious trauma highlights the need for targeted support and interventions to mitigate its impact. These findings underscore the importance of personal resilience in helping healthcare workers manage the demands of their profession. High resilience levels suggest that these workers possess the capacity to navigate adversities effectively, but the presence of moderate vicarious trauma indicates a need for enhanced support systems. There is need for Hospital administrators and policymakers to prioritize initiatives aimed at building resilience among healthcare workers. This can include implementing tailored training programs, providing robust mental health support, and fostering a supportive work environment. Further research is recommended to explore specific strategies and interventions that can effectively enhance resilience and well-being in diverse healthcare settings.

Keywords: Personal resilience, healthcare workers, determination, endurance, adaptability, recuperability.

Background to the Study

Personal resilience is being examined as a multifaceted concept that encompasses the capacity to effectively cope with stress and adversity. It is influenced by a range of factors, including determination, endurance, and adaptability [1]. In this study, personal resilience is used to refer to a multidimensional concept encompassing determination, endurance, adaptability, and recuperability.

Personal resilience has emerged as a pivotal element within the healthcare domain, demonstrating its capacity not only to shield individuals from the adverse effects of trauma but also to foster posttraumatic growth [2]. However, despite this acknowledgment, documented research findings suggest that different categories of healthcare workers exhibit varying responses to traumatic experiences [3]. Resilience besides transcending endurance of adversity; embodies the ability to adapt, rebound, and flourish amidst challenges [3]. This attribute is particularly vital for healthcare professionals who regularly navigate high-stress environments, grapple with emotional strain, and manage demanding workloads [4]. Moreover, resilience acts as a protective shield against burnout and compassion fatigue, facilitating preservation of psychological well-being, the commitment to patient care, and ability to navigate the complexities healthcare landscape.

In their research, West et al 2020 [5] outlined the various dimensions of personal resilience, shedding light on its multifaceted nature. Accordingly, endurance refers to an individual's ability to persevere through difficult situations without succumbing to defeat while determination embodies one's resolve and persistence in striving to achieve set goals, even in the face of adversity. On the other hand, adaptability reflects capacity to be resourceful and flexible to effectively navigate challenging environments and adjust to diverse circumstances

while recuperability underscores an individual's aptitude for bouncing back and recovering from setbacks, injuries, or hardships. These dimensions collectively provide a comprehensive understanding of personal resilience, emphasizing its importance in successfully coping with life's trials and tribulations.

The impact of personal resilience among healthcare workers, as highlighted by Nyagaya 2015 [6], is multifaceted and profound. Thus, resilience serves as a vital defense mechanism against burnout and compassion fatigue, preserving the mental and emotional well-being of healthcare professionals amid the demanding nature of their work. Secondly, it correlates with enhanced job performance and satisfaction, empowering healthcare workers to effectively navigate challenges and deliver superior care to patients. Furthermore, as emphasized by Zakeri et al 2021 [7] personal resilience contributes to organizational resilience by fostering collaboration, communication, and support within healthcare systems. By prioritizing initiatives aimed at building resilience, healthcare organizations can cultivate a resilient workforce capable of enduring crises and providing uninterrupted, compassionate care to those in need.

Despite the multifaceted and compelling rationale for evaluating the level of personal resilience among healthcare workers, there remains a gap in understanding the specific mechanisms and strategies necessary for effectively identifying and addressing resilience-related challenges within healthcare settings. Although there is need to quantify resilience levels, there is a lack of a comprehensive frameworks or standardized methodologies for conducting such evaluations consistently across diverse healthcare contexts [8].

Statement of the Problem

This study sought to evaluate the level of personal resilience among healthcare workers at KCRH, Kirinyaga County, Kenya. Thus, in their role in providing essential services, they often face numerous challenges, including high stress levels, heavy workloads, and exposure to traumatic events. Thus, while personal resilience is recognized as a key factor in mitigating the

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negative impacts of these challenges, there is limited understanding of the specific resilience levels among healthcare workers in Kenya as is the case elsewhere. Furthermore, there is lack of tailored interventions and support systems in place to effectively promote and sustain resilience within this population. This study therefore sought to address this gap by systematically assessing the level of personal resilience among healthcare workers at KCRH, identifying potential factors influencing resilience levels, and exploring strategies to enhance resilience and well-being in this context.

Literature Review

Personal resilience among Healthcare Workers

That healthcare workers are integral to the functioning of medical systems, yet their well-being can be severely tested during public health crises [9] advocates for an integrative resilience approach, which acknowledges the importance of individual, educational, and organizational factors in fostering resilience among healthcare professionals. Thus, there is need for tailored interventions in medical education and supportive protocols within healthcare institutions to promote resilience. Additionally, there is need to assess the effectiveness of psychological interventions in improving mental health outcomes for healthcare workers, underscoring the value of such strategies [10]. Together, these studies highlight the necessity for comprehensive resilience-enhancing strategies in healthcare settings, offering invaluable insights for educators, institutions, and policymakers to safeguard the well-being of healthcare professionals, especially during times of public health emergencies.

Baskin and Barleltt 2021 [11] observed that despite increased stress and burnout levels, USA healthcare workers exhibited significant resilience during the COVID-19 pandemic, attributed to factors like strong professional identity [12], effective coping strategies, robust social support, and organizational backing. The authors using a meta-analysis observed only 28.8% prevalence of low resilience among healthcare workers. These studies emphasize the importance of

addressing resilience-enhancing factors to support healthcare workers' well-being, particularly during crises.

Although Doctors in the USA face significant challenges, including long work hours exceeding the national average, heavy workloads, emotional strain from difficult patients, and stress from making life or death decisions, there was a positive association between resilience, self-compassion, mindfulness, and a sense of meaning in life among doctors, with higher resilience linked to lower burnout levels [13]. There was high rates of burnout, anxiety, and moral distress among doctors.

Rushton et al 2019 [14] highlighted the critical importance of personal resilience among nurses, given the inherently high-stress nature of their profession. Lin et al [15] defined resilience as the ability to navigate adversity and maintain well-being and that this is shaped by individual factors like optimism, self-efficacy, and emotion regulation [15]. Nurses with higher resilience levels show improved job satisfaction, decreased burnout, and longer careers, emphasizing the need to support and cultivate resilience within the nursing workforce.

Research Methodology

Data was collected from healthcare workers at Kerugoya County Referral Hospital (KCRH) in Kirinyaga County, Kenya. Participants included a diverse group of healthcare professionals among them doctors, nurses, clinical officers, laboratory technicians, pharmacists, and other support staff. A total of 149 healthcare workers participated in the study. The study employed a descriptive research design to evaluate the levels of personal resilience among the healthcare workers. A stratified random sampling method was used to ensure that all categories of healthcare workers at KCRH were represented proportionately in the sample. The workers were first categorized into different strata based on their job roles. From each stratum, a random sample was drawn to make up the total sample size of 149 participants. To ensure reliability and validity of data, the study used established and standardized measurement tools. The Vicarious

Trauma Scale (VTS) was used to measure the levels of vicarious trauma among participants. The Adult Personal Resilience Questionnaire (APRQ), a 20-item self-administered questionnaire, was used to measure personal resilience across four dimensions: determination, endurance, adaptability, and recuperability. Both tools have been validated in previous studies and are widely used in resilience research. Data was analysed using Statistical Package for Social Sciences (SPSS) version 27 and summarized using descriptive statistics, including frequencies, percentages, means, and standard deviations. Results were presented in summary tables to provide a clear and concise presentation of findings. Data was presented in a manner that highlighted the key findings and facilitated an understanding of the overall resilience levels within the healthcare workforce at KCRH. Ethical approval for the study was obtained from the relevant institutional review board. The study was conducted in accordance with ethical standards to protect the rights and well-being of participants. All participants were informed about the purpose of the study and of their respective roles in their study. Written informed consent was obtained from each participant prior to their involvement in the study. Confidentiality and anonymity of the participants were strictly safeguarded. Personal identifiers were removed from the data to ensure that individual responses could not be traced back to any participant. Participation in the study was entirely voluntary, and participants were free to withdraw from the study at any point without any consequences.

Results

Level of personal resilience among healthcare workers in Kerugoya County Referral Hospital, Kirinyaga County, Kenya

The purpose of the study was to evaluate the level of personal resilience among healthcare workers at Kerugoya County Referral Hospital (KCRH) in Kirinyaga County, Kenya. using the Adult Personal Resilience Questionnaire (APRQ), the study assessed four dimensions of personal resilience: Determination, Endurance, Adaptability, and Recuperability. Results

showed high levels of resilience across all dimensions. In the Determination dimension, the average score was 4.42, with 57.1% of respondents strongly agreeing on setting and achieving goals. Endurance scored 4.18, with 50.3% affirming their ability to withstand hardships. Adaptability had a score of 4.06, highlighting the healthcare workers' ability to navigate challenges and adapt to diverse circumstances. Finally, Recuperability scored 3.93, showing significant agreement on the ability to recover from setbacks and adversity. These results demonstrate that healthcare workers at KCRH possess robust resilience, which is crucial for managing the high-stress environments and emotional strains typical in healthcare settings. Table 1 below shows data on personal resilience as observed in the study

Table 4. 8: Personal Resilience Descriptive Statistics

Dimension	Statement	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	Score (1-5)
Determination	Once I set a goal, I am determined to achieve it	(0)0.0%	(4)2.7%	(5)3.4%	(53)36.7%	(84)57.1%	4.48
	I persevere at the things I decide, despite difficulties	(0)0.0%	(4)2.7%	(6)4.1%	(52)35.4%	(85)57.8%	4.48
	Being determined is an important part of my character	(0)0.0%	(1)0.7%	(12)8.2%	(59)40.1%	(75)51.0%	4.44
	I keep trying for the things I want until I reach them	(1)0.7%	(1)0.7%	(14)9.5%	(48)32.7%	(83)56.5%	4.41
	It is in my nature to be persevering	(2)1.4%	(5)3.4%	(14)9.5%	(54)36.7%	(71)48.3%	4.29
Average score							**4.42**
Endurance	I am able to live through difficult times	(0)0.0%	(3)2.0%	(19)12.9%	(73)49.7%	(52)35.4%	4.21

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	I can withstand difficult situations	(1)0.7%	(3)2.0%	(20)13.6%	(63)42.9%	(60)40.8%	4.19
	I can endure the problems that life brings	(0)0.0%	(4)2.7%	(22)15.0%	(62)42.9%	(58)39.5%	4.18
	I can survive even the hardest of times	(0)0.7%	(3)2.0%	(24)16.3%	(63)42.2%	(57)38.8%	4.16
	I can endure even when I am attacked	(0)0.0%	(6)4.1%	(23)15.6%	(75)51.0%	(43)29.3%	4.14
Average score							**4.42**
Adaptability	I have the ability to adapt to difficult situations	(3)2.0%	(8)5.4%	(18)12.2%	(61)41.5%	(57)38.8%	4.10
	I can change to fit into many kinds of circumstances	(2)1.4%	(9)6.1%	(20)13.6%	(67)45.6%	(49)33.3%	4.10
	I can find ways to adapt to unexpected conditions	0)0.0	(4)2.7%	(28)19.0%	(59)40.1%	(56)38.1%	4.05
	I am well able to adjust to problems that confront me	(2)1.4%	(4)2.7%	(27)18.4%	(65)44.2%	(49)33.3%	4.05
	I am very flexible when my environment changes	(0)0.0%	(0)0.0%	(33)22.4%	(66)44.9%	(48)32.7%	4.03
Average score							**4.06**
Recuperability	I recuperate even from things that hit me hard	(1)0.7%	(6)4.1%	(27)18.4%	(74)50.3%	(39)26.5%	4.00
	I recover from any misfortune that happens to me	(3)2.0%	(6)4.1%	(25)17.0%	(71)48.3%	(42)28.6%	3.98
	I am able to bounce back from any kind of adversity	(3)2.0%	(8)5.4%	(27)18.4%	(63)42.9%	(46)31.3%	3.97

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	I always resume my life regardless of the type of setback	(3)2.0%	(7)4.1%	(32)21.8%	(53)36.1%	(53)36.1%	3.96
	I can recover from any type of problem	(6)4.1%	(17)11.6%	(35)23.8%	(35)23.8%	(54)36.7%	3.78
Average score							**3.938**

Summary

The study assessed personal resilience levels among healthcare workers at Kerugoya County Referral Hospital in Kirinyaga County, Kenya. Using a five-point Likert scale, the study evaluated four dimensions of resilience: Determination, Endurance, Adaptability, and Recuperability, with scores below 3.00 indicating insufficient resilience (16). There was high resilience across all dimensions, with scores of 4.42 in Determination, 4.18 in Endurance, 4.06 in Adaptability, and 3.93 in Recuperability, indicating sufficient resilience in these areas. In the Determination dimension, 57.1% strongly agreed on setting and achieving goals, while 57.8% showed perseverance through difficulties. Endurance dimension results showed that 50.3% could withstand hardships. Adaptability scores indicated that 41.5% could navigate challenging situations. Ability to recover from setbacks was significant. Notably, resilience alone might be insufficient for critical care nurses facing moral distress, underscoring the need for additional support systems. Overall, the study underscores high resilience levels among healthcare workers at KCHR, while also pointing out the importance of comprehensive support to address specific challenges.

Conclusion

The overall findings indicate that healthcare workers at KCRH exhibit substantial resilience, with an overall mean score of 4.15 across all dimensions. Specifically, the resilience dimensions showed high levels, with Determination scoring an average of 4.42, Endurance 4.18, Adaptability 4.06, and Recuperability 3.93. These findings demonstrate the healthcare workers'

robust capacity to set and achieve goals, persevere through challenges, adapt to challenging circumstances, and recover from setbacks. The study highlights the critical role of personal resilience as a protective factor against the highly stressful environments typical in healthcare settings. The high resilience levels observed suggest that these healthcare workers are well-equipped to manage the emotional and physical demands of their roles. However, the study also emphasizes the importance of ongoing support systems and interventions to further enhance resilience and address any underlying vulnerabilities. Thus, enhancing personal resilience among healthcare workers is critical to improving their well-being and, by extension, the quality of patient care they provide.

Recommendations

There is need for Kerugoya County Referral Hospital (KCRH) to implement resilience training programs, provide mental health support, foster a supportive work environment, enhance work-life balance, conduct regular assessments, develop crisis intervention strategies, promote professional development, and strengthen organizational policies. These measures would bolster healthcare workers' resilience, ensuring their well-being and improving patient care quality at the hospital.

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ASSESSING THE LEVEL OF VICARIOUS TRAUMA AMONG HEALTHCARE WORKERS AT KCRH, KIRINYAGA COUNTY, IN KENYA.

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Abstract

Vicarious trauma is referred to the emotional and psychological distress experienced by health care workers, who directly absorb the traumatic experiences of patients, thus disrupting their sense of emotional safety, trust, self-esteem, and intimacy. The broad objective of this study was to measure the level of vicarious trauma among healthcare workers at Kerugoya County Referral Hospital (KCRH), Kirinyaga County. The study sampled 149 healthcare workers using multistage sampling procedure. Questionnaires were used to collect data; Socio-Demographic Questionnaire, Vicarious Trauma Scale (VTS). The data was analyzed using statistical software SPSS version 27 and presented in summary tables, detailing frequencies, percentages, means, and standard deviations. The study findings show that healthcare workers at KCHR showed a moderate level of Vicarious Trauma levels with a score of 33.3. The data hold significant importance for evidence-based decision-making, particularly in designing tailored healthcare training and support networks and provides vital insights for hospital administrators to implement effective interventions. Policymakers can use this data to formulate policies addressing trauma management and worker well-being, thus directly impacting management of mental health issues which is a growing public health concern.

