EXPLORING FACTORS FOR SUPPORTING POST COVID-19 EDUCATION SYSTEMS RESILIENCE: INSIGHTS FROM RWANDA AND KENYA

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ABSTRACT

The devastating effects of the COVID-19 pandemic helped to shed light on the hidden challenges of global education systems. The lockdown period in turn presented reasons for ensuring preparedness for education and learning in times of crisis. The sudden switch to online learning on one hand enabled education and learning, but only to those who could access technology, while it also worsened existing inequalities between the affluent and those at the margins. This dynamic proved that technology alone cannot address the challenges of education and learning during pandemics and crisis, unless supported by other enablers. To address these challenges, this research explored the intersections of technology, infrastructure, collaboration, and community engagement in transforming education systems. Focusing on the African context, this study aims to identify context-specific strategies for building resilience and strengthening education systems. This research fills a critical knowledge gap in existing literature by providing context-specific case studies from Africa, a region previously underrepresented. Through in-depth analysis, this study uncovers the intricate challenges confronting education systems and presents actionable recommendations for harnessing technology, infrastructure, collaboration, and community engagement to drive transformative change in education. The findings emphasize the need for a multi-stakeholder approach, collective action, and shared responsibility among various stakeholders to mitigate pandemic and natural disaster disruptions.

KEYWORDS

COVID-19 pandemic, Education systems, Resilience, Equity, Effectiveness

1. INTRODUCTION

The COVID-19 pandemic has brought about an unprecedented crisis in global education, exposing significant deficiencies in contingency planning and preparedness (Anderson, 2022). UNESCO (2020) found that since its emergence in late 2019, the pandemic has had a devastating impact on education worldwide, affecting over 1.6 billion learners and disrupting education systems globally. In response to the pandemic, governments and education authorities implemented various measures to mitigate the spread of the virus. In response, widespread school closures affected over 90% of the global student population. This led to a swift transition to

remote learning, with numerous schools and educators pivoting to online and blended learning models to minimize disruption (Munoz-Basols, Gutierrez, Strawbridge et al., 2023). This shift was accompanied by an increased reliance on digital resources, including online platforms, educational software, and mobile apps, which became essential tools for continuing education in the face of unprecedented disruption. The pandemic necessitated a swift and widespread transition to online and technology-dependent modes of education, forcing education institutions and educators across the spectrum of digital capability and enthusiasm to adapt and innovate. Regardless of their prior experience or comfort with technology, educators at all levels were compelled to leverage digital tools and platforms to continue teaching and learning, driving a rapid expansion of online education. According to Kuhn (1962), the rapid transition to online learning and the widespread adoption of technologies during the pandemic may mark a disruptive paradigm shift in education, with far-reaching consequences for teaching and learning. The experiences and practices adopted during this period of crisis are likely to have a lasting impact, shaping the education landscape for years to come. As educators and learners navigate new technologies and teaching methods, they are likely to discover ground-breaking approaches that revolutionize the delivery, accessibility, and overall experience of education.

Despite efforts to mitigate the pandemic's impact, students, teachers, and communities faced numerous challenges. Many students lacked access to devices, internet connectivity, and digital literacy skills, exacerbating existing inequalities. Furthermore, inadequate investment in education infrastructure, including digital infrastructure, hindered the ability of education systems to respond effectively. Teachers often lacked the necessary training, support, and resources to deliver remote learning, while students struggled to stay engaged and motivated in virtual environments. Perhaps most concerning, the pandemic intensified existing inequalities, with marginalized groups facing even greater barriers to accessing education, thereby widening the gap in educational opportunities and outcomes.

At a much higher level, the COVID-19 induced lockdowns and school closures exposed the vulnerabilities of education systems, resulting in disproportionate learning continuity along regional, continental, and country-specific economic, social, and political lines. The pandemic has thus exposed existing inequalities in education, particularly in terms of social well-being, access to technology, internet connectivity, and digital literacy (World Bank, 2020). The pandemic had a disproportionately devastating impact on education security, particularly concerning the safeguarding of learners' and teachers' social and emotional wellbeing. Marginalized groups, including women and girls, children with disabilities, and refugees, were especially vulnerable, with uneven and often insufficient protection measures in place. (ADEA, AU/CIEFFA & APHRC, 2021). These disparities have underscored the need for transformative changes in education systems to ensure they are resilient, equitable, and effective in the face of future crises. In the post pandemic era, it's crucial to reflect on the valuable lessons learned and capitalize on the opportunities for innovation, transformation, and resilience in education. This can pave the way for a more equitable, effective, and sustainable future.