Keywords: Vicarious Trauma, Traumatic events/experiences, Mental Health and Wellbeing of Health Care Workers

Background to the Study

Vicarious trauma refers to the profound emotional and psychological impact experienced by individuals, such as therapists or other professionals, who are exposed to traumatic experiences of others [1]. In this study it refers to emotional and psychological distress experienced by health care workers, who directly absorb traumatic experiences of patients, thus disrupting their sense of emotional safety, trust, self-esteem, and intimacy.

Healthcare professionals, including doctors, nurses, psychologists, and those performing other specialized roles, are essential in delivering quality care to patients, both within healthcare facilities and in community settings (WHO, 2021). Their responsibilities include assessing, treating, and managing various health conditions. However, this crucial role exposes them to patients who have undergone physical and psychological trauma, making them vulnerable to experiencing vicarious trauma themselves (Remigio Baker et al., 2020).

Untreated vicarious trauma experienced by healthcare workers can result in burnout, compassion fatigue, and diminished job satisfaction, ultimately impacting their ability to deliver quality care. The emotional toll of witnessing patient trauma may jeopardize both patient outcomes and satisfaction. Healthcare providers' mental and emotional health is closely intertwined with the quality of care they can offer thus unresolved vicarious trauma may induce emotional detachment, decrease empathy, and impair decision-making, increasing the likelihood of medical errors. It is therefore, imperative to address vicarious trauma to safeguard healthcare worker well-being to maintain the therapeutic bond with patients, and uphold optimal healthcare standards (Mento, 2020).

Current research on vicarious trauma among healthcare workers reveals gaps in specificity to certain settings or populations, inconsistent measurement tools, and limited evidence-based

interventions [5]. Studies often overlook the unique challenges faced by different specialties or environments, necessitating targeted research. Additionally, reliance on self-report measures and oversight of cultural factors in vicarious trauma assessment pose limitations. Notably, effective interventions tailored to healthcare workers' needs are lacking, despite increasing awareness. Addressing these gaps is crucial for enhancing support and resilience among healthcare professionals to ultimately improving patient care and well-being.

Statement of the Problem

Despite the critical role of healthcare workers in delivering quality care, prevalence and impact of vicarious trauma among them is inadequately addressed. Untreated vicarious trauma can lead to burnout, compassion fatigue, and decreased job satisfaction among healthcare professionals, ultimately compromising patient care quality and outcomes. Additionally, vicarious trauma may manifest in emotional detachment, reduced empathy, and impaired decision-making, posing risks of medical errors. However, there is limited understanding of the specific factors contributing to vicarious trauma within different healthcare settings and populations, as well as a lack of evidence-based interventions to mitigate its effects. Addressing these gaps is essential to safeguarding the well-being of healthcare workers and optimizing patient care delivery. The purpose of the study is to assessing the level of vicarious trauma among healthcare workers at KCRH, Kirinyaga County, in Kenya

Literature Review

Vicarious Trauma among Healthcare Workers

Vicarious trauma among healthcare workers necessitates exploration of the nature of their exposure to traumatic events. A previous study by Siebenhüner et al. (2020) highlighted that healthcare professionals, including doctors, nurses, and emergency responders, are routinely immersed in environments where they witness or hear about distressing incidents such as

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accidents, violence, illness, and death. This exposure can also occur through direct encounters with patients or indirectly through the accounts provided by colleagues, medical records, or media reports [7]. However, Dar & Iqbal, 2020 in their study stated that the nature and intensity of exposure may vary depending on the healthcare setting, specialty, and individual role within the healthcare system. Regardless of the specific context, the cumulative effect of repeated exposure to trauma can significantly impact the mental well-being of healthcare workers, underscoring the importance of understanding and addressing vicarious trauma within this population.

An empirical review by Habtamu et al. (2021) and Hallinan et al. (2019) sheds light on the significant impact of vicarious trauma on the mental health of healthcare workers. The constant exposure to traumatic events in clinical settings can lead to a range of adverse psychological symptoms among healthcare professionals. These symptoms may include intrusive thoughts, nightmares, hypervigilance, emotional numbing, anxiety, depression, and even post-traumatic stress disorder (PTSD). These findings underscore the pervasive nature of vicarious trauma and its potential to detrimentally affect the well-being and functioning of healthcare workers. There is need to implement proactive measures to address and mitigate the negative psychological effects of vicarious trauma among healthcare professionals, highlighting the urgency for organizational support and interventions aimed at promoting resilience and coping strategies within healthcare settings.

A study by Escudero-Escudero (2020) [10], highlighted that factors, such as the intensity and frequency of exposure to traumatic events, personal history of trauma, lack of social support, and insufficient coping mechanisms, significantly increase vulnerability of healthcare workers to vicarious trauma. The detrimental effects of vicarious trauma on professional outcomes, including decreased job satisfaction, burnout, compassion fatigue, and reduced quality of patient care have been cited [7,11]. These findings underscore the critical need for healthcare

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organizations to prioritize identification and mitigation of risk factors associated with vicarious trauma among their staff, while also implementing interventions aimed at fostering resilience and enhancing coping strategies to safeguard the well-being of healthcare professionals and optimize patient care outcomes.

Empirical inquiries into the organizational and cultural aspects of vicarious trauma among healthcare workers, as explored by Wilson et al. (2020) [12], unveil a complex interplay among workplace dynamics, stigma, help-seeking behaviors, and enduring repercussions. Dordunoo's (2021) investigation underscores the significance of organizational cultures that prioritize staff well-being, foster transparent communication, and address systemic challenges like workload and staffing to mitigate vicarious trauma and its adverse outcomes have been cited [13]. The pervasive stigma surrounding mental health in healthcare settings, potentially hindering healthcare professionals' willingness to seek assistance for vicarious trauma-related symptoms has been highlighted [14]. Similarly, the importance of combating stigma and fostering a culture of psychological safety to encourage early intervention and support-seeking has been stressed [15]. A longitudinal study emphasized the enduring impact of vicarious trauma on healthcare workers' mental health, job satisfaction, and overall quality of life, underscoring the ongoing need for comprehensive prevention, intervention, and sustained support initiatives within healthcare environments [16].

Research Methodology

The research enrolled 149 healthcare workers obtained from a group of licensed social workers, most of whom reported being exposed to working directly with distressed or traumatized clients. A multistage sampling method was used to ensure a diverse representation of healthcare workers at KCRH in Kirinyaga County, Kenya. Various hospital departments served as primary sampling units, from which participants were randomly selected, ensuring representation across specialties and roles were used. the study. Healthcare workers directly involved with

trauma patients and exposed to explicit details of trauma events, were included in the investigation. The Vicarious Trauma Scale (VTS) is recognized for its reliability and sound psychometric properties, with reliability scores ranging from 0.81 to 0.96 and 0.76 to 0.83 for different dimensions [17] showing good internal consistency reliability ($\alpha = 0.77$) among licensed social workers who frequently work in traumatic circumstances. The VTS developed to assess distress levels from working with traumatized clients, has demonstrated good validity across various populations [7]. Its strong content validity stems from resilience measures and theories [12] and it exhibits excellent convergent and divergent validity [19]. Scores on the VTS correlate well with other vicarious trauma measures and predict future VT symptoms among health workers [17]. These participants were deemed suitable for the study due to their exposure to the risk of developing VT during their work. Consequently, a sample of 149 healthcare workers out of a potential 237 was included in the study. Excluded from the study were healthcare workers not directly involved with trauma patients, those absent during the study period, those who declined participation. Vicarious Trauma Scale (VTS) questionnaires were used to evaluate the subjective distress experienced when working with clients who have experienced trauma. Data was analysed using statistical software SPSS version 27 and presented on tables, providing frequencies, percentages, means, and standard deviations. The researcher obtained ethical approvals and informed consents, ensuring confidentiality.

Results

Level of vicarious trauma among healthcare workers in Kerugoya County Referral Hospital, Kirinyaga County, Kenya

The study aimed to assess the Level of vicarious trauma among healthcare workers. VT was measured using the Vicarious Trauma Scale (VTS) to assess the subjective distress experienced when working with clients who have experienced trauma. The VTS comprises 8 items, each rated on a 7-point Likert scale where respondents express their level of agreement. These 8 items

collectively yield a total score ranging from 8 to 56. Scores falling between 8 and 28 suggest low levels of Vicarious Trauma, scores between 29 and 42 indicate moderate levels, and scores between 43 and 56 suggest high levels of Vicarious Trauma.

Table 1: Vicarious Trauma Descriptive Statistics per Items

Statement	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree	Mean	Std. Deviation
VTS_1_My job involves exposure to distressing materials and experiences.	(0)0.0%	(8)5.4%	(7)4.8%	(7)4.8%	(18)12.2%	(49)33.3%	(58)39.5%	5.82	1.409
VTS_2_My job involves exposure to traumatized or distressed clients.	(1).7%	(12)8.2%	(4)2.7%	(9)6.1%	(19)12.9%	(39)26.5%	(63)42.9	5.73	1.572
VTS_7_Sometimes I feel overwhelmed by the workload in my job.	(2)1.4%	(14)9.5%	(12)8.2%	(23)15.6%	(29)19.7%	(35)23.8%	(32)21.8%	5.01	1.639
VTS_6_Sometimes I feel helpless to assist my	(4)2.7%	(15)10.2%	(13)8.8%	(20)13.6%	(28)19.0%	(29)19.7%	(38)25.9%	4.99	1.759

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Statement	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree	Mean	Std. Deviation
clients in the way I would like.									
VTS_3_I find myself distressed by listening to my clients' stories and situations.	(2)1.4%	(26)17.7%	(9)6.1%	(21)14.3%	(26)17.7%	(25)17.0%	(38)25.9%	4.84	1.843
VTS_5_I find myself thinking about distressing material at home.	(2)1.4%	(32)22.4%	(13)8.8%	(19)12.9%	(24)16.3%	(33)22.4%	(23)15.6%	4.55	1.801
VTS_8_It is hard to stay positive and optimistic given some of the things I encounter in my work.	(3)2.1%	(25)17.1%	(18)12.3%	(24)16.4%	(20)13.7%	(31)21.2%	(25)17.1%	4.50	1.830
VTS_4_I find it difficult to deal	(9)6.1%	(37)25.2%	(21)14.3%	(14)9.5%	(17)11.6%	(13)8.8%	(36)24.5%	4.20	2.089

Statement	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree	Mean	Std. Deviation
with the content of my work.									
Average	2.2%	15.8%	8.8%	12.6%	15.9%	19.9%	24.8%		

Results on table 1 indicate that a significant majority of respondents with (58)39.5%, (Mean: 5.82, Std. Deviation: 1.409) strongly agree that their job entails exposure to distressing materials and experiences, suggesting that this aspect of their work is prevalent and potentially impactful. 6.3 respondents (42.9%) (Mean: 5.73, Std. Deviation: 1.572) strongly agreed that their job involves exposure to traumatized or distressed clients, indicating the significance of this aspect on their well-being. A notable number of participants (35)23.8% (Mean: 5.01, Std. Deviation: 1.639), acknowledge feeling overwhelmed by the workload, highlighting a significant challenge in managing work demands. Moreover, a considerable proportion of health care workers (38)25.9% (Mean: 4.99, Std. Deviation: 1.759)., strongly agreed that they feel helpless to assist clients as desired, suggesting potential challenges in meeting client needs effectively.

38 of respondents (25.9%) (Mean: 4.84, Std. Deviation: 1.843), strongly agreed that they are distressed by listening to clients' stories and situations, indicating emotional impact from their work. Furthermore, a significant proportion, totaling (33)22.4% (Mean: 4.55, Std. Deviation: 1.801). agreed that they think about work related distressing situations at home, suggesting work-related thoughts intrude into personal life. 31 respondents with 21.2% (Mean: 4.50, Std. Deviation: 1.830), agreed that it's hard to stay positive and optimistic due to work encounters, indicating potential challenges in maintaining a positive outlook. While (36)24.5% respondents

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(Mean: 4.20, Std. Deviation of 2.089.) strongly agreed that they find it difficult to deal with the content of their work.

Table 2: Level of VT among the healthcare workers at KCRH

No of item	Level	Mean score	No of health care workers
8	Low VT	20.9	39
8	Moderate VT	35.0	19
8	High VT	44.1	89
Average		**33.3**	**147**

The result presented on table 2 above shows the level of VT among the healthcare workers at KCRH. 39 healthcare workers scored 20.9 out of 56, implying a low level of vicarious trauma. Theoretically, this suggests a relatively minor impact of VT-related symptoms within this group. 19 healthcare workers scored 35.0 out of 56, indicating a moderate level of VT suggesting a more pronounced experience of VT symptoms compared to those in the low VT category. Notably,89 healthcare workers scored 44.1out of 56, signifying a high level of vicarious trauma implying that a substantial portion of healthcare workers in KCHR are grappling with high level of VT-related symptoms.

Summary

The study conducted at Kerugoya County Referral Hospital in Kirinyaga County, Kenya, aimed to assess the levels of vicarious trauma among healthcare workers, utilizing a Likert scale to gauge respondents' perceptions. There was moderate level of vicarious trauma, with an average

mean score of 33.3, indicating a moderate or average level of vicarious trauma. A significant portion of respondents 58, (39.5%) strongly agreed that their job involved encountering distressing materials and experiences, while 63, (42.9%) strongly agreed that their job entailed interacting with traumatized or distressed clients. These findings underscore the need for interventions to address the mental health and job satisfaction of healthcare professionals, consistent with previous studies highlighting the impact of prolonged exposure to trauma on burnout and compassion fatigue (Neillie & Rose, 2021). Additionally, challenges in workload management were reported by 35 of participants (23.8%), while feelings of helplessness were indicated by 38 (25.9%) healthcare workers. These findings echo the importance of strategies to mitigate overwhelming stress and enhance support systems (Nassar et al., 2020). Difficulty in maintaining positivity and coping with work content was expressed by a majority of respondents (31, 21.2%), with a substantial proportion (24.5%) finding it difficult to deal with the content of their work. These findings align with previous research findings highlighting the prevalence of vicarious trauma among healthcare workers in Kenya and the importance of addressing its impact on professionals' mental health (Kokonya et al., 2015).

Conclusion

The research conducted at Kerugoya County Referral Hospital in Kenya provides insight into the prevalence and impact of vicarious trauma (VT) among healthcare professionals. The findings indicate a significant acknowledgment of VT among respondents, underscoring a pervasive issue among the hospital's staff. High levels of exposure to distressing materials and clients further substantiate this acknowledgment. Additionally, challenges in maintaining a healthy work-life balance and the strain on mental well-being highlight the occupational setting's impact on healthcare personnel. These findings align with the World Health Organization's assessment of VT among healthcare professionals, emphasizing the global nature of this issue and the necessity for comprehensive intervention strategies. Similar high rates of

VT reported in studies from the USA, Canada, and Australia underscore the universal need for tailored support mechanisms and interventions. Urgent organizational support and resources are essential to address the challenges posed by VT among healthcare professionals not only at Kerugoya County Referral Hospital but also worldwide. Efforts should prioritize interventions promoting mental health and well-being, fostering a healthy work environment, and providing accessible support services for healthcare personnel facing vicarious trauma.

Recommendations

There is need for a comprehensive approach to address vicarious trauma among healthcare workers, recommending strategies for hospital management, policy makers, and academics alike. Hospital management is advised to prioritize resilience-building interventions, adjusting workload, and cultivating a supportive work environment. Implementing trauma-informed care through staff training is emphasized. Policy makers, particularly within the Ministry of Health, are should allocate resources, develop national guidelines, and raise public awareness to support healthcare workers' well-being. Collaboration between academicians, healthcare workers, policymakers, and community stakeholders is encouraged to develop culturally-sensitive interventions and disseminate research findings effectively. Through these concerted efforts, healthcare organizations and policymakers can ensure resilience and well-being of healthcare workers, ultimately enhancing the quality of care provided to the population in Kenya.