On the flipside, the pandemic also brought to the forefront opportunities for innovation and transformation in education. One notable outcome was the rapid development and adoption of education technology solutions, including online and blended learning platforms, which were swiftly implemented to support remote learning. Furthermore, the pandemic highlighted the vital need for digital literacy skills, leading to a surge in investment in digital literacy programs. In response, educators were driven to innovate, exploring new teaching and learning approaches such as flipped classrooms, gamification, and personalized learning, which have the potential to enhance student engagement, motivation, and overall learning outcomes. The pandemic further fostered enhanced collaboration and community engagement, as educators, policymakers, and community leaders converged to develop innovative solutions. In the final analysis, Covid-19

served as a catalyst for transformative change, offering a rare chance to reimagine and redesign education systems with a renewed emphasis on equity, inclusion, and resilience, paving the way for a more just, adaptable, and student-centered education landscape.

The post- Covid-19 era continues to offer an opportunity to rebuild education systems that prioritize sustainability, resilience and climate change mitigation. However, as governments, educators, and communities work to address the pandemic's challenges, they are simultaneously faced with a complex array of emerging issues, including climate change, globalization, shifting demographics, ongoing conflicts, displaced populations, and the exponential growth of education technology and artificial intelligence, which collectively threaten to reshape the education landscape in profound and far-reaching ways. The urgent need to establish and strengthen national, regional, and global education monitoring systems and institutions has become increasingly apparent. These systems and institutions can facilitate the generation and dissemination of timely, relevant, and context-specific data and research evidence. This, in turn, can inform policy and decision-making, ultimately strengthening education system resilience globally.

A number of significant challenges persist in all efforts to improve education system resilience post-COVID-19, and these challenges make up the problem that this research paper seeks to tackle. Firstly, the concept of education system resilience, while widely embraced as a mitigatory strategy to the COVID-19 pandemic, remains poorly defined, poorly researched, and lacking in consensus around its meaning in theory and practice (Cameron, Pon, D'Angelo & Cooper, 2024). The conspicuous interplay is particularly pronounced in understanding the interplay between individual resilience and broader social and systemic dynamics. Furthermore, it poses challenges in developing effective planning processes and policies for disaster risk reduction, crisis-sensitive education planning, and addressing climate change impacts, globalization, and technological advancements. To address this knowledge gap, it is essential to explore the intersection of technology, infrastructure, collaboration, and community engagement in the post-pandemic era. By examining the complex relationships between these factors, policymakers and educators can develop targeted strategies to enhance education system resilience. Ultimately, this will ensure that education systems are better equipped to withstand future crises and provide high-quality education for all, fostering a more resilient and equitable education landscape

Furthermore, while there is extant literature examining the disruptive impact of COVID-19 on education globally, highlighting the need for resilient education systems (Cameron et al, 2024; Tarricone, Mestan, & Teo, 2021; Tadesse & Muluye, 2020), there is a significant gap in the existing body of knowledge. Specifically, the current literature lacks context-specific case studies from Africa, neglecting the unique challenges and opportunities facing the continent's education systems, fails to provide tailored policy suggestions for strengthening African education systems in the face of crises like COVID-19. This research aims to address this knowledge gap by exploring the impact of COVID-19 on education systems in Africa, with a focus on identifying context-specific strategies for building resilience and strengthening education systems on the continent. Finally, research has focused so much on the temporal consequences of the Covid-19 and related natural disasters at the level of education, without focusing on the long term, and this research attempts to do that.

Currently, many education systems continue to face significant challenges. Limited access to technology, internet connectivity, and digital literacy has exacerbated existing inequalities in education. The inadequate investment in education infrastructure, particularly digital infrastructure, has severely impeded education systems' capacity to respond efficiently and effectively to the pandemic, exacerbating existing inequalities and hindering the continuity of quality education.. Furthermore, insufficient collaboration among stakeholders, including

governments, private sector entities, donors, and communities, has hindered the development of effective solutions. These challenges highlight the need for a comprehensive approach to addressing the complex issues facing education systems.