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RE-ENGINEERING UNIVERSITY LIBRARY SERVICES WITH EMERGING TECHNOLOGIES IN KENYA: PROSPECTS AND CHALLENGES

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Abstract

The current wave of advancements in technology has significantly altered the quality of services provided by university libraries, as well as the expectations that society has of them. Consequently, if university libraries don't start utilizing emerging technologies to enhance delivery of information and services, they risk becoming obsolete in the twenty-first century. It is against this background that this paper examines prospects and challenges associated with use of emerging technologies by university libraries in Kenya. By studying emerging technologies and their application in university libraries, librarians in Kenya will be able to foster new ways of service delivery which will help them to maintain their competitiveness in drawing and retaining patrons. This article reviews previous studies, explores various emerging technologies available in Kenya, how they can be utilized by university libraries and the challenges arising from their implementation. Results show that there are many opportunities for improving service delivery in Kenyan university libraries through emerging technologies such as mobile technologies, Instant Messaging, QR Code, mobile Apps, among others. However, although Kenyan university libraries are making efforts towards adopting emerging technologies for service delivery, the rate of adoption is still slow, and the variety of technologies being adopted is still narrow in comparison to the options available. This has been attributed to challenges such as lack of ICT skills, limitation of funds, policies, support from top management, as well as power outage, poor attitude of library staff and poor infrastructure. The study recommends that university libraries in Kenya should adopt emerging technologies in order to deliver exceptional services. Additionally, training of library staff, improving ICT infrastructure and top organization support amongst other factors should be put in place in order to enhance adoption of emerging technologies.

Keywords: Emerging Technologies, Library Services, Library Automation, University Libraries

Introduction

University libraries gather, preserve, and make information resources available to students, faculty and staff, as well as other users, hence, they support their parent institutions' academic and research endeavors [1]. By supporting the institutions' research, teaching and learning, activities, they help the institutions achieve their mission and vision. Without libraries that are sufficiently stocked with print resources, Information and Communication Technology (ICT) along with its associated technologies, employees with adequate training and high quality information services that are in line with the needs of the patrons, the purpose of universities cannot be fulfilled [2)]. The development of the Internet and associated technologies has resulted in a fundamental shift in how library patrons access information, interact with one another, and cooperate. Similar to this, the breadth and depth of what library patrons can do with new applications powered by Information and Communication Technology (ICT) are expanding daily [3]. This change requires librarians to gain skills in handling emerging technologies, information dissemination, scholarly interaction, and strategy creation [4]. As agents of change for modern and cutting-edge technology, librarians have always responded to new technologies that improve their products and services. This paper therefore highlights the various emerging technologies available in Kenya and the need for University librarians in Kenya to apply these emerging technologies to improve service delivery and documents the challenges associated with utilizing emerging technologies in Kenyan university libraries.

Need of the Study

It is important for university libraries to embrace emerging technologies in order to satisfy their patrons' expectations. Given the fast-changing technology landscape, Kenyan university libraries must adapt and change to enable them effectively manage the evolving needs and demands of their patrons. By implementing technologies university libraries will be able to keep

up with the most recent developments in the field to support research and maintain their competitiveness in keeping patrons abreast with emerging technologies.

Definition of Emerging Technologies

Emerging technologies are the new and inventive technologies that are either being developed now or are anticipated to be developed soon [5]. Such technologies are generally distinguished by their capacity to have significant impacts on industry and daily elements of life [6]. In the context of information science and libraries, emerging technologies are defined as technological advancements that have lately been found to be pertinent to library service delivery [6]. Several studies [7-11] have cited the examples of these technologies that can be used to support university libraries in service provision including Quick Response (QR), barcode technology, data mining, Artificial Intelligence (AI), web conferencing, cloud computing, virtual reality, robotics, social network websites technologies, semantics technologies, Radio Frequency Identification (RFID) technologies, institutional repositories, Library Mobile Apps, smart library research data management tools among others. According to these studies, there are a lot of new technologies that are useful for librarians, especially when it comes to assisting scholars. Technology is developing quickly, as noted by Moruf and Dangani [12], and potential users, like university libraries, can choose which ones to use. For this reason, it's critical to align the technology at hand with the pertinent services that libraries can offer researchers in the twenty-first century.

Opportunities for Emerging Technologies in university libraries in Kenya

As new trends and technologies emerge, university libraries must constantly adapt [5]. Given that research and information management have been demonstrated to benefit from developing technologies, university libraries in Kenya have no option but to incorporate emerging technologies in their operations in order to improve service delivery [6]. Some of the key emerging technologies, along with some suggestions on how university libraries in Kenya can utilize them to improve their service delivery as discussed below.

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1. Mobile Technologies

The rise in popularity of mobile devices like tablets and smartphones has had a noticeable effect on how people interact with and obtain information in recent years [5]. Consequently, university libraries have recognized the potential of mobile technologies and implemented the same to improve service delivery. The ability to access resources and services while on the go is one of the major benefits of mobile technologies for university libraries. In order to facilitate the process, numerous university libraries have created mobile applications that enable patrons to search library catalogues using their mobile devices, make book reservations, and access electronic resources. This has created an environment that allows convenience and accessibility of library services for people who have no time or means of visiting the physical library. Mobile technologies have also created new channels for interaction between university libraries and their patrons, in addition to improving convenience and accessibility. University libraries in Kenya can also use mobile technologies to provide access to electronic information resources. The library's OPAC can also be accessible over mobile devices which makes it easy to retrieve resources in the library. Similarly, they can use instant messaging such as WhatsApp to interact with users so as to share news, advertise events as well as provide reference services. Instructional materials such as tutorials or videos can also be shared with the patrons through mobile technologies.

2. Instant Messaging (IM) / Chat service

Instant messaging (IM) or Chat service is a method of text-based interaction between two or more people in real time. This provides instantaneous communication between a customer and a customer service provider [13]. Ayo-Olafare [14] noted that information centres are currently using IM such as WhatsApp to provide "real-time reference" services, enabling users to communicate in real-time with information providers, as if they were in a face-to-face reference situation. Moreover, information centres have added a static live chat widget to those sites

where users are most likely to require immediate assistance, including the library home page, catalog page, and research guides [15]. The libraries can thus utilize IM mobile applications such as WhatsApp to provide reference services, communicate with and send overdue and renewal notifications to patrons. Libraries can also use WhatsApp to create groups for patrons who share the same interests for the purpose of sharing information and collaboration. They can also include a chat box on their OPAC where users can instantly ask and get answers to questions regarding the library sources and services.

3. QR Code

This is a barcode with two dimensions that allows for fast access to material or information by scanning it with a smartphone or tablet [5]. There are several ways that university libraries employ QR codes to improve information access and user experience. One of the common usage of QR codes in university libraries is in accessing library resources quickly. For instance, physical books and library signage may have QR codes that, when scanned, provide users with additional details about the book or resource. The libraries can thus use QR codes to provide library orientation and tours, educate users on library resources and services and gather feedback as well as suggestions for improvements from the patrons.

4. Facial Recognition

This is a biometric technique that determines an individual's identity digitally by statistically measuring their facial traits [16]. The libraries can use facial recognition in place of the traditional user cards to identify patrons who walk into the library in terms of who they are, their residence, the books they have checked out, as well any books in their possession that may be overdue. Even though facial recognition makes daily living easier, there are serious security and privacy risks that may be of concern to patrons [17].

5. Mobile Apps

The number of people using mobile devices has sharply increased during the last few decades. This is because many individuals now rely heavily on smartphones to access the internet. According to Rehm and Uszkoreit [18], a mobile app is a software that is downloaded onto a mobile device and uses the touchscreen to deliver information and services. Enhancing access and convenience of library resources is possible with the aid of mobile applications. In addition, personalized services, such as recommendations and customized search results based on user interests and usage patterns, can be offered to users [19]. By doing this, patron engagement with the library increases and the entire user experience is enhanced. The libraries can also utilize mobile apps to enable users access information resources as well as provide services. Thus, Mobile apps such as Mpesa can also be used for payment transactions in instances where users need to pay overdue fines or pay for photocopying services.

6. Social Networking service

This is a web-based software that makes it easier to build social networks virtually, for people who have shared interests and goals or who are intrigued about what others are pursuing [20]. Most of the social network services, according to Ayo-Olafare [14] are web-based interfaces that enable user communities to engage with one another by utilizing features such as messaging, chat, email, audio and video chat, blogging, discussion forums and file sharing among others. Faisal [21] further noted that the main reasons why information providers use social networking is to get in touch with the users at their convenience, market information resources and events, offer current awareness services and interact with users and obtain feedback. The libraries can also use social networking platforms like Facebook, Instagram, LinkedIn and Twitter to advertise services and resources including research guides, workshops, and new acquisitions. This would in turn increase user awareness and utilization of the library's resources. Additionally, they could use these sites to communicate with the patrons and respond to their

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enquiries. Further, the libraries can advertise their resources and services as well as publish updates, event announcements, and daily news on these channels.

7. Big Data

This is a term used to refer to the massive volumes of structured and unstructured data that are produced in many fields [22]. Through the acquisition of insights into the behavior of users and their preferences, big data analytics can help university libraries improve their service delivery [5]. They can also use big data analytics to monitor the use of their resources such e- journals, databases and e-books in order to determine which resources are most popular, when they are most used, and what kinds of devices are using them. Additionally, by examining user behavior including their search terms, browsing habits, and usage of library resources, the libraries can find gaps in their collections and make well-informed judgments about procurement of the needed collection. Moreover, tailored recommendation systems that take in account the patrons' interests and usage patterns can be created by university libraries using big data analytics to propose appropriate books and articles to users.

8. Internet of Things (IoT)

This is a network of actual items such as cars, buildings, as well as other devices that have sensors, software, and connection that enables them to gather and share data [16]. These days, the most significant innovation for library services is the Internet of Things [5]. Libraries in Kenya for example can use Internet of Things (IoT) technology to provide orientation, as well as a virtual tour of the library to recently registered users where they can use a mobile app to download and watch a video tour that takes them through an overview of the library. To further assist users in retrieving resources they want, a shelf guide can be generated from their favorite list using Internet of Things (IoT) technology. The libraries can also automate regular chores like inventory management, book check-in and check-out, and cleaning schedules in order to free up library staff time for other duties. Last but not least, IoT technology can notify users of

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accrued library fines, and let them make payments online without having to wait in ques in the library.

9. Block chain Technology

This is a decentralized ledger technology that removes the requirement for a centralized authority and enables safe and open transactions [5]. In essence, Blockchain technology permits members within a group to record transactions in a shared ledger, meaning that once a transaction is published, it cannot be modified while the blockchain network is in operation [23]. Blockchain technology may be used by libraries to manage digital rights and licenses for materials like e-books and e-journals. It can also be used to ensure long-term accessibility and preservation of electronic resources by creating unchangeable records of usage rights, ownership, and licensing. Furthermore, its powerful and decentralized storage networks can offer a visible and dependable audit record of preservation operations. Blockchain technology can also help the university libraries to simplify and lower transaction costs associated with interlibrary loans by enabling safe and transparent tracking of such activities. Additionally, it can be used to build decentralized platforms for university research sharing and open-access publishing.

10. Virtual reality

According to Avila [24], Virtual Reality (VR) is "a computer-generated simulation of a three-dimensional image or environment that can be interacted with by a person wearing specialized electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors, in a way that appears real". Oyelude [25] further noted that this technology intends to give users the impression that they are actually present and are having a real time experience of what is happening. Virtual Reality can be utilized by university libraries in Kenya to help librarians with provision of information literacy training. Through virtual tours, librarians can show users how to navigate the space and virtually locate resources in the library. Varnum [26] asserted that

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Virtual reality is one way to incorporate powerful computing technology into information literacy instruction since it utilizes an experiential learning approach in which students apply and conceptualize the material being taught through their own experiences.

11. Augmented Reality (AR)

This technology aims at enhancing the real environment with layers of digital data, or the real-time reality of the user with the goal of digitally integrating and expanding it [27]. Varnum [26] asserted that AR technologies have played a great role in taking university libraries from simple facilities where users can access materials, to transforming them into innovative spaces with a capacity for dynamic interactions and experiences. By integrating AR in university libraries in Kenya, patrons can engage in immersive and interactive experiences, including the generation of virtual tours and interactive maps that facilitate library navigation. Moreover, Augmented Reality (AR) can enhance the way that library resources are found and explored by allowing users to get additional information such as summaries, reviews, and related resources by scanning book covers or QR codes, hence boosting user interaction and helping users make well-informed decisions.

12. Artificial Intelligence (AI)

This is a field of computer science that seeks to close the gap that exists between humans and machines. Its goal is to build machines that think or act like humans [5]. University libraries can leverage Artificial Intelligence to carry out tasks such as subject indexing, descriptive cataloging, reference services, shelf reading, technical services, collection development, information retrieval and trends in collection development, circulation statistics and patron usage. The libraries can also employ natural language processing algorithms, which translate user queries and return pertinent search results to enhance the search functionality in library databases. Furthermore, by responding to often asked queries, directing users to relevant resources, and offering crucial research support, AI-driven Chatbots can offer prompt and

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effective customer care to patrons. AI can also be used by libraries to provide users with tailored recommendations depending on their search, borrowing, and reading histories.

13. Expert Systems

These are software programs designed to imitate the judgment of humans in a specific field [5]. They seek to address complicated challenges in a specific field by mimicking the decision-making process of an expert [28]. Expert systems can be used by the university libraries to offer users guidance, reference services, and answers to often asked queries. They can also assist in examination of user behavior, circulation, and library usage statistics in order to offer suggestions for collection growth. Moreover, they can assist the libraries in automating the process of cataloging and classifying library resources by discovering pertinent subject headings and class numbers based on the content of the resources. Additionally, by analyzing users' search terms and providing suggestions that are tailored to their requirements, Expert Systems can also be utilized to help users find relevant content. They are also capable of analyzing the state of library resources and suggesting the best conservation and preservation strategies.

14. Semantic Web

Semantic Web, which is an attribute of the Internet, is the capacity to exchange and reuse data across numerous systems, apps, and platforms [5]. It describes and presents data in a machine-readable format using a set of standards and technologies so that computers can comprehend and interpret the meaning of the data. This technology holds promise for revolutionizing university libraries' data management and sharing practices, fostering cooperation and interoperability, and improving student, faculty, and researcher experiences [5]. Adoption of the semantic web technology by university libraries in Kenya would help in standardization of description and organization of metadata and make it possible for them to handle and exchange metadata among many platforms and systems. Additionally, it would improve the university library catalogues' search capabilities by returning more precise and pertinent search results

depending on the context and meaning of the user queries. The semantic web can also be used by university libraries to improve the user experience by providing personalized suggestions depending on user preferences, interests, and previous search history.

15. E-resources

The term "e-resources" describes digital or electronic materials that are accessible online [5]. They include electronic books, electronic journals, online databases, audio and video materials, and other electronic resources that may be accessed online or through other electronic channels. In the recent past, there has been a high tendency of researchers making e-resources their first choice when it comes to seeking information resources for their research [6]. More often, university libraries acquire electronic resources to support instruction, research, and learning. Expanding e-resource collections to accommodate patrons' evolving requirements is a contemporary trend in university libraries [6]. University libraries can thus take advantage of the Open access (OA) to expand their e-resources collection so as to meet the increasing demand for digital content by the patrons. They can also increase the range of the e-resources provided to include interactive and multimedia content in order to enhance learning and research.

16. Data mining

One of the most helpful new technologies that information professionals can employ to create order in the chaotic world of information is data mining tools [6]. By offering insight into the makeup of database collections, data mining enables libraries to assist scholars in an efficient manner. Using data mining, university libraries can quickly spot new research trends and use that information to offer scholars current awareness services and targeted information distribution, sparing them a great deal of preparatory effort.

17. RSS Feeds

Really Simple Syndication (RSS), through a technology known as Extensible Markup Language (XML), enables a web site to list the most recent updates that have been released, such as lists of

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new journal articles. It also enables anyone using the web to monitor fresh updates on their preferred website(s) [14]. RSS feed readers browse pre-selected websites in search of newly updated information before downloading it directly to the desktop of the user. Using this service, users can syndicate and republish information on the Web. University libraries can use RSS technology to send information on specific subjects to their users through their websites, podcasts and blogs or produce RSS feeds that users can subscribe to for information on new additions to collections, services, and subscription database content.

18. Live streaming

Multimedia streaming refers to progressive transmission of multimedia files via a computer network, where the final user sees or hears the content as it is being sent by the distributor [14]. Given the availability of network infrastructure and computers to facilitate multimedia streaming, university libraries can leverage live streaming for online instruction by incorporating more interactive media facets. Through live streaming videos, new patrons can receive live orientation, user training sessions and demonstrations on how to utilize various information services such as online databases, online catalogues, discussions, events, and exhibitions. Further, university libraries can include live stream media as part of their collection in order to provide access to them as well as archive them. Applications for digital repositories and technologies for digital asset management make this possible.

19. Podcasting

Podcasting is a combination of the terms broadcasting and iPod, which is a well-known MP3 player manufactured by Apple Computer. This is the technique of recording audio digital media files for online distribution via RSS feeds for computer and portable media player playback [29]. Such feeds can be subscribed to by users, who would then have these files downloaded automatically into the tool they use to manage audio on their personal computers. A feed reader or aggregator that can read feed formats like RSS or Atom can be used to subscribe to, syndicate,

and automatically download new content from a podcast when it is added, setting it apart from other digital media formats [14]. Libraries can employ podcasts to supplement their programs for new patron orientation. They can also use them for information literacy, marketing information resources and provision of news about what is happening in the information centre. According to Kaushik[30], using podcasting technology to provide services in the information centres gives patrons another way to access ready-made content in a portable format that supports a mobile learning environment.

20. Vodcasting

Vodcasting is derived from two words, "video-on-demand" (VOD) and broadcasting. It is similar to podcasting. Ayo-Olafare [14] noted that Vodcasting is used to send video content, whereas podcasting is used to deliver audio files. Like podcasts, vodcasts can be listened to on a computer or a Personal Media Assistant (PMA). Vodcasts can be used by university libraries to give orientation tours and instruction on how to access online resources to patrons. They can also be used in promotion and publicizing of resources and services available in information centres.

21. Blogs

A blog is a type of website that is typically kept up to date by one person and with regular updates consisting of pictures or videos along with commentary and event descriptions [14]. Typically, reverse chronological sequence is used to present entries and are regarded as simple tools for publishing. They give a person or group of people the ability to publish information and leave comments on it [31]. Although most of the blogs are run by subject matter experts who are prepared to share their expertise, ideas and opinions with others, blogs can generally be thought of as online diaries. University libraries in Kenya can use blogs to promote and publicize information services, as well as for outreach activities. Through their blogs, university libraries can enlighten their users and provide information about events and new resources. Blogs can

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also serve as a web interface via which users can access library materials and services offered by the library in addition to providing tools for offering Selective Dissemination of Information (SDI), reference services and Current Awareness Service (CAS) through development of subject-specific blogs.

22. Wikis

A wiki is a group of web pages that anybody with access to can edit or add to by using a streamlined markup language [32]. More often than not, wikis are used to build community and collaborative websites. They are similar to public web pages that anybody with a registered account may edit, add to, and publish content on [14]. Wikis can be used by university libraries as a platform for communication to promote social contact between the librarians and patrons. Within wikis, library staff and users can both exchange queries and information.

23. Remote Access

Remote access enables users to access a device or a network from any location. Through remote access, users have the ability to handle data and files saved on remote devices, facilitating continued collaboration and productivity from any place [5]. A virtual private network (VPN) that offers a secure connection between two devices is used for remote access via the Internet. In essence, the VPN works as a tunnel to maintain the confidentiality and continuity of traffic. Through remote access, university libraries in Kenya are able to have multiple users simultaneously access licensed information resources from anywhere at any time, which enables the user population of information centres to utilize electronic resources to the fullest. These libraries are currently using EZproxy, a URL-rewriting proxy server, as well MyLOFT app to provide remote access to their information resources.

24. Cloud Computing

Cloud computing is built on web technologies thus it is a service offered over the Internet or a network, where a server is connected to a large number of computers [33]. All of the machines

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linked to that server location can use the apps, which are installed on a remote server. Therefore, not every application needs to be set up on a single machine. Platform as a Service (PAAS), Software as a Service (SAAS) and Cloud as a Service (CAAS) are the service paradigms for cloud computing. In order to share scholarly material university libraries can adopt Duraspace, DuraCloud which offers open-source repository solutions for information centres like DSpace and Fedora Commons which are well known for IR solutions. They can also utilize Google Apps such as Gmail, Google Docs, Google Sites, Google Video, and others which are as a result of Google cloud computing project for communication. Libraries can also offer orientation and information literacy classes to their patrons using sved videos, presentations, and files in the cloud.

25. Assistive Technologies

Assistive technologies are electronic solutions that enable individuals with disabilities to access and fully utilize ICTs [34]. According to Midhula and Sudhier [35] access to information sometimes poses a challenge for individuals living with disabilities, and libraries can now be equipped with the newest technology and gather, store, and distribute information to these users in their preferred format. Various assistive technologies are required for different types of disability, for instance, in order for users with visual impairments to make efficient use of printed and digital information materials, they need assistive technology devices, such as computers with screen readers such as Nonvisual Desktop Access and Job Access with Speech (JAWS), screen magnifiers, and voice recognition software, to make efficient use of information [36,37]. Libraries can also provide videos with captions for the hearing-impaired users. Thus, academic libraries should be places that promote inclusion and equitable access for everyone, regardless of physical abilities, by adopting inclusive policies, having trained staff, and embracing assistive technologies [38].

Challenges of Emerging Technologies application in university libraries in Kenya

Despite the advantages of using emerging technologies, research indicates that only few Kenyan university libraries have made significant efforts to provide library and information services that utilize several of these technologies. Several studies [39-44] indicated that university libraries in Kenya have adopted emerging technologies such as Web 2.0 tools, cloud computing, mobile technologies, digital libraries and Internet of Things for provision of information services. This implies that the university libraries are taking steps to leverage emerging technologies in provision of information services. However, the rate of adoption remains slow and the breadth of emerging technologies being utilized is restricted in comparison to the available options. Several factors have been identified as the root cause of this situation, some of which are discussed below.

1. Lack of Technological Literacy

Technological literacy comprises the librarian's ability to consistently use relevant technological tools to manage, assess, and create or produce information that can satisfy or respond to user queries [45]. The university library has become an excellent opportunity for tech-savvy librarians due to the advent of advanced technologies and a range of library materials that are in digital formats [44]. A study by Musangi et al [43] revealed that majority of Kenyan university librarians depend on their academic training to provide library services. Because of this, their knowledge and skills, which were derived from the coursework they completed for their bachelor's or master's degree, are insufficient for usage with emerging technologies. Furthermore, the study established that very few librarians had received specialized training on the new library services; the rest had either self-initiated the training or had received it as an after-sale benefit for the product or service that the library had purchased. This presents an unending risk to Kenyan university libraries' ability to properly integrate and use emerging technologies in provision of library services.

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2. Poor Attitude of Library Personnel

A key component of the library is its staff. Thus, the personnel at the library have a significant impact on whether the library succeeds or fails [45]. Since libraries are service-oriented organizations, they cannot use emerging technologies if librarians have a negative attitude towards them. A study by Rajab and Ogalo [46] revealed that most of the librarians in Kenya have technophobia, hence, they do not consider using emerging technologies in university libraries as a viable choice. One internal deterrent to librarians becoming proficient in technology is technophobia, which has prevented them from acquiring the knowledge necessary to employ emerging technologies [47] Rajab and Ogalo [46] further noted that Technophobic librarians still prefer to provide services manually, which takes time and may waste patrons' time and schedule of activities.

3. Inadequate Funding

The financial burden of acquiring and using cutting-edge technological equipment in university libraries presents management with financial impossibilities [45] because libraries depend on funding to function efficiently yet universities have historically viewed their libraries as either non-generators of revenue or as mere spenders of same. As a result, there has been prevalent reductions in budgets for Kenyan university libraries [44]. This lack of funding has forced these libraries to concentrate on finding ways to generate their own funds. Considering the fact that the quality of technological tools provided in university libraries in Kenya is partly a function of the quantum of funds available, insufficient funding is one of the main obstacles to utilization of emerging technologies in these libraries.

4. Power Outage

This is related to brief power outages, particularly in the case of the electric supply [45]. One of the issues preventing emerging technologies from being utilized in Kenyan university libraries is an unreliable supply of electricity [39,48,49]. Continuous power supply is necessary for the

proper operation of facilities needed for utilization of emerging technologies. Usage of these technologies is thus severely hampered by lack of or irregularities in power supply.

5. Poor ICT infrastructure

ICT infrastructure comprises computers, networks, the internet, display screen technologies and accessories [50]. One of the main forces behind transformation of libraries is ICT infrastructure, which also contributes significantly to maintaining integration of systems and processes. As a result, the availability and integration of the necessary infrastructure facilitates the adoption of emerging technologies with amazing success [43]. Several studies such as [39,48,51] established that university libraries in Kenya did not have the required ICT infrastructure necessary for adoption of emerging technologies leading to the limited adoption of emerging technologies in Kenyan university libraries.

6. Lack of top management support

An organization's top management defines and directs the organization toward achieving its objectives [3,43]. Adoption of emerging technologies in university libraries is dependent upon the visionary leadership of the library and the support of university management. A study by Otike and Barát [44] revealed that some university libraries in Kenya are not supported by the universities' top level management in their bid to adopt emerging technologies for service provision.

7. Lack of policy guidelines

Strong supporting policies are necessary for a robust ICT deployment, in addition to technical infrastructure hence there is need for institutions to develop comprehensive ICT policies [52]. A successful policy is one that the organization develops, shares, adopts collectively. Rules, regulations, and initiatives that take policy consideration have a significant impact on ICT components like funding and security, among other aspects. Several studies [40,44,48] established

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that one of the reasons for slow adoption of emerging technologies in university libraries in Kenya is lack of policies to provide guidelines for adoption.

8. Lack of proper Library buildings

A number of buildings hosting libraries in Kenya were designed and built before the advent of ICT leading to challenges in deploying technology-based services. In terms of physical infrastructure, modern libraries do not only provide space for housing collection, reading space and staff offices but also needs to accommodate other facilities such as multimedia centre, training facilities equipped with modern equipment, discussion rooms among others. In some instances, libraries have failed to accommodate persons with disabilities due to lack of facilities such as ramps, lifts. Studies have shown that a number of libraries have not adequately catered for persons with disability [53].

9. Inadequacy of Library and Information Science Curriculum

Human resources play a critical role in successful implementation and deployment of technologies in libraries. Due to the dynamic nature of Information Technology requirements in a modern library, graduates from Library and Information Science (LIS) Schools need to be adequately prepared to handle the emerging trends. Rukwaro and Bii (54) noted that the curriculum in Kenya's LIS schools do not have sufficient information communication technology courses and hence affecting the ability of graduates to facilitate implementation of technologies in libraries.

Conclusion and recommendations

We are living in a time when hardware, software, and online technology is changing rapidly, and it seems like this change will only accelerate. This technological revolution has changed university libraries, creating new avenues for managing resources and providing information services. The latest technological trends covered in this paper, including mobile technologies, Instant Messaging (IM), social networking services, Internet of Things (IoT), facial recognition

and Artificial Intelligence among others, are turning university libraries into vibrant centres for learning and research. Although implementing these emerging technologies may be expensive, it is essential to meet user needs and stay relevant in the constantly shifting academic landscape. As a result, university libraries in Kenya must keep evolving and adapting to satisfy the constantly evolving needs and demands of lecturers, researchers, and students in the quickly changing technological environment. To make it easier to integrate and utilize emerging technologies in university libraries in Kenya, this paper makes several recommendations. First, the staff should be trained on emerging technologies. This will encourage them to accept and use emerging technologies by making them see these technologies as agents of library transformation. The university libraries also need to have adequate funds set aside towards integration of emerging technologies, the ICT infrastructure should be improved, policies on use of emerging technologies should be put in place, the library should get adequate support from top management, and the country's electricity supply ought to be improved by the government. In cases where this is not possible, universities ought to offer a backup power source to prevent blackouts and the subsequent effects they have on the usage of emerging technologies.

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DIGITAL TECHNOLOGY AND COMMUNITY EMPOWERMENT: BRIDGING THE RURAL- KNOWLEDGE CENTER GAP

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Abstract

Rural communities in developing countries continue to experience marginalization due to centralization of services in urban areas and institutions. The imbalance in distribution of resources and provision of services isolates rural communities making them remain ignorant of the advancements that can lead to their own socio-economic empowerment. Rural communities lack access to innovations and knowledge necessary for their transformation due to lack of good and effective channels for relaying information or mechanisms that can enable them to tap the knowledge they need to broaden their world view, interpret their situations, and address the barriers that prevent them from getting access to digital technologies. Government and non-government agencies through their research and practices have generated knowledge and information on different issues that have distracted community transformation over the years and which if properly disseminated would enhance the problem-solving ability of the communities. Knowledge would free and empower people from ignorance and set them on a firm path to discovering themselves, interpret reality with confidence, and making decisions that would improve their well-being. This paper argues that rural communities can be empowered by bridging the digital gap through enhanced knowledge management strategies. Through an extensive review of existing literature, this study seeks to explore different strategies for disseminating knowledge to communities using digital technology and examine how government agencies, not-for-profit organizations and local community initiatives can facilitate access to information and enhance digital literacy among rural communities. The findings of the study would potentially advise policy on digital empowerment of rural communities with the view to enabling them tap into the existing opportunities to better their lives.

Keywords: **Rural Communities, Community Empowerment, Digital Technology, Knowledge Center, Knowledge Management.**

Introduction

This paper examined the digital landscape in Kenya, highlighting the challenges encountered by the rural community in accessing technology, the inequalities in access, usage and benefits of ICT in Kenya between the rural and urban communities. It argues that addressing the acute digital divide in Kenya requires more than just high mobile phone penetration and a widespread mobile money transfer platform. There is need to develop internet access strategies that prioritize connecting the majority of people who lack internet access despite owning multiple mobile phones. The key focus areas for these strategies would include bridging the rural–urban divide, gender disparity, digital illiteracy, insufficient or inaccessible ICT and high mobile penetration contrasted with limited connectivity.

Background of the Study

Since attaining their political independence most countries in Africa have grappled with the persistent problem of unbalanced regional development. Through various policies and interventions, the governments of these countries have tried to reverse the imbalance that stems from the colonial policies that had created wide disparities and imbalances between regions leading to marginalization of many communities in the country. For example, a 2007 report on well-being in Kenya confirmed persistence of disparities especially in the distribution of resources including dissemination of innovation. Most of the time, distribution tends to favor the centers where this knowledge is generated. Wide disparities also exist between urban and rural areas in Kenya, with 85 percent of the poor people living in rural areas characterized by lack of resources and services they need to better their lives [1].

Rural communities lack access to innovations that they need to and knowledge necessary for their transformation due to lack of good and effective channels for relaying information or mechanisms that can enable them to tap the knowledge they need to broaden their worldview, interpret their situations, and address the barriers that prevent them from getting access to digital technologies. This digital gap has remains a major stumbling block to communities as it

stands between them and knowledge centers, thus preventing them from accessing innovations that can transform their lives. Thus with appropriate knowledge, they would discover themselves, interpret reality with confidence, and make decisions that can improve their well-being [2]. Using enhanced knowledge management strategies, rural communities can be empowered by bridging the digital gap between themselves and centers of knowledge [3]. Thus information and communication technologies (ICTs) cannot ensure empowerment, they can potentially expand political, social, and economic freedom given the necessary relevant sociocultural technical, economic, and political conditions. ICTs have exploded in the last decade providing a tremendous diversity of tools enabling citizens to participate in the governance of villages, cities, states, and countries and in the establishment of entrepreneurial undertakings that have transformed socioeconomic livelihoods.