This paper analysed the intersections of technology, infrastructure, collaboration, and community engagement be leveraged to transform education systems and ensure they are resilient, equitable, and effective in the face of future crises. The analysis argued that navigating the intersections of technology, infrastructure, collaboration, and community engagement is crucial for transforming education systems and ensuring they are resilient, equitable, and effective in the face of future crises. Education stakeholders can co-create ground-breaking solutions that tackle the intricate challenges posed by the pandemic if they leverage these intersections. Such a collaborative approach has potential to promote strengthened education systems, further ensuring that these systems are better prepared to mitigate the impact of future disruptions.

The findings unequivocally highlight the critical importance of a multi-stakeholder approach in the global effort to mitigate disruptions caused by pandemics and natural disasters. This emphasizes the necessity for collective action, extensive education, and shared responsibility among diverse stakeholders, including governments, educators, communities, and international organizations. Fostering collaboration and coordination helps the global community to develop robust, resilient education systems capable of withstanding future disruptions and providing uninterrupted, quality education for all. The post-pandemic era presents a unique opportunity for various stakeholders to learn from the past, use the lessons learnt to strengthen education system resilience, and empower individuals at different levels to be ready to mitigate and withstand effects of possible future disruptions. The presented case studies from Rwanda and Kenya served as models for resilient education communities in Africa, offering a blueprint for addressing similar challenges. Overall, this paper concluded with a resounding call to action, advocating for the recognition of all stakeholders as key development actors in strengthening education futures in Africa. This analysis serves as a foundational step in a broader, critical examination aimed at uncovering valuable insights and solutions to the disruptions that have impacted the education sector. Its purpose is to spark further investigation and dialogue, ultimately contributing to the development of resilient education systems that can effectively withstand future challenges and provide uninterrupted, quality education.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

This study's conceptual framework is anchored in the intersectionality of technology, infrastructure, collaboration, and community engagement. The intersection of technology, infrastructure, collaboration, and community engagement framework gives rise to innovative and equitable solutions. Effective community engagement relies on robust infrastructure and strategic use of technology to facilitate inclusive participation and information exchange. Collaborative approaches play a pivotal role in cultivating trust and amplifying marginalized voices, thereby ensuring that community needs and concerns are meaningfully integrated into decision-making processes. By recognizing the intricate interconnectedness of these elements, practitioners and policymakers can co-create context-specific, technologically enabled solutions that champion social justice, equity, and collective ownership, ultimately fostering a more inclusive and equitable education landscape. Through this framework, this study posits that the effective navigation of these intersecting factors is crucial for fostering resilient and sustainable post-pandemic recovery in Rwanda, Kenya, and South Africa. The conceptual framework comprises four key dimensions: (1) technology, encompassing digital tools and innovations; (2) infrastructure, including physical and institutional structures; (3) collaboration, involving multi-stakeholder partnerships and networks; and (4) community engagement, focusing on participatory approaches and social inclusion.

This study is grounded in the theoretical framework of Social Ecological Systems (SES) theory. The theoretical framework of Social-Ecological Systems (SES) has its roots in several disciplines, including ecology, sociology, anthropology, and systems theory. The groundwork for SES was laid by early influences such as Ludwig von Bertalanffy's General Systems Theory (1937) and ecologists like Arthur Tansley (1935 in Salomon, 2008) and Eugene Odum (1953), who introduced the concept of ecosystems. The term "Social-Ecological Systems" was popularized by Berkes and Folke (1998), who integrated insights from ecology, anthropology, and sociology to understand the interconnectedness of human and natural systems.

These milestones and contributors have collectively shaped the theoretical framework of Social-Ecological Systems, which continues to evolve and inform research and practice in fields like sustainability, conservation, and environmental governance. The SES theory provides a nuanced understanding of the complex interactions between technological, infrastructural, social, and institutional factors, positing that the resilience and adaptability of social-ecological systems depend on the alignment of these factors. In the context of post-pandemic recovery, SES theory suggests that the effective integration of technology, infrastructure, collaboration, and community engagement can enhance the resilience and sustainability of social-ecological systems in Rwanda, Kenya, and South Africa. By applying SES theory, this study aims to provide insights into the complex dynamics underlying post-pandemic recovery in these countries.

3. LITERATURE REVIEW

Two data sets are presented in this literature review. The first data set is from a general desk review of literature on the subject under study, while the second data set presents two case studies from Rwanda and Kenya.