Technology, community, and public policy should work together to bridge the digital divide to give underprivileged people access to enable them to engage in the digital economy [4]. However, changes in the era affect the nature and attitude of the community in responding to the situation, the village community's traits and attitudes still survive to this day, namely cooperation and accepting what is. Village communities are known for their cooperation and acceptance, attributes and attitudes that can be relied upon in carrying out village development [5] which needs to be carried out by the village community albeit with assistance from both competent professionals and external parties [6]. Optimizing the ability of rural communities in village development is known as empowerment which closely relates to the notion of participatory, independent, network, and justice based on individual and social strengths [7]. The concept of empowerment is oriented towards removing the existing power in a community to be able to carry out activities so that the village becomes developed. Programs for village empowerment need to look at the potential of the village and adapt it to current conditions that have entered the new normal period [2]. Community empowerment is defined as government-

led efforts to assist local communities in planning, deciding, and managing their resources so that they have the capacity and independence to be economically, ecologically, and socially sustainable in the long run [8]. Community empowerment is therefore closely related to sustainable development, which necessitates the dynamic prerequisites of economically, environmentally, and socially independent communities [9]. It is also an economic development concept that encompasses community values which create a new paradigm in development that is people-centered, participatory, empowered, and sustainable. Furthermore, the concept of development with a community empowerment model does not only meet the fundamental requirements of the community but also seeks options for local economic growth [10] which can be achieved through digital technology by disseminating information [11]. Knowledge sharing entails transferring tacit (undocumented) and explicit (documented) information from one person to another. In a community, it not only increases cohesiveness but also empowers society by giving access to new ideas, resources, and expertise.

Knowledge sharing in the community significantly impacts societal intellectual assets. It boosts productivity, improves decision-making, and strengthens the community culture. Incorporating a knowledge-sharing culture is mandatory for the success of any society. The conduit of knowledge sharing needs to be shared rather than storing or documenting it because when the community struggles to access information, the bottom line is that it's left behind in many aspects. This paper aims to elaborate on the importance of knowledge sharing and how the use of digital technologies can lead to the shrinking of the digital gap.

Digital technologies have advanced more rapidly than any innovation in our history – reaching around 50 percent of the developing world's population in only two decades and transforming societies, enhancing connectivity, financial inclusion, access to trade and public services [12]. Some of the sectors where digital technologies have been embraced include the health sector, for instance, Artificial Intelligence (AI)-enabled frontier technologies are helping to save lives,

diagnose diseases, and extend life expectancy. In education, virtual learning and distance learning have opened programs to students who would otherwise be excluded. Public services are also becoming more accessible and accountable through blockchain-powered systems, and less bureaucratically burdensome because of AI assistance.

Research on knowledge sharing indicates that communities in remote areas experience challenges in accessing digital technologies [13]. Notably, those areas that are not yet connected remain inaccessible to the benefits of these technologies and are consequently left behind [14]. The pace of connectivity is slowing, even reversing, among some constituencies [12]. For example, globally, the proportion of women using the internet is 12% lower than that of men. While this gap narrowed in most regions between 2013 and 2017, it widened in the least developed countries from 30% to 33% [12].

Statement of the problem

Kenya stands as a prominent digital and economic centre in East Africa. Despite this, it falls behind in global digital GDP rankings, highlighting a significant digital divide. UN Conference on Trade and Development (UNCTAD) data highlights this gap, emphasizing disparities in information and communications technology (ICT) access, usage and benefits, impacting economic growth and human development not only in East Africa but also globally [12]. Thus, merely possessing high mobile phone penetration and a widespread mobile money transfer platform does not resolve this acute digital division. To address this issue, the Kenyan government should develop internet access strategies to connect the majority who lack internet access, despite owning mobile phones. These strategies must tackle ICT equipment availability, affordability, digital illiteracy and policy development to address infrastructure issues such as poor broadband coverage and internet reliability. Furthermore, the government should aim to bridge rural–urban and gender divides. Over the past two decades, ICTs have significantly impacted the developed world, influencing various sectors. However, Africa, including Kenya,

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lags behind in ICT adoption [2], impacting the continent's development. Despite international, regional and local efforts to bridge this digital gap, Kenya's digital divide persists. This policy brief delves into Kenya's digital divide, offering a framework for analyzing this issue and offering recommendation

Objectives of the study

This sturdy sought to explore different strategies for disseminating knowledge to rural communities using digital technology and how government, not for profit organizations and community initiatives can facilitate access to information and enhance digital literacy and to support socio-economic empowerment of rural communities.

Literature Review

To address the digital divide between centers of knowledge and rural communities, the Kenyan government should develop internet access strategies to connect the majority who lack internet access, despite owning mobile phones. These strategies must tackle ICT equipment availability, affordability, digital illiteracy and policy development to address infrastructure issues such as poor broadband coverage and internet reliability. Furthermore, the government should aim to bridge rural-urban and gender divides. The social, political, and economic sectors of any society desire and endeavor to be equipped with digital technologies to enhance information sharing which is essential for transformational development. Access to knowledge instills confidence in people and increases the passion required to live and work in a technology-driven world. Despite this great need for digital literacy for information sharing, rolling out the necessary frameworks has been slow resulting in a knowledge gap between rural communities and knowledge centers, which are mainly concentrated in urban areas.

The rural-urban digital divide programs aim to level the playing fields and ensure remote regions have the same digital advantage as their metropolitan counterparts, however, Kenya News Agency [15] indicated that connectivity in Kenya is far from universal levels of digital

literacy at rural community levels. Thus, there are noteworthy gaps in infrastructure coverage, affordability, energy reliability and other factors widening the urban-rural digital gap in the 47 Counties of the country. Therefore, the research attempts to explore strategies that can be used to improve and bridge the digital gap.

Rural -Knowledge Centre Gap

The digital divide is the gap between individuals and communities with access to digital technologies and those without has remained a significant challenge in rural areas. It is manifested by lack of connectivity and limited digital literacy skills which hinder rural populations from fully participating in the digital economy and accessing essential services hence the need for strategies that can improve connectivity and digital inclusion in rural areas.

As digital infrastructure, technology, and connectivity evolve, investment in rural digital connectivity must be prioritized for economic growth, social inclusion, and improving quality of life [16]. Getting access to everyday essentials like healthcare, education, financial services, and even entertainment for social interaction can be extremely difficult for those living in remote or under-served areas. However, if internet access is available it would be lifesaving as it would provide greater flexibility and convenience and, in turn, bridge the social inclusion gap, positively impacting mental well-being and leading to an empowered generation.

In developing countries, prioritizing approaches that would increase digital infrastructure in rural areas could ensure that communities have access to the same digital services as those in well-served areas. Kenya has in the last two decades made noteworthy strides in technological advancement, evidenced by the development of the Konza Technopolis, licensing of more internet and cellular service providers, digitization of government services, for example, e-citizen platform, Ardhisasa, NEMIS (a data management platform for the department of education) and the institutionalization of ICT through government departments and corporations such as ICT Authority. There is an equally high rate of adoption evidenced by the

growth of mobile subscriptions (133% of the population in 2022), increased installation of fiber optic per capita, and increased geo-coverage of fixed and mobile broadband. However, despite this digital progression, there is still a digital divide between urban and rural areas, and it remains crucial that a range of connectivity approaches be considered because digital technology is a great asset to economic growth [15].

Importance of enabled connectivity

Improved digital connectivity in Kenya has improved the socio-economic life of people [16]. For example, in the economic sector, growth is evident in new job opportunities that have already increased productivity in different areas of the economy and enhanced the growth of small and medium-sized businesses. This has enabled businesses to operate more efficiently, increasing access to markets and customers, and facilitating innovation and development of new products and services. For example, because of digitalization, knowledge of different methods of producing goods and services is readily accessible by individuals, groups, and communities that were unable to access it in the past and has enabled them to transform their lives. The social life of communities has been influenced greatly by digital connectivity leading to increased social interaction locally and globally which has transformed and enhanced relationships and partnerships which in turn have brought cohesion in families and groups. This developed and enhanced ability to connect via instant messaging and video conferencing which have enabled people to communicate more easily and in real time, regardless of their geographical location. Another advantage of digital connectivity is witnessed in the improved access to healthcare services, especially in remote rural areas. For example, with telemedicine, patients can consult with healthcare professionals remotely, reducing the need for physical appointments. The education sector has not been left behind since access to education has been made easy. Currently, many learning institutions across the globe run online academic programs that have enabled many people.to learn. Social media has also played a major role in the formal and

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informal dissemination of information globally leading to social inclusion and great enlightenment of marginalized communities.

Notably, it is agreeable that digital investment plays an essential role in driving economic growth by increasing access to markets and customers, especially for small and medium-sized enterprises (SMEs) and farmers. Digital platforms and e-commerce can enable SMEs to reach a national and global consumer base, which can help them grow and compete with larger firms. It can also enable stimulation, innovation, and development of new products and services.

Automation and digitization of service provision can streamline processes and change the speed of operations, leading to greater productivity and output. Thus, better rural digital connectivity will ensure the local population can access essential services including healthcare and education. This can reduce rural-to-urban migration and retain human capital in their rural communities instead of relocating to urban and better-connected areas, which will inevitably benefit the local economy.

Bridging the Digital Technology Gap

To bridge the digital connectivity gap and enhance access to broadband service in rural areas, the Affordable Connectivity Program was created in late 2021[17]. However, the challenge is the kind of infrastructure available to rural communities to expand access to all residents. Multiple types of infrastructure are preferred since they can create broadband connectivity, each with unique benefits and drawbacks. In all cases, cost is a driving factor that must be addressed if the digital gap is to be reduced. Some of the options that can be used include:

Fiber-Optic Cables
Unlike the copper cables in plain old telephone services (POTS) which use electrical voltage to transmit data, fiber-optic cables are broadband-specific cables buried underground that create a communicating network of glass or plastic carrying light data. This revolutionary invention can

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provide a fast and reliable internet connection with the advantage that since the cables are buried, the quality of the connection is not impacted by weather and is infrequently damaged.

Satellite Internet

Satellite Internet uses a satellite dish that can facilitate two-way (upload and download) data transmission. Individual users mount a small satellite dish on roof tops or other static objects in their homesteads to transmit data signals from the at-home satellite dish to one in orbit around the Earth. Mounting a satellite dish is easy and once done, the Internet connection is instant and often faster than a POTS connection. However, compared to fiber-optic, satellite service is slower. Its easy installation and non-reliance on larger internet providers is a significant perk for users in rural and remote areas. However, even though a satellite server would not be subject to the functionality of an entire system such as the POTS and fiber-optic, the individual device can be damaged and immediately interrupt service.

4G and 5G Networks

Mobile/Cellular carriers provide 4G (fourth generation) and 5G (fifth generation) networks of cellular communication, which use radio waves to transmit data that enables Internet connection. The difference between 4G and 5G is the data transmission speed. 5G networks are more efficient, handle more connections per antenna, and provide faster upload and download speeds and will eventually replace the 4G network. An antenna that can navigate these radio waves can be placed on established infrastructure like telephone poles and public institutions.

Fixed-Wireless Networks

Fixed-wireless networks serve as stationary towers and antennae that carry data through radio waves transmitting a carrier's signal across frequencies. Technology has significantly advanced 5G networks of cellular communication that enable internet connection [17]. Fixed-wireless deployment relies on a central tower that broadcasts signals to other receivers installed by individual users. Like a satellite dish, a 5G antenna can be installed on a user's property and provide a wireless connection to multiple personal devices.

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Digital literacy and skills among rural populations for effective utilization of digital technologies

Even though digital skills are no longer a luxury, but a fundamental necessity, millions across the globe lack access resulting in a significant digital divide, particularly in rural communities that suffer from limited infrastructure, financial constraints, and cultural barriers which are formidable obstacles to technology adoption. Limited digital access translates to missed opportunities in education, healthcare, agriculture, and entrepreneurship, hindering individual and community-wide development [18]. Having recognized the transforming power of digital literacy, numerous organizations have embarked on a journey to bridge the digital gap by ensuring good technology is accessed, understood, applied, and integrated into the daily lives of communities.

Ensuring that digital technologies benefit the rural population leads to smart villages, which are places where rural communities are empowered and can take the initiative to find solutions to the challenges they face [19]. However, it should be noted that digitization can be a powerful force for change if it is well applied to the rural context and implemented with voluntary involvement of rural communities. Consequently, implementation of a bottom-up and tailor-made approach to build digital skills initiatives involving the local community and tuning them to the local context are likely to give good project outcomes.

Community Engagement and Collaboration for Sustainable Digital Inclusion Initiatives

Digital inclusion is a critical aspect of modern society, as access to technology and the internet has become essential for everything from education and employment to healthcare and social connections. However, not everyone has equal access to these resources, and many individuals and communities are left behind in the digital age. Bridging this gap requires a multifaceted

approach that addresses issues of infrastructure, affordability, and digital literacy as hereby discussed.

Infrastructure: The first step in promoting digital inclusion is ensuring that everyone has access to the necessary infrastructure. This includes not only high-speed internet but also devices such as computers and smartphones. One promising approach is to invest in community-based broadband networks, which can provide affordable and reliable internet access to underserved areas.

Affordability: Even with access to infrastructure, many individuals and families may struggle to afford the cost of devices and internet service. To address this issue, some companies and organizations offer discounted or free devices and internet access to low-income individuals. For example, Comcast's Internet Essentials program provides low-cost internet and computers to eligible households, and the nonprofit PCs for People refurbishes and distributes computers to low-income families, an approach that may not be possible in developing countries.

Digital literacy: Promoting digital inclusion requires ensuring that individuals have the skills and knowledge necessary to use the technology effectively. This includes not only basic computer skills but also digital literacy in areas such as online safety, privacy, and information literacy. One effective approach is to offer digital skills training and support through community organizations, libraries, and other public institutions. For example, the Digital Promise program offers a range of digital skills training resources for educators and learners of all ages. Thus by investing in community-based broadband networks, offering subsidies and discounted devices, providing digital skills training and support, we can help bridge the digital divide and ensure that everyone has equal access to the opportunities and resources of the digital age.

Strategies for promoting digital inclusion for community empowerment.
Provision of Affordable Internet Access

One of the most important strategies for promoting digital inclusion is to ensure that affordable internet access is available to all. Many individuals and communities are unable to access the internet due to high costs. By providing affordable internet options, such as low-cost plans or subsidies for low-income households, we can bridge the digital divide. For example, in countries like Estonia and Finland, the government has made Internet access a legal right, ensuring that all citizens have affordable and reliable access to the Internet.

Increasing Digital Literacy

Another crucial aspect of promoting digital inclusion is to increase digital literacy among individuals who may be unfamiliar or uncomfortable with technology. This can be achieved through various initiatives, such as community training programs, workshops, and online tutorials. For instance, organizations like Google and Microsoft have created digital literacy programs that provide free training and resources to help individuals develop the necessary skills to navigate the digital world.

Improving Access to Digital Devices

In addition to internet access and digital literacy, it is also important to ensure that individuals have access to the necessary digital devices, such as computers, smartphones, or tablets. This can be a significant barrier for individuals who cannot afford these devices. To address this, initiatives like the One Laptop per Child program have been implemented in developing countries to provide students with affordable laptops for educational purposes.

Creating Digital Public Spaces

Creating digital public spaces is another effective strategy for promoting digital inclusion. These spaces can provide free internet access and resources, allowing individuals to connect, learn, and engage with the digital world. Libraries, community centers, and schools can serve as digital public spaces, offering not only internet access but also workshops, training programs, and

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online resources. For example, the New York Public Library offers free Wi-Fi access and computer workshops to help bridge the digital divide in underserved communities.

Collaboration and Partnerships

Collaboration and partnerships between governments, not for profit organizations, and private sector organizations are crucial for promoting digital inclusion. By working together, these entities can leverage their resources and expertise to develop innovative solutions and initiatives. For instance, the Digital Inclusion Alliance in the United Kingdom brings together various organizations to address digital exclusion by sharing best practices, coordinating efforts, and advocating for policy changes.

Advocating for policies that promote digital inclusion

Finally, in their endeavor to reduce the digital gap, businesses and agencies can advocate for policies that promote digital inclusion. Some policies can either promote or hinder digital inclusion efforts. By advocating for policies that promote digital inclusion, businesses can help in enhancing connectivity and access to digital tools and resources by people in rural areas. Today there are a number of local organizations that advocate for policies that provide tax incentives for businesses that provide digital skills training to their employees and rural communities.

Businesses play a crucial role in promoting digital inclusion. In this endeavor, they provide affordable access to technology, offer digital skills training, support digital infrastructure development, collaborate with community organizations, and advocate for policies that promote digital inclusion. By doing so, they help to bridge the digital divide and ensure that everyone has equal access to technology. Businesses need to recognize and appreciate the big role they play in the promotion of digital inclusion and the

Methodology

The study adopted a desktop research methodology based on a literature review. Data was systematically retrieved online from databases. These included the Academic Journal of Interdisciplinary Studies, SCImago Journal & Country Rank (SCImago), and the Directory of Open Access Journals (DOAJ). SCImago and DOAJ are openly available and provide their data in an easily downloaded format. The study largely focused on the average number of citations received by a journal, commonly called an impact factor. Citation metrics of digital divide and empowerment were analyzed in two different ways. Firstly, they were analyzed with journals as the unit of analysis, which was at the level the data retrieved from the different databases. The study also weighted citation metrics of the articles published.

Findings and Discussion

The research found that bridging the digital divide and promoting digital inclusion is essential for community empowerment. This can be attained through implementing the strategies such as;

1. providing affordable internet access,
2. increasing digital literacy,
3. improving access to digital devices,
4. creating digital public spaces, and
5. fostering collaboration and partnerships, can ensure that everyone has equal opportunities to participate in the digital world, hence bridging the gap.

What You Need to KnowBridging the digital divide Strategies for promoting digital inclusion
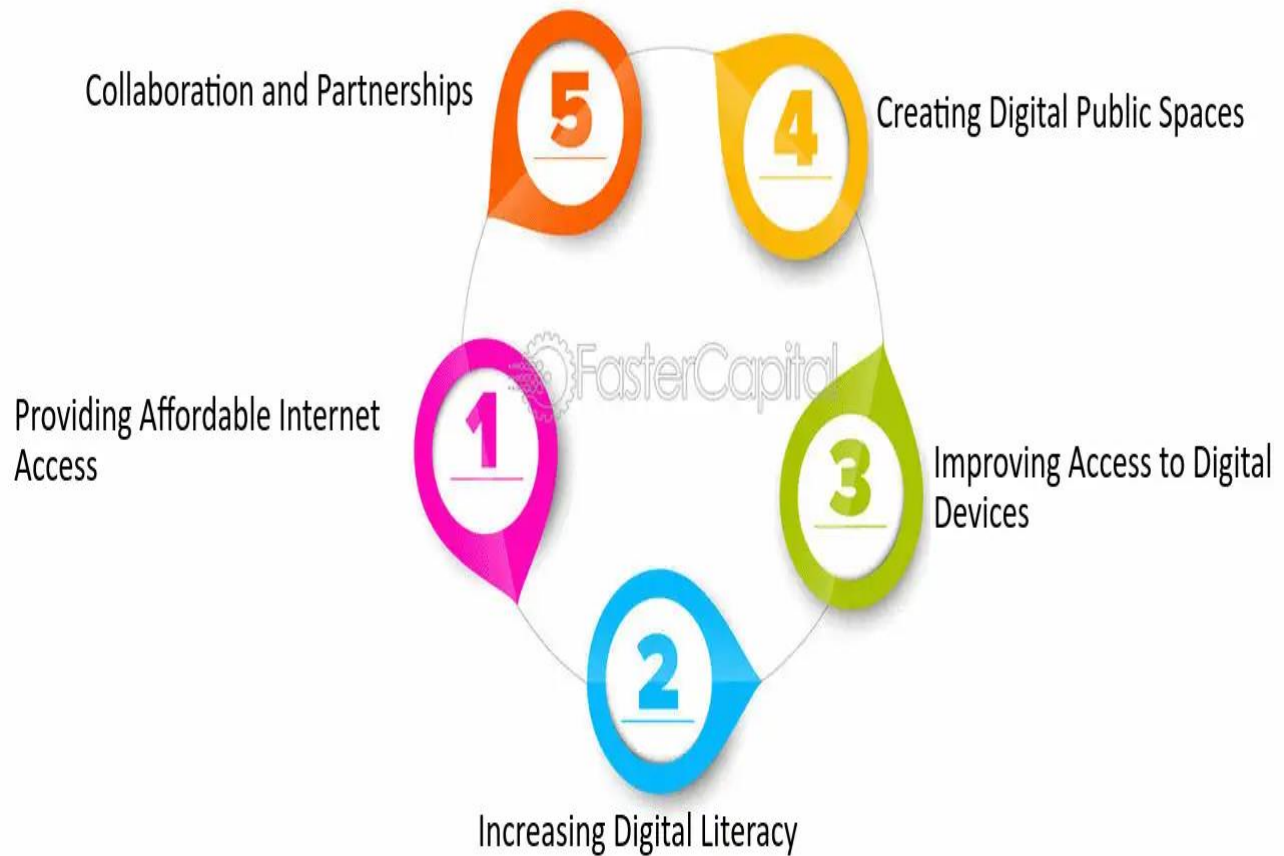
source:[23]

According to Intermax Networks [19] the internet is a gateway to information and opportunities from education and healthcare to commerce and social interaction. However, despite its undeniable importance, millions worldwide still lack reliable access to high-speed internet. This

digital divide, often exacerbated by socioeconomic factors and geographical location, poses significant challenges for individuals and communities seeking to fully participate in the digital age [19]. They have the potential to significantly impact bridging the digital divide and ensuring that everyone has equal access to technology. This can be achieved through, providing affordable access to technology, providing affordable access to technology, collaborating with community organizations and Advocating for policies that promote digital inclusion

Conclusion

Kenya's digital divide persists due to disparities in access, affordability and digital literacy. Urban areas exhibit higher digital literacy and adoption, while rural and marginalized communities lag behind. Limited availability of digital equipment at all levels of education hinders digital literacy. Infrastructure investments, low-cost satellite internet and public-private partnerships are critical to accelerating digital engagement.

Recommendations

Progressive policies should encourage equitable access by lowering taxes and tariffs so that the rural community with limited income can afford and access technology.

Digital inclusion programmes in kenya should be extended to the rural communities not only in the slum areas in the urban setting. Information technology should be a compulsory subject in all levels of education, not as elective subject.

Libraries and digital spaces should be embraced and empowered in the rural setting as a training ground for information literacy skills for the communities.

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EFFECTS OF TECHNOLOGICAL CHANGES ON LIBRARY OPERATIONS AND SERVICES AT EGERTON UNIVERSITY LIBRARY

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Abstract

The introduction of Information and Communication Technologies (ICTs) has caused notable alterations in operations and services provided by libraries. This has brought up a number of managerial and technical problems that, if left unchecked, could affect information management. The study's goal was to evaluate how technological advancements have affected library operations and services in order to provide a framework for managing technological advancements in libraries as they relate to Egerton University's information management procedures. The study to track the technologies that Egerton University Library had implemented, identify technological advancements and their effects on staff competencies, services, and library operations, and suggest a framework for integrating new ICTs into service management. The Information Technology Infrastructure Library (ITIL) was chosen by the study as its theoretical foundation. The research was conducted using a case study method within a qualitative paradigm. Fifty (50) responders, including professional and paraprofessional library staff as well as four (4) employees from the Procurement and ICT departments, were chosen using the purposive sample technique. Face-to-face interviews were used to gather data, which was then thematically analyzed. The study found that the advantages of adopting technology far outweighed the drawbacks. Thus, technological advancements and modifications cannot be evaded by any organization/institution and more so libraries and information centres worldwide.

Keywords: ICT, Academic Libraries, Library Operations and Services, Technological Advancements, E-Waste Management, Egerton University

1.0 Introduction

Academic libraries are vital to society and universities alike. Krubu and Osawaru [1] described academic libraries as those that are primarily housed at and provide services to postsecondary institutions. Their goal is to back the parent institution's teaching, learning, and research endeavors. Their collections are curated to cater for the needs of both current and prospective clients. They process, organize, evaluate, store and disseminate information to users. These libraries offer their patrons a variety of services, such as circulation and reference services and access to OPAC, multimedia services, electronic resource services, searching and retrieval services as well as customer services.

Information technologies (computing and communication technologies) have enhanced functions of academic library, especially in relation to information processing, organization, storage, and analysis techniques and collection development strategies. Krubu and Osawaru [1] declared that "a variety of technologies are currently being adopted by libraries to support its operations but these technologies affect management of information." Thus, positive and negative effects are felt by libraries due to technological changes. Positively, technology adds value to library functions and operations, promotes effectiveness and saves time [1]. However, libraries face challenges of e-waste management, storage space, cost issues and newer skills needed to operate the ever-changing body of technology. Smith [2] asserted that ICT has a profound impact on all areas of academic libraries. He further noted that libraries are no longer custodians of information materials but providers of information. Technology has thus created these dynamics changing the way current libraries provide services.

According to Borgman [3] the emphasis of utilizing technology in libraries has over the past 40 years changed from addressing local issues to addressing global issues. These objectives advanced through three incremental steps before reaching the current phase of addressing system and service interoperability, which includes improving internal operations' efficiency and facilitating access to nearby and external resources.

Information technology advancements, particularly the digital initiatives, have thus had a major impact on library services and operations and over the course of the previous five years, advanced quickly, creating large capacities for resource storage, high-speed network facilities for information retrieval, and portable devices with wireless access and mobile technology for easy information usage [4]. Other notable developments in IT include replacement of text-oriented search engines for web interfaces by visual search engines focused on images and a range of social network applications.

Libraries are impacted by these new technologies in every way, including handling information retrieval, organization, organization, storage, manipulation, and user distribution. According to Krubu and Osawaru [1] information management procedures in libraries are being reshaped by ongoing technological advancements computing, communication, and mass storage.

Further, technological changes have affected library activities and operations particularly in consortia and library collection expansion initiatives offering a chance to offer clients access to an abundance of digital based knowledge resources and value-added information services. In addition, libraries are utilizing contemporary technologies to automate basic operations, set up management information systems, create effective networks for resource sharing and library collaboration, and establish institutional repositories for sharing research output [5]. However, it has also brought with it difficulties like handling change and the rapid increase in electronic waste. Training expenses apply to both service providers and users. Thus, for library users to be proficient in using all available technologies, especially those related to information access and

management, information literacy training must be provided on a continuous basis. There are also expenses associated with buying equipment that eventually become obsolete as well as the burden of moving or transforming data from old electronic storage devices to current, emerging storage technologies. These technological advises however lead to rapid expansion of electronic waste and its consequences for the environment and public health.

Problem Statement

Libraries employ a range of technologies to improve the caliber and effectiveness of the services they provide. New technologies, however, have an impact on how libraries manage their information. The use of automated library management systems is rapidly replacing manual ones at the moment. These developments in technology impact every library procedure. For example, the evolution of storage devices has progressed significantly, transitioning from audio cassettes to flash drives, from CD-ROMs and floppy disks to technology related to cloud computing and digitization. Digitization has the potential to replace optical technologies like CD-ROMs in the near future. These changes pose challenges to libraries since they need to ensure constant transfer of stored information to new devices to avoid risk of losing data.

In addition, technological developments have increased library costs by necessitating purchase of new equipment and providing staff training on usage of emerging technologies for information management. Of concern too is the problem of e-waste management. Thus, most of the equipment upon being declared as obsolete are damped in some rooms within the library potentially causing environmental and health problems.

Research Objectives

1. The study sought to investigate the information technologies adopted over the years, the factors that influenced their adoption and how application of these technologies have affected operations and services offered by libraries.

Literature Review

Information Technology Infrastructure Library (ITIL) Framework

Information Technology Infrastructure Library (ITIL) framework was created by the British Government's Central Computer and Telecommunications Agency (CCTA) in the 1980s and was applied in this study. ITIL is a set of guidelines that governs information technology best practices and serves as a foundation for providing IT services [6]. The framework is built upon the BS15000 British standard. According to Kissee [6], putting the ITIL framework into practice necessitates a high level of change management. The framework primarily addresses service support, which includes identifying and documenting IT configuration items as well as procedures for dealing with changes, issues, and incidents [6]. The factors to be taken into account are as follows:

a) *Incident Management:* This explains how to restore normal operations as quickly after something has gone wrong. For example, instances where data or information was lost as a result of updating or introducing new technology. As a security precaution, such situations can be effectively handled by keeping a backup or operating a separate manual information management system.

b) *Problem Management*: this entails two steps: first, determining the underlying causes of incidents that are reported to the service desk; and second, planning modifications to the IT infrastructure to stop the incidents from happening again. Problems encountered by customers are frequently revealed in a report on user surveys regarding the services provided by the library. When producing an update or releasing an information management system, such instances can be examined and suggestions for modifications to the IT infrastructure can be made.

c) *Change Management:* Covers the methods and protocols needed to guarantee timely, effective, and regulated management of changes. It is imperative to form a committee to

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oversee change management. This will guarantee that library policies and procedures are regularly discussed, enabling timely, effective, and regulated management of changes.

d) *Release Management:* The process of organizing new releases should take into account both non-IT and IT requirements. Prioritization is crucial when implementing any new technology. Every time a new version is deployed, it is important to take into account both non-IT requirements, like personnel with the necessary training, and IT requirements, such infrastructure and pertinent configurations, to make sure all library functions and services function as intended.

e) *Configuration Management:* The process of locating, managing, and keeping track of an item's or service's configurations. Maintaining documentation of all configurations of products and services for any technology purchased for pre- and post-problem solutions is crucial. This guarantees that there will always be a fallback in case of configuration issues.

f) *Service Delivery:* Aspects of service transition are covered by the ITIL framework, which also examines whether the planned strategy can be successfully implemented and how the design delivers on it. The ITIL framework highlights change management as a crucial element. Any technology that is purchased has a specific goal in mind. For instance, the purpose of an integrated library management system is to offer many different services, such as circulation, OPAC, reservations, reminders, and fines administration, among others. Hence, even though the periods of change, any new technology should continue to provide the desired function.

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The ITIL framework establishes a standard approach for use inside IT, which helps to create a uniform level of process in the entire firm. Any organization, including libraries, can incorporate elements of the ITIL framework into their information management practices, such as management of software assets, license changes, financial matters and capacity management to determine how much a change will cost to implement. Because it offers change management solutions, this framework can assist libraries in effectively managing the impact of IT changes on information management practices.

Summary of Technological Advancements and their Impact on Library Services and Operations

Libraries today incorporate a wide range of technologies to enhance the services they provide. Each day brings new advancements that impact how information is organized and accessed within libraries, influencing not only administrative tasks and technical operations, but also the overall delivery of library services.

a) Library Operations

High-quality library resources and collections are essential for successful library operations. Darga and Hu [4] lamented at the numerous adjustments to the library's acquisitions budget allocation [4]. These adjustments include a decrease in funding for non-electronic/digital resources (books and printed periodicals) and an increase in electronic and digital resources (e-books and e-journal ordering). Online resources are also more widely available and are gradually taking the place of optical devices (CD-ROMs, DVDs). The modifications are intended to free up space for informational sections and student-serving learning zones, as well as the increase of multimedia resources in libraries. The Essential Electronic Agricultural (TEEAL) CD collection and other CD-based resources like AGORA, AGRICOLA, HINARI, MEDLINE, and CABI abstracts were replaced, among other things, by the sophisticated and preferred online e-

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resources that Egerton University Library has adopted. Early versions of these early library systems, like CDS/ISIS or WINISIS provided by UNESCO, were also used. These early versions lacked online accessibility, had few modules, were not based on MARC records, and were not very advanced. The more recent library system generations are built around MARC data and interoperability, and they're all web-accessible.