3.1. Desk Review

The COVID-19 pandemic has dramatically accelerated the imperative for education systems to embody resilience, adaptability, and responsiveness in the face of crises. As aptly noted by Tsoukas and Hatch (2001:979), crises not only generate and intensify complexity but also underscore the intricate nature of the systems being studied. Moreover, complexity is inherently tied to the ways in which we conceptualize and organize our thinking about these systems, highlighting the need for a nuanced and dynamic approach to education system design and management. Education system resilience refers to the ability of education on systems to anticipate, prepare for, and respond to shocks and stresses, while maintaining their core functions and promoting learning outcomes (UNESCO, 2020). Strong education systems are paramount for guaranteeing continuity of learning, even amidst disruption, crisis, or adversity, ultimately safeguarding the educational progress and well-being of students and communities worldwide.

Despite its importance, education system resilience remains a relatively under-researched area. While existing literature has predominantly explored individual resilience, it has neglected the crucial systemic and structural factors that foster resilience within education systems as a whole (Cameron et al., 2024). Moreover, the majority of research on education system resilience has been conducted in high-income countries, leaving a significant knowledge gap regarding the distinct challenges and contexts faced by low- and middle-income countries, which necessitates more nuanced and context-specific investigations.

In recent years, there has been growing recognition of the need for education systems to be more resilient and adaptable. The United Nations' Sustainable Development Goals (SDGs), for example, emphasize the importance of inclusive and equitable quality education, as well as the

need for education systems to be resilient and responsive to the needs of all learners (UN, 2015). Echoing this sentiment, the Global Partnership for Education (GPE) has underscored the imperative for education systems to cultivate resilience and adaptability, especially in the face of crises and shocks (Cameron, 2024). Nevertheless, despite these endeavours, substantial knowledge gaps persist in our comprehension of education system resilience, particularly in low- and middle-income countries, where context-specific insights and solutions are urgently needed. There is a need for more research on the factors that contribute to education system resilience, as well as the strategies and policies that can be used to promote resilience in different contexts. This study aims to address this gap by exploring the intersection of technology, infrastructure collaboration, and community engagement in promoting education system resilience in the post-pandemic world.

The effective integration of technology, infrastructure, collaboration, and community engagement is crucial for transforming education systems and ensuring they are resilient, equitable, and effective. Technology serves as a catalyst in expanding access to education, facilitating the harnessing of digital platforms for online and blended learning, and leveraging digital resources, artificial intelligence, and adaptive learning technologies to create personalized learning pathways. Furthermore, the strategic integration of virtual and augmented reality technologies can give rise to immersive, interactive, and engaging learning experiences that simulate real-world environments, thereby revolutionizing the educational landscape. However, developing infrastructure is essential to support technology-enhanced education, including reliable internet connectivity, digital devices, digital literacy skills, and robust infrastructure maintenance and support systems.

Effective collaboration among stakeholders, including government-private sector partnerships, community engagement, donor support, and inter-agency coordination, is also critical for developing and implementing effective education solutions. Community engagement plays a pivotal role in fostering the creation of tailored solutions that cater to the distinct needs and challenges of local communities. Educators and policymakers can develop context-specific initiatives that not only address the unique complexities of the local context but also cultivate a sense of ownership and collective responsibility once they involve community members in planning and decision making. This includes supporting community-led initiatives, encouraging parental involvement, and ensuring that education solutions are culturally sensitive and relevant to the local context. By integrating these key elements, education systems can be transformed to better serve the needs of all learners, regardless of their background or circumstances.

According to Eslit (2023), the post-COVID-19 landscape presents a critical opportunity for local communities to play a vital role in mitigating climate change. The study's findings underscore the pivotal role of local communities in the global effort to address climate change, emphasizing the need for collective action, comprehensive education, and shared responsibility. Furthermore, Eslit's research highlights the importance of fostering collaborative relationships among local communities, policymakers, legislators, donors, education officials, learners, and teachers. These partnerships are essential for designing effective climate and pandemic institutions, mechanisms, and technologies, as well as promoting climate education, supporting community-driven initiatives, and empowering individuals to leverage technology and drive change at the grassroots level. The COVID-19 pandemic has starkly illustrated the interconnectedness of human health and the environment, with climate change exacerbating the spread of diseases, thereby necessitating a unified and multi-faceted response.

Cattapan, Verney, Acker-Verney & Dorbrowolsky (2020) demonstrated how the COVID-19 pandemic has highlighted the importance of community engagement in addressing the needs of marginalized groups. In the context of education, community engagement plays a critical role in

ensuring that the voices of excluded groups are heard and their needs are addressed. This involves providing resources to enable marginalized groups to undertake their own engagement initiatives and advocate on their own behalf.

Effective community engagement in education during crisis requires flexibility, existing networks, and dedicated time and resources. Governments and educational institutions must reach out to marginalized groups and involve them in decision-making processes to ensure that their needs are addressed. By doing so, community engagement can help promote equitable education and address the unique challenges faced by marginalized groups during crisis.

The integration of technology in education has revolutionized traditional teaching and learning methods. Increased usage of online platforms and e-learning tools has significantly expanded access to education, providing a myriad of opportunities for learners with diverse needs, abilities, and learning styles to engage with educational content in a flexible and personalized manner. The COVID-19 pandemic served as a catalyst, accelerating the adoption of digital learning solutions and emphasizing the value of flexible, adaptable learning models.

This experience is likely to have a profound and lasting impact on the education sector, revolutionizing the future of teaching and learning. As Gkeredakis, Kifshitz-Assef, and Barrett (2021) astutely observed, the utilization of digital technology in response to crises introduces novel and theoretically misunderstood dynamics. This underscores the pressing need for further research into the diverse applications and consequences of digital technologies during crises. Moreover, their work highlights the importance of reframing crises as opportunities for growth, disruption, and exposure. By leveraging digital technologies, innovation can be accelerated, but this also presents coordination challenges and risky implementation, necessitating careful consideration and strategic planning. Digital technologies thus require a rapid shift or organisational practices and operations to new digital spaces as the only enabler for work continuity. For example, the use of digital technologies has ranged from enabling contract-tracing, remote learning, and the use of advanced technologies for both research and learning purposes (Min, Lifshitz-Assaf & Levina, 2021). The researcher caution the potential that digital technologies have to promote over-dependence while distorting work practices. An important perspective from Barrett and Orlikowski (2021), posist that while the shifts in digital technology use to cope with the Covid-19 pandemic cannot be over-emphasised, there lies a risk for such shifts to be misunderstood. The researchers contend that organizational and institutional responses to crises are not merely facilitated by digital technology, but are, in fact, deeply intertwined with it. Echoing similar sentiments, they acknowledge that collective efforts to mitigate crises cannot be disconnected from the complex "digital configurations" that comprise various platforms, servers, networks, algorithms, and big data (Barrett & Orlikowski, 2021: 16). This perspective is further reinforced by Nan and Lu (2014: 1141), who emphasize the inherent entanglement of human agents and digital technologies as "coevolving forces" that shape emergency responses. This nuanced understanding highlights the need to consider the intricate relationships between technological, social, and organizational factors in crisis management.

Faraj, Renno, and Bharadwai offer a critical perspective on the notion that technology is a panacea for the COVID-19 pandemic and related crises. Instead, they argue that digitalization is replete with contradictions and challenges, particularly for third-world countries. A primary concern is the unequal distribution of digital access, which exacerbates existing disparities in digital literacy, knowledge levels, and education opportunities across regions, countries, and socioeconomic strata. The integration of technology in education has revolutionized traditional teaching and learning methods. The rapid usage of digital technologies has significantly enhanced the accessibility of education, providing a wide range of opportunities for learners with diverse needs, abilities, and learning styles to access high-quality educational content, resources, and

experiences. The COVID-19 pandemic served as a catalyst, accelerating the adoption of digital learning solutions and emphasizing the value of flexible, adaptable learning models.

As a result, educators and students have had to navigate the challenges and opportunities presented by virtual classrooms and remote collaboration. This dynamic exerts a profound and lasting impact on the education sector, revolutionizing the future of teaching and learning. However, it is crucial to acknowledge that the integration of technology in education has been marred by inequities. The benefits of digital learning have disproportionately favoured affluent communities, while marginalized and low-income groups have often been relegated to the side-lines, exacerbating existing educational disparities. The pervasive digital divide has underscored the urgent need for targeted interventions and strategic policies to ensure that technology amplifies, rather than impedes, educational access and opportunities for all, ultimately bridging the gap between the digitally privileged and underprivileged.

Oborn, Pilosof, Hinings, and Zimlichman (2021) emphasized that during crisis, institutions should not be perceived as sources of resistance to change, but should be advanced to play significant roles of driving digital innovation. The researchers further argued that technological advancements, especially during times of crisis, must be accompanied by corresponding institutional reforms at both political and economic levels. Furthermore, they noted that successful technology adoption during crises requires integrating technological capabilities with institutional logic.

Faraj, Renno & Bharadwaj (2021) critiqued the inadequate policy coordination to match the rapid technological development and virtual shifts necessitated by the Covid-19 pandemic and various natural disasters. This casts aspersions on the effective adaptability of education policies and teaching codes of conduct during the lockdown period. Specifically, were these policies and codes updated in response to both the crisis and the new remote teaching paradigm? What checks and balances were put in place to ensure that pedagogy remained relevant, uniform, and effective across all learning environments? Furthermore, were mechanisms established to prevent and detect cheating and manipulation in marking schemes and practices, maintaining the integrity of the assessment process? Policymakers must work closely with various stakeholders, including educators, parents, students, and the business community to guarantee continuity of education systems and learning post pandemics and disasters. This collaborative approach enables policymakers to gather valuable insights into the challenges faced by each stakeholder group, ultimately informing more effective policy updates. Involving stakeholders and policymakers in planning processes can make it easier for practitioners to identify areas that require strengthening, facilitating the development of more responsive and adaptive education policies. Furthermore, stakeholder collaboration can help policymakers balance competing interests and priorities, leading to more equitable and sustainable education solutions.

Williams, Perlow, and Turek (2021) built upon these arguments by highlighting that the adoption of virtual technologies and online platforms, particularly in the education sector, presents a multifaceted opportunity that extends beyond merely ensuring continuity. Instead, they posited that this shift should be viewed as a unique chance for innovation in learning and professional development. The researchers underscored the importance of closely monitoring the processes involved as workers transition to virtual work environments. This includes identifying the essential elements that facilitate a seamless adjustment, such as task-oriented interactions, process-focused engagements, and relationship-building activities. These elements are crucial in replicating the collaborative opportunities that may be compromised in virtual settings, thereby ensuring that teamwork and productivity remain intact.

The layering of individuals based on their limited access to technology constitutes a egregious violation of human rights and poses a significant impediment to achieving Sustainable Development Goals (SDGs) 9 and 4. SDG 9, which focuses on Industry, Innovation, and Infrastructure, aims to establish resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. Conversely, SDG 4 emphasizes the importance of ensuring Quality Education for all. The disparate distribution of digital resources perpetuates a deleterious cycle of disadvantage, wherein marginalized communities are systematically denied opportunities for social mobility and economic empowerment that digital technologies can provide, thereby exacerbating existing social and economic inequalities.

Zilber and Goodman's research supports this argument, revealing that during the COVID-19 pandemic, the technologies deployed in low-income countries were significantly inferior to those implemented in high-income countries. This inequality resulted in low-income countries receiving lower-value technologies, which further entrenched existing power imbalances and hindered their ability to effectively respond to the crisis.

3.2. Case Studies

3.2.1. Rwanda's One Laptop per Child initiative[1]

Rwanda's initiative to provide laptops to every child in the country demonstrates a model for strengthening education systems' resilience, not only through the strategic use of technology but also through collaboration with other stakeholders and government. The One Laptop per Child (OLPC) Programme, implemented in the country showcases a comprehensive approach to enhancing education outcomes by leveraging technology, building teacher capacity, and fostering partnerships between government, schools, and communities. Through an investigation of the design, implementation, and impact of the OLPC Programme, this case study highlights key lessons and strategies for building resilient education systems that can withstand challenges and provide high-quality learning opportunities for all students.