Osinulu and Amusa [7] asserted that the cornerstone of library services is the collection of libraries because collections show how strong a service is. Academic libraries should have expansive, current, complete, and high-quality collections. These collections ought to satisfy the needs of users and complement the parent institutions' courses. Usability, comprehensiveness, diversity, and scale are the criteria used to evaluate the quality of an academic library's holdings. This means that the library must offer a wide range of reliable, current materials to fulfill its mission and the requirements of postgraduates, instructors, staff, and undergraduates. Additionally, the collections must meet the requirements outlined by national and international regulatory organizations, which can only be accomplished by utilizing modern technology.

Processing procedures in libraries have also been impacted by technological advancements. The necessity for conventional manual processing in libraries has decreased because of new information technology solutions. Digital and electronic resources alter workflows, procedures, and the skills and abilities needed by support workers and librarians. All of these modifications result in altered management and organization of libraries. For example, the AMLIB Integrated Library Management System (ILMS) has been implemented by Egerton University Library to replace its manual cataloging and classification procedures with automated systems. Staff members' time has been saved by technology, and workflow procedures have evolved to produce more accuracy, efficiency, and productivity. The technical processing processes are now able to achieve worldwide standards for cataloging and classification thanks to the new

technology introduced by the AMLIB. Online Z39.50 searching of databases and other libraries is available through AMLIB.

A number of libraries believe that digitizing a portion of their local holdings is a crucial operation. Although it is not yet ubiquitous, this method demands facilities and equipment that are uncommon in a number of libraries. Still, a few information centres have been able to launch similar initiatives. Currently, Egerton University Library is using Dspace software to digitize its journals, theses, dissertations, and archive documents in order to preserve the original materials while also improving the works' visibility and remote availability via electronic databases. Egerton University Institutional Repository (EUIR) was created as a result of this. The Library is also having issues with staffing levels and insufficient infrastructure.

According to Okiy [8], electronic databases have thousands of e-books and digitized journals; therefore, libraries must provide users with a mechanism to find the finest ones. A significant initiative to provide free digital versions of African journal papers is African Journals Online (AJOL). For researchers in Africa, this online resource, together with JSTOR, provides a plethora of digitized peer-reviewed journal articles. Libraries in low-income African nations can access additional electronic databases, such AGORA and HINARI, by registering with an educational institution.

b) Library Services

Through application of library softwares such as AMLIB Integrated Library Management System (ILMS) used in Egerton University, library services can be significantly improved. In automated systems, services like document delivery to clients, current awareness services (CAS) and selective dissemination of information (SDI) can be more effective, efficient, and quick. Additionally, ILMS makes it easier for users to use Net OPACs, which improves search functionality and allows users to access information resources without being constrained by physical distance from the library.

Mohammed claims that the majority of the restrictions on accessing and using information resources and services have been lifted by the development of computer and electronic technologies. Currently, the "electronic word" residing as bits and bytes of computer memory has replaced the "written word" [9]. Ramesh [10] noted that the emergence of the Internet and new information technologies are transforming libraries, and virtual libraries may pose a danger to survival of traditional libraries. He went on to mention other media that are having a significant impact on libraries and information management, including online reference, chat rooms, discussion boards, email, voice mail, multimedia services, and bulletin boards [10]. In his summary of the remarkable advancements, Omekwu [11] states that "printed media has been invaded by hi-tech information systems.

3.0 Research Methodology

Data for this study was obtained from the Egerton University Library using a descriptive case study design. Employees from the ICT, procurement, and library departments at Egerton University made up the study's population. There were eighty-three (83) employees working in the Library system, comprising three library branches and a records center at the University Main Campus, Njoro. There were fifty-four (54) and thirty-eight (38) employees overall in the departments of procurement and information technology, respectively. Therefore, one hundred and seventy-five (175) staff members were the target population.

Two employees from the ICT Department, two (2) from the Procurement Department, and fifty (50) paraprofessional and professional staff members from the Library Department were chosen through the use of purposeful sampling. Therefore, the sample size was 54 respondents.

4.0 Findings

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a) Technologies adopted

The first question was on the various technologies adopted over the years. When Egerton University received a variety of World Bank ICT equipment in 1999, the University Library gradually began using ICTs. Included in this equipment were Pentium II computers, scanners, plotters (750 HP), fax machines, bar code readers, file servers, DTP workstations, multimedia PCs, and various printers (HP-Laserjet, Line, Dot Matrix, Inkjet). Due to technological advancements, all of these donations have become obsolete and have either been lost, retired, or disposed of in the library store. The primary driver of technological changes, according to respondents, is technology obsolescence. Diskette ports were present in the World Bank gifts, and the floppy disks contained some data. Since the new computers did not have ports for diskettes, all the data on floppy disks was either lost or thrown away when they were replaced. In 2010, the Library made the decision to move to the integrated library management system, AMLIB, and deleted some information on indexed newspaper articles that had been stored on floppy disks.

Due to the University Library's obligation to adapt to the shifting needs of its users and the global advancements in information management, including collaboration in information sharing, cost sharing through consortiums, and accessibility with no constraints like time or space, the use of ICTs in the library was inevitable. The need to serve diverse users including Persons with Disabilities (PWDs) has led to adoption of ICTs to support their information needs. The University Library has acquired the Jaws software for the deaf and the handheld magnifiers for the partially blind. The Disability Mainstreaming Unit in the University provides other supporting equipment to the PWDs. ICTs have helped to create virtual campuses and libraries, which has increased student access and involvement. Other ICTs that have been adopted by the University Library include RemoteXs that has replaced EzProxy, Pentium IV computers which

have replaced Pentium II computers and Laser printers to replace the Dot Matrix and Inkjet printers.

The University Library has also adopted Electromagnetic (EM) Library Security System, Closed Circuit Television (CCTV), walk-through metal detector gates and smoke detectors to secure the information resources.

The following information was gathered and is shown on Table 1 in order to improve understanding of the first objective, which was to determine what factors affected technology adoption.

Table 1: Technology Adoption Influencers

S/No	Respondents' Sample Direct Quotes (Excerpts)	Implications (Motivating Elements)	Respondents (n)	%
1.	"...it's important to stay up to date with evolving technologies."	Keep pace with technology	29	57
2.	It is evident that there is a global trend toward the shift from analog to digital services and operations.	Adherence to current world trends	9	18
3.	"...the need for new electronic equipment to meet user needs and improve operations…"	Up to date technologies	7	13
4.	"...the requirement for new electronic equipment to enhance operations and satisfy user needs..."	Consortia and cooperative services and operations	3	6
5.	"...the need to serve diverse users including PWDs…"		2	4

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6.	...information resources are expensive and they should be secured..."	Security purposes	1	2
	Total		**51**	**100**

The main motivation, according to thirty-two (63%; n=32) respondents, was staying up to date with emerging technologies. The global trend toward digitization (17%; n = 9), the need to improve operations (14%; n = 7) and the obligation to coexist with other university libraries (6%; n = 3) were additional motivators for the use of technology, as illustrated on Table 1.

Egerton University library has a strong desire to execute innovative technology in order to fulfill the evolving demands of its patrons. The library has consequently purchased new ICT hardware and software in order to provide access to electronic books and journals. According to one of the respondents, Egerton University has benefited from the consortium as a member of KLISC, receiving scientific data that is needed by its clients. The Online Public Access Catalog (OPAC), which allows users to view the library's collection and make reservations for loaned items, is another way that library users can currently access the collection.

The Library has thus been driven to implement novel technologies in order to facilitate execution of its functions, encompassing acquisition, categorization, and cataloging and has been able to handle important activities and reduce the workload of the Cataloguing/Classification section by utilizing the AMLIB. Technology has made communication between book vendors and the University Library relatively easier and less expensive.

The Library adopted modern technologies to support services and operations in order to co-share with other university libraries. According to Qutab et al [12], the goal of technology application is to guarantee that the majority of library users can quickly and easily obtain pertinent, accurate, and up-to-date information from both local and remote databases [12]. The

responders went on to say that "in order for libraries to function effectively in the modern era, manual processes or methods would have to give way to technologies (ICTs) and a computer driven environment and that libraries must take a more proactive response to ICT."

Implication of technology on library operations

The study's second objective was to determine how technology advancements might affect staff knowledge and abilities, library operations, and services. The results on the effects of technology advancements on information management procedures are shown on Table 2.

Table 2: Technology Developments' Effects on Library Services

Sample Direct Quotes (Excerpts) from Respondents	Technology advancements' effects on information management techniques
	Beneficial Implications
"With the use of technologies like copy cataloging, staff members can work quickly and efficiently, for example, in the classification and cataloging section."	Increased productivity and operational efficiency.
"..using a computer speeds up both lending and receiving."	Achievement of timely services
"University libraries work together and jointly acquire information resources through KLISC..."	Saving money on the purchase of information resources through consortiums, internet purchases, etc.
"Users of the internet can access a variety of information resources."	expanded access to a greater variety of materials, remote access, frequent updates on interesting subjects, etc.

"...automated sections use LAN technology to quickly and easily transfer information between sections."	Simple and quick data transfer between machines
"…every time a new technology is acquired, we receive training."	Enhancement of educational development
"…digitization of theses/dissertations is on-going…"	Digitization of local content
...there are thousands of e-books and e-journals available, and they barely take up space on a desktop computer."	Conservation of library space
"Using email technology makes it convenient for the library and book suppliers to exchange information."	Quick and convenient information exchanges
"…teleconferencing technology facilitates professional idea sharing through group discussions."	access to knowledgeable and skilled people in a variety of industries;
"…ICTs have made it possible for Kenyan university libraries to work together to acquire electronic materials. (e.g KLISC)…"	Improvement of collaboration across geographic distances
"…The internet contains a wealth of information, including retrospective and archived information…"	Access to archived information worldwide;
"…the resources in the library are accessible to PWDs. …"	The JAWS software for the deaf and the handheld magnifiers for the blind have supported the PWDs
	Negative Implications

"…our library budget increases in tandem with each new piece of technology that is bought. …."	Budget increases for IT equipment, installation, upkeep, staff and user training and retraining, and recruiting new employees, consultants, and temporary project workers to execute the new technologies
"…The institution as a whole still lacks a sufficient ICT infrastructure, and the internet is inconsistent...."	Poor and inadequate ICT Infrastructure and facilities
"…When the manual library management system was replaced with an automated one, some data was lost...."	issues with data conversion, transfer, and security can result in information or data loss
"….The library management system's supplier provides haphazard training, each requiring extra funding. Some modules haven't been used to their full potential yet. …."	A local computer/software market that is primarily exploitative and that provides inadequate after-sale maintenance and support;
"…The stability of the internet determines access to electronic resources.as opposed to print materials, which are a real, ongoing stock …"	Absence of long-term physical collection
…the reason why AMLIB (library management system) updates take so long is because funding isn't disbursed on time.	Decision- and policy-makers' ignorance of the impact that information networks have on a country's industrial and economic growth
"…In our library store, we have a lot of outdated ICT equipment. …"	Production of electronic garbage

Users were asked to share their thoughts on how technological advancements might affect the services and operations of libraries. As shown on Table 2, the study revealed that there are some positive outcomes as well as a few negative ones. However, there is need or libraries to adopt new technologies because the benefits much outweigh the drawbacks. Classification/Cataloguing operations and circulation services have benefited most from ICT application according to respondents who stated that the Library has raised its level of productivity and operational efficiency as well as timely services, as seen on Table 2.

The few unfavorable outcomes are controllable and consist of higher budgetary requirements, the possibility of data or information loss, and the need to improve staff members' abilities to handle technology advancements. Strategic management for university libraries has placed a strong emphasis on staff, automation, and effective use of new information technology, as noted by Hayes and Becker [13]. In addition to the timely services listed on Table 2, library management's attention has been needed to secure the necessary funding, hire the necessary staff, oversee the procedures involved in buying equipment and software, and allot the space and operating funds required to keep them. Technological advancements result in higher fiscal budgets since new technologies are more costly, particularly when outdated equipment needs to be replaced because it is incompatible. According to the study, since then, all of the Pentium II computers that the World Bank gave in 1999 have been replaced with newly acquired PCs with current technologies. Hayes and Becker [13] agree, noting that equipment and associated software, along with the information itself, will become more expensive. The publishers are not going to lower the price at which they disseminate content, and the producers of new software and technology devices are in the business to make money. There is need to allocate the requisite space and operational resources for their housing. x in addition to prompt services, as seen on Table 2.

Recommendations

Library ICT Policy

To address technological advancements and their associated impacts, including staff capacity management, license change management, software asset management, financial management, cost of implementation, and lifecycle configuration management, Egerton University Library should create a suitable ICT policy. The suggested strategy should provide seamless handling of technology advancements and be revised on a regular basis.

ICT Budget

The library must have a substantial ICT budget in order to enable effective automation and transformation in operations and service delivery. Application of technological breakthroughs should follow the constantly evolving norms and trends. Timely licensing, upkeep, and staff training on new and developing technologies of the library system would all be made possible by the availability of an ICT budget.

Staff Training

Staff members should get frequent training on developing technologies from the University Library. Training would guarantee that employees are confident enough to use new technologies, eliminating any indication of technophobia. Schedules for refresher training on the current ICTs, such as the library management system, should be followed, with a focus on the times when the system is updated or gets new releases.

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PRESERVING THE PAST, ENSURING THE FUTURE: CHALLENGES AND INNOVATIONS IN DIGITAL PRESERVATION OF INFORMATION

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Abstract

The task of digital preservation, which entails safeguarding enormous amounts of knowledge for future generations, is crucial for contemporary society. The intricate field of digital preservation is examined in this paper, with a particular emphasis on how the variety of formats and sources calls for fundamental adjustments in preservation methods. In the ever evolving technological landscape, reactive and flexible methods are needed; traditional ones are no longer adequate. Concerning digital archiving, the primary objectives of this research are data integrity, obsolescence, and the ongoing threat of technological revolution. An extensive guide to long-term digital data storage is to be provided, along with an explanation of new methods and technologies created to address these concerns. An in-depth and comprehensive literature review and analysis of pertinent case studies form part of the methodology. Important subjects comprise metadata standards, emulation, format migration, and cooperative initiatives in the preservation community. Anticipated results include a thorough grasp of the challenges encountered by digital preservation initiatives as well as an investigation of effective strategies and resources to get past these roadblocks. This study enhances to the current of knowledge on

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digital preservation by pointing out obstacles and providing workable fixes for long-term preservation. It emphasizes the necessity of modifying conservation methods to take advantage of evolving technological capabilities and advocates for an active, future-focused approach to safeguarding the enduring legacy of our digital heritage.

Keywords: Digital Preservation, Format Migration, Data Integrity, Obsolescence, Technological Change

1.0 Introduction

The digital age has revolutionized the way information is created, disseminated, and preserved [1]. Worldwide, the creation, access, and dissemination of information have been completely transformed by the advent of digital technologies. The increase in digital information has thus created previously unheard-of opportunities for accessibility and dissemination, ranging from digital content and multimedia artifacts to digitized manuscripts and archival documents. However, with the boundless opportunities presented by digitalization, there exist formidable obstacles that endanger the enduring viability of digital assets.