The OLPC Programme is a groundbreaking initiative aimed at enhancing education through technology in primary schools, launched in 2008. The programme provided laptops to students, enabling them to access digital content, develop computer skills, and expand their knowledge in various subjects. The OLPC Programme was designed to achieve several key objectives. Firstly, it aimed to enhance education through interactive digital content, allowing students to do experiential learning as well as understand difficult concepts from a practical point of view. Secondly, the programme sought to transform the role of teachers from knowledge holders to facilitators, guiding students as they accessed the vast knowledge available on the laptops, servers, and the internet. Ultimately, the program sought to foster a comprehensive range of skills among primary school students. It aimed to develop their proficiency in computer skills and programming knowledge, while also enhancing their subject-specific knowledge in science, mathematics, languages, and social sciences through online research and interactive digital content. By achieving these objectives, the program aimed to equip primary school students with the essential skills and knowledge required to thrive in an increasingly digital and interconnected world.

To achieve these objectives, the programme consisted of several key components. These included ensuring school infrastructure readiness, developing relevant digital content, building the capacity of head teachers and teachers, and providing repair and maintenance support. The

[1] The case study for Rwanda's One Laptop per Child initiative was adapted from https://www.reb.gov.rw/olpc.

programme also emphasized the importance of project sustainability and contribution to ICT growth. To date, the OLPC Programme has made significant progress with a total of 269,116 laptops deployed in 933 schools. In addition, 9,350 teachers in 850 schools have received training on basic ICT skills and OLPC usage, enabling them to effectively integrate technology into their teaching practices. The programme has also developed digital content, including interactive activities and games, to support the new curriculum. The impact of the OLPC Programme has been profound, with students showing improved engagement, motivation, and learning outcomes, and teachers reporting increased confidence in using technology to support teaching and learning. Moreover, the programme has revealed the value of effective teacher training and support, relevant and engaging digital content, robust infrastructure and maintenance support, and collaboration between government, schools, and communities to ensure programme sustainability and success.

On the flipside, the promises that the One Laptop per Child (OLPC) program initiative presented when the programme was first introduced in Rwanda was not effective enough to yield the desired results during the Covid-19 pandemic. The program's shortcomings were a result of a number of factors in the political, social and economic landscape of the country.

Low Literacy Rates and Socio-Economic Challenges: Rwanda's low literacy rate and significant socio-economic challenges hindered the program's success. Himbara (2018) found that 40.7% of the citizens of Rwanda live below the poverty line, with 92.2% living on less than $5.50 per day. This poverty exacerbates the urban-rural divide, limiting access to ICT equipment and internet connectivity (Himbara, 2018, p. 1). Furthermore, the Covid-19 lockdown pushed 66.2% of Rwandans below the poverty line.

Limited ICT Infrastructure and Affordability: The OLPC program's reliance on internet connectivity and ICT infrastructure was compromised by Rwanda's limited broadband penetration, particularly in rural areas. Although the government reported 95% 4G coverage, only 4.6% of Rwandans use 4G, while 46% rely on 2G due to affordability issues (Uwizeyimana, 2022). The high cost of internet connectivity and ICT equipment rendered them unaffordable for most Rwandans.

Rural-Urban Divide and Poor Infrastructure: The rural-urban divide in Rwanda further exacerbated the program's ineffectiveness. Rural areas lack basic infrastructure, including electricity, with only 27% of the population having access to electricity (MINICT, 2017, p. 11). This limited access to electricity hindered the use of laptops and other ICT equipment. Although the government partnered with the Rwanda Energy Group to prioritize electrification of public sites, the partnership did not effectively address the scale of the problem.

Limited Digital Literacy and Technical Support: The program's effectiveness was also hindered by limited digital literacy among parents and teachers, making it difficult for them to provide technical support to students. While having laptops for all kids is a good move, when parents have no knowledge and access, there will be no one to assist those children with homework or home schooling in the absence of their teachers.

Inability to Provide E-Education Services: The lockdown failed to curb the spread of the disease. Rather, the lockdown succeeded in disrupting education and learning which could not proceed in the absence of adequate ICT tool, skills to use online platforms, adequate electricity supplies and Wi-Fi services.

The OLPC program in Rwanda demonstrated that technology can enhance education resilience, but its failure to ensure systematic learning for all during Covid-19 highlights that digitalization

alone is insufficient. Rwanda's socio-economic challenges, limited ICT infrastructure, rural-urban divide, and affordability issues hindered the program's effectiveness. To succeed, future e-education initiatives must address these underlying challenges. The Rwandan Government should invest in affordable and accessible e-government infrastructure, increase digital literacy, and make ICT equipment and internet connectivity more affordable, especially for the poor, women, and rural populations.

3.2.2. Kenya

The rapid evolution of technology has transformed the education sector, offering opportunities for innovative learning approaches. In Kenya, the government has committed to expanding the education system to combat ignorance, disease, and poverty (Republic of Kenya, 1965). The government has introduced various initiatives to address these challenges, including the National Policy on Curriculum Reforms, which aims to nurture every learner's potential. However, Kenya's education system faces challenges, including inadequate ICT infrastructure, inefficient internet connectivity, and limited access to electricity (Sife et al., 2007; Mtebe et al., 2014).

Technology is key in enhancing education, through the facilitation of improved student engagement, collaboration, and practical hands-on learning (Costley, 2014). Virtual platforms bring many benefits to learning, such as access to educational materials, interactive videos, and virtual classes. Fort School is an e-learning platform designed to provide Kenyan students with access to quality educational materials. The platform offers a range of features, including interactive videos, virtual classes, and past exam questions and marking schemes. Fort School aimed to avail equal access to learning materials to all students alike, despite their socio-economi backgrounds.

Research indicates that Kenyan students respond positively to online learning platforms, perceiving them as devoid of disruptions and distractions associated with traditional classroom teaching (Government of Kenya, 2020). However, challenges persist, including unreliable electricity connectivity and limited access to digital devices (Mccrocklin, 2019). Despite these challenges, online learning platforms like Fort School offer a promising solution to Kenya's education challenges. Availing state of the art learning spaces as well as the required learning materials can enable Fort School to bridge the gap between formal and informal education, ensuring that every learner has access to relevant and inclusive education that meets international labor force standards.

The adoption of online learning platforms is critical in enhancing education in Kenya. As noted by the World Economic Forum, education is key to addressing 21st-century skills, preparing students for the evolving job market, bridging the gaps between the developed and developing world, and improving 21st-century skill performances (Anon, 2015). Furthermore, the OECD defines education as a medium of sociocultural, economic, environmental, and political advancement, largely attributed to the highly effective globalization and rate of technological advancements (OECD, 2019). Therefore, it is imperative that Kenya transforms its education system and embraces online platforms like Fort School to ensure that its young population is equipped with the necessary skills to compete in the global market.

Fort School, an innovative e-learning platform, has demonstrated several strengths in its approach to education. Availability of quality educational materials has made access to education for students from diverse socio-economic backgrounds and geographical locations easier. The platform's interactive features, such as quizzes and virtual classes, offer personalized learning experiences tailored to individual students' needs. Furthermore, Fort School's online nature

provides flexibility and convenience, enabling students to learn at their own pace and on their own schedule.

Despite its strengths, Fort School faces several weaknesses that hinder its effectiveness. The absence of internet services in rural areas excludes marginalized communities from benefiting from the platform. Additionally, the platform's reliance on technology creates a barrier for students to learn and gain the required skills for fully utilising digital technologies. The online nature of the platform also raises concerns about the lack of human interaction, which is essential for social skills development and emotional support. Moreover, the quality of the educational content provided on the platform is crucial, and any shortcomings in this area may compromise the learning outcomes.

To address these weaknesses, several recommendations can be made. Firstly, Fort School can collaborate with internet companies to ensure that rural communities also have access to internet in order for them to utilise the platform. Developing offline capabilities can also enable students to access educational materials without relying on internet connectivity. To address the lack of human interaction, Fort School can integrate features that facilitate virtual mentorship programs or online discussion forums. Regularly reviewing and updating educational content is also essential for continuity and meaningful usage. Finally, establishing support systems, such as counselling services or mentorship programs, can help ensure students' emotional and psychological well-being.

In summary, this literature review, which presented two data sets from general reviewed literature and from case studies of Rwanda and Kenya has underscored the critical importance of resilient education systems in the face of crises, such as the COVID-19 pandemic. The intersection of technology, infrastructure, collaboration, and community engagement has emerged as a crucial factor in promoting education system resilience, albeit before the Covid-19 threat, in Rwanda and Kenya. However, despite the technological and partnership advancements to make learning easier in those countries, significant challenges still persist, including the unequal distribution of digital resources, high internet costs, the rural urban development disparities, inadequate policy coordination, and the need for institutional reforms. To address these challenges, policymakers, educators, and stakeholders must collaborate to develop adaptive and responsive education policies that prioritize equity, inclusivity, and