Houghton [2] observed that organizational challenges in digital preservation include technical, administrative, legal, and logistical aspects. According to Tripathi [3] digital preservation requires collective measures incorporating traditional and digital means, including bundling, storage, quality control, and risk preparedness, to ensure the enduring preservation of digital objects. Elsewhere, Burda and Teuteberg [4] argued that digital preservation faces organizational challenges, such as lack of cost-benefit analysis and decision-making methods, and suggested a

need for a research agenda for future exploration. This paper looks at the innovations and difficulties experienced in digital preservation with a particular emphasis on the value of saving historical documents, scientific knowledge, and cultural heritage for future generations.

Objectives

The objectives of this study were to analyze the challenges inherent in digital preservation, as identified in the existing literature, identify innovative strategies and technologies to address these challenges, makes recommendations for advancing digital preservation and highlight areas for future research and collaboration.

Methodology

This study uses a literature review of peer-reviewed papers, reports, and institutional documents on the subject, a thorough search of academic databases, institutional repositories, and pertinent websites. To narrow down the search results, terms like "format migration," "digital preservation," "long-term access," and "technological obsolescence" were used. Subsequently, a thematic analysis of the chosen literature was conducted to pinpoint recurring issues, creative solutions, and suggestions for improving digital preservation techniques.

Challenges in Digital Preservation

Preservation of digital information has become an important concern for institutions, organizations, and society at large in the rapidly changing digital age. While observing that digital assets must be protected for future generations he observed that digital preservation brings with it several complicated issues with organizational, legal, ethical and technological components [2]. This study examined the various obstacles that digital preservation initiatives must overcome and addresses the complexities of format migration, technology obsolescence,

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data authenticity, and sustainability and policy frameworks. Through a thorough analysis of these issues, there is a possibility of gaining a deeper understanding of the intricacies of digital archiving and identify tactics and solutions to effectively address these issues.

Technological Obsolescence

Technological obsolescence poses a significant challenge to long-term digital preservation. As observed by El Idrissi [5] long-term digital preservation faces challenges from software and format obsolescence, requiring fundamental preservation strategies to guarantee accessibility, authenticity, and integrity of digital objects for a long time. The author observed that digital materials are prone to format obsolescence and hardware/software dependencies due to their inherent fragility and susceptibility to rapid technological changes. Thus, the swift advancement of hardware and software platforms presents a noteworthy peril to the sustained accessibility of digital assets, given that obsolete file formats and outdated technologies grow progressively incompatible with contemporary systems. Elsewhere, Bekele et al [6] cautioned that the integrity of our scientific knowledge and cultural heritage is at risk when digital materials become unreadable and inaccessible over time due to technological obsolescence if preventive measures are not taken [6].

Format Migration

Considering the wide variety of file formats used to encode digital content, format migration is another crucial issue in digital preservation. Xie et al. [7] proposed that there may be need to migrate digital assets to more sustainable formats to ensure their long-term viability as file formats become outdated or unsupported by evolving technology. He indicated that format migration and preservation metadata are crucial for the digital preservation of scientific data, enabling reproducible experiments and promoting research and innovation [7]. Data loss, corruption, and fidelity loss are just a few of the possible hazards associated with format

migration, which is a difficult and resource-intensive process. Because of their intrinsic complexity and interdependencies, complex digital objects like multimedia files and interactive websites also pose unique preservation challenges.

Data Authenticity

One of the main issues with digital preservation is preserving the integrity and authenticity of digital materials. Thus, digital assets, in contrast to physical artifacts, are subject to unauthorized changes, manipulation, and tampering, which raises questions about the data's authenticity and reliability. Robust cryptographic checksums, audit trails to identify and stop unwanted modifications, and digital signature verification techniques are necessary to ensure the integrity of digital materials. Furthermore, proving provenance and authenticity metadata establishment is essential for recording the chain of custody and confirming legitimacy of digital materials over time.

Sustainability and Funding

According to Burda and Teuteberg [4] scarcity of resources and conflicting priorities, make digital preservation projects face formidable challenges in terms of funding and sustainability. Important investments in staff, software, hardware, and training are needed to create and maintain a sustainable digital archiving infrastructure [4]. Further, ongoing financial and other support from governmental bodies, charitable institutions, and other stakeholders is necessary to guarantee the long-term viability of digital repositories and archives. There are concerns about sustainability and longevity of digital preservation initiatives due to funding challenges.

Legal and Ethical Considerations

 Digital preservation is heavily influenced by ethical and legal factors, which include things like copyright, privacy, and intellectual property rights. Corrado [8] observed that digital preservation faces challenges beyond just technology, including intellectual property and

economic concerns, which impact software preservation and web archiving. The use and distribution of digital materials are governed by a complex legal environment that includes copyright restrictions, licensing agreements, and privacy regulations. These regulations present challenges for digital preservation initiatives. In addition, moral questions about the digitization and sharing of indigenous knowledge, culturally sensitive materials, and personal data present complex moral challenges that call for careful thought and discussion with the appropriate parties.

Innovations in Digital Preservation

Emulation

Replicating the original software environment in which digital materials were created and accessed is called emulation, and it is a promising method of digital preservation. Arunkumar and Devendran [9] suggested that a combination of migration and emulation can effectively preserve digital data, reducing dependence on future technology and ensuring its longevity. Thus, faithful reproduction and rendering of digital content in its original context is made possible by emulation, which ensures a lasting accessibility and usability of digital assets by simulating outdated hardware and software platforms. Digital materials can thus be accessed and interpreted for eternity thanks to emulation, which provides a workable solution to the problems of format obsolescence and technological dependency.

Blockchain Technology

It has been demonstrated in a study how Blockchain-based data preservation system effectively preserves medical data, ensuring privacy and security while ensuring reliable treatment progress [10]. The authors indicated that decentralized and impenetrable mechanisms provided by blockchain technology for storage and verification of digital assets offer enormous potential for digital preservation. This technology can be used by digital preservation projects to create

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unchangeable records of ownership, provenance, and authenticity for digital materials. In another report, Bernal Barnabe et al. [11] observed that privacy-preserving solutions in blockchains are evolving to enable users to become anonymous and take charge of their private data during digital transactions, addressing challenges in diverse scenarios like eGovernment, eHealth, and Cooperative. This possibility increases accountability and trust in the preservation process. Additionally, strong protections against data loss, censorship, and unauthorized changes are provided by blockchain-based decentralized storage systems, guaranteeing the longevity and integrity of digital assets.

Artificial Intelligence

With automated methods for content analysis, metadata extraction, and preservation planning, Artificial Intelligence (AI) has the potential to completely transform digital preservation. In a report by Russo and Ciaccio [12] AI technologies, specifically Vision Transformer and Diffusion models, have the potential to enhance environmental monitoring and preservation by improving accuracy, efficiency, and communication. The authors observed that Artificial Intelligence (AI) driven algorithms are able to evaluate enormous amounts of digital material, spot preservation hazards, and rank the importance and value of different materials in order of preservation. Furthermore, digital materials can be automatically transcribed, translated, and indexed with the help of AI-driven methods like machine learning and natural language processing, which will improve their discoverability and accessibility.

Decentralized Storage Solutions

Muthalibu [13] argued that digital asset preservation is made possible by decentralized storage solutions like distributed ledger technologies and peer-to-peer networks, which provide robust and censorship-resistant platforms in contrast to centralized storage systems that are susceptible to censorship and single points of failure, decentralized storage solutions disperse digital

content among multiple nodes in a network, guaranteeing fault tolerance and redundancy. The resilience and longevity of digital assets can be improved by digital preservation initiatives by utilizing decentralized storage solutions to reduce the risks of data loss, censorship, and unauthorized alterations.

Persistent Identifiers

As distinct and long-lasting references to digital assets, persistent identifiers, or PIDs, are crucial tools in the field of digital preservation. Through consistent citation, expedited discovery, and easy access across various platforms and repositories, these identifiers play a vital role in guaranteeing the longevity of digital publications. PIDs are assigned to digital assets so that long-term access and management of these resources can be managed efficiently for the benefit of future generations under digital preservation initiatives. Di Cosmo et al. [14] pointed out that, by offering a trustworthy framework for locating and selecting digital assets, PIDs essentially play a major part in digital preservation since they make it easier to organize, cite, and retrieve digital content. Digital preservation efforts can thus ensure that digital content remains relevant and useful in an ever-changing digital landscape by putting in place a strong infrastructure for its ongoing management and accessibility through methodical implementation of PIDs.

5. Case Studies

Digital information preservation is a difficult task in the rapidly changing digital world. Kapeliushna et al. [15] observed that globally, enterprises are facing the challenges of safeguarding digital resources, guaranteeing their availability, and preserving their authenticity in the long run. Prominent initiatives aimed at tackling these issues head-on include the Digital Preservation Strategy of the European Commission, the Digital Stewardship Alliance (NDSA), and the Digital Preservation Coalition (DPC). These groups lead the charge in ensuring sustainability and accessibility of digital materials for upcoming generations via cooperation, advocacy, and strategic planning.

The National Digital Stewardship Alliance- (NDSA)

Gallinger et al.[16] observed that, the goal of the NDSA is to advance digital stewardship in the US through a cooperative network of institutions and organizations focused on creation of standards, guidelines, and resources for digital preservation through cooperative projects, working groups, and advocacy initiatives. The Levels of Digital Preservation framework, one of the main projects of the NDSA, offers a tiered method for evaluating and enhancing digital preservation practices. The five levels of the framework, which go from basic to advanced, each correspond to a set of skills and tasks required for efficient digital preservation. Institutions can thus prioritize areas for improvement and evaluate their preparedness for digital preservation by implementing these levels of Digital Preservation framework.

Bringing together a broad community of professionals, including librarians, archivists, technologists, and researchers, the NDSA encourages cooperation and knowledge-sharing among its members through working groups, task forces, and annual meetings, which helps to develop best practices, standards, and resources for digital preservation. Additionally, the NDSA has further been instrumental in promoting national funding and policy initiatives for digital preservation. The NDSA has developed capacity within the cultural heritage sector and increased awareness of the value of digital preservation through cooperative projects and partnerships.

6. Future Trends

Future growth and innovation in the field of digital preservation are anticipated due to the need to handle the ever-changing opportunities and challenges of the digital age. Emerging trends and fresh approaches will reshape the field of digital preservation in the years to come, propelled by the innovative work of institutions devoted to safeguarding our digital legacy. Georgopoulos [17] observed that the future of digital preservation is expected to be shaped by

transformative technologies and cooperative efforts aimed at safeguarding the lasting accessibility and relevance of the digital cultural heritage. These efforts will range from adoption of decentralized and blockchain-based systems to improve the integrity and longevity of digital assets, to advancements in artificial intelligence and machine learning for automated metadata curation and enrichment.

a) *Integration of Emerging Technologies*: Incorporation of new technologies, including Artificial Intelligence (AI), Machine Learning and Blockchain, is one of the most significant future paths in digital preservation. Woods and Lee [18] noted that these technologies have a great deal of promise for streamlining metadata extraction processes, keeping digital materials authentic and intact, and automating archiving workflows. Utilizing AI-driven algorithms, businesses can increase the effectiveness and scalability of their digital preservation initiatives by optimizing digitization, metadata generation, and content analysis processes.

b) *Enhanced Collaboration and Interoperability*: Digital preservation will continue to advance primarily due to collaboration and interoperability as observed by Hilbert [1]. Collaboration between heritage institutions, research organizations, and technology providers to share resources, expertise, and best practices will be crucial as the volume and complexity of digital materials continue to rise. Furthermore, promoting standards-based methodologies and interoperability will make it easier to exchange and access digital materials across various platforms and repositories.

c) *Focus on Diversity, Equity, and Inclusion*: Initiatives for digital preservation will place more of a focus on inclusion, equity, and diversity in the coming years. Organizations will ensure that digital collections reflect a wide range of cultural, linguistic, and geographical diversity because they understand how important it is to preserve diverse voices and perspectives. Additionally, addressing inclusivity and accessibility concerns

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will be a top priority in order to guarantee that digital materials are usable by all users, including those with limited technology access or disabilities.

d) *Sustainable Preservation Strategies***:** Organizations working to create sustainable preservation methods that balance social, economic, and environmental factors will continue to prioritize sustainability in their digital preservation efforts. The importance of reducing the environmental impact of digital preservation activities—such as through energy-efficient storage options and ethical e-waste management—will only increase. Furthermore, the long-term viability of digital preservation initiatives will be enhanced by programs that enable communities to take charge of their digital legacy and develop local competence.

e) *Ethical and Legal Considerations***:** Boughman in a study pointed out that digital preservation techniques will continue to be shaped by ethical and legal issues, especially in relation to copyright, privacy, and intellectual property rights [18]. To maintain appropriate management of digital artifacts, organizations will need to negotiate complex legal frameworks and ethical standards as indicated by Corrado in a study about legal considerations on a digitization undertaking. Furthermore, it is imperative that digital preservation programs prioritize addressing cultural sensitivity, indigenous rights, and community permission [8]. This will necessitate stakeholder consultation and ethical standards' observance.

f) *Collaborative Partnerships***:** The future of digital preservation initiatives will be greatly influenced by collaborative collaborations [20]. Thus, the need for collaboration across institutions, industries, and disciplines is growing as the complexity of digital preservation concerns rises. In order to maximize the pooling of resources, technology, and knowledge, future paths in collaborative partnerships will require cultivating cross-sectoral cooperation involving government agencies, academic researchers, corporate

stakeholders, and cultural heritage institutions. Proposals such as the DPC-Digital Preservation Coalition and the NDSA- National Digital Stewardship Alliance serve as excellent examples of collaborative approaches that work well for exchanging knowledge, developing capacity, and creating best practices for digital preservation.

g) *Capacity Building and Training*: Initiatives aimed at increasing capacity and providing training will remain crucial in providing experts with the abilities and information required to handle the challenges associated with digital preservation. Expanding access to education and training programs is a future direction for capacity building and training, especially in underprivileged areas and communities. Professionals can learn about new trends and technologies, improve their digital preservation skills, and share best practices with colleagues through programs like webinars, online courses, and workshops. Stakeholders can guarantee the sustainability of digital preservation efforts and empower a new generation of professionals in the field by funding capacity building and training initiatives.

h) *Policy Development and Advocacy*: Legal, regulatory, and funding frameworks pertaining to digital preservation will be significantly shaped by policy development and advocacy as pointed out by Corrado [8]. He suggested that advocating for policies that support open access, data sharing, and long-term sustainability in digital preservation initiatives is one of the future directions in policy development and advocacy [8]. Advocacy groups and policymakers can be crucial in promoting the adoption of best practices and standards, advocating for funding to support preservation initiatives, and educating the public about the value of digital preservation. Digital preservation advocates can impact policy decisions and guarantee that digital preservation stays a top priority on national and international agendas by interacting with legislators, advocacy

groups, and stakeholders. Professionals in preservation and guarantee the long-term viability of digital preservation initiatives.

7. Findings

Digital preservation poses complex challenges, including technological obsolescence, data integrity, and sustainability, as identified in numerous studies. Innovative strategies and technologies proposed in the literature, such as emulation, blockchain technology, and decentralized storage, offer promising solutions for addressing these challenges and ensuring the long-term preservation of digital resources. Collaboration among libraries, archives, museums, and technology developers is consistently emphasized in the literature as essential for advancing the field of digital preservation and developing interoperable standards and tools.

Conclusion

The literature assessment cited in this study demonstrate the vital relevance of digital preservation in conserving cultural heritage and intellectual materials for future generations. By adopting new trends and technologies presented in the literature, institutions and practitioners can overcome the obstacles of digital preservation and assurelong-term accessibility and usability of digital resources. Moving forward, coordinated efforts and persistent funding are required to advance digital preservation while effectively preserving communal memory and knowledge. Digital preservation is thus, a complicated and varied enterprise that requires ongoing collaboration, creativity, and investment. As the rapidly changing digital landscape is navigated, it becomes increasingly important to address the numerous issues associated with safeguarding digital information.

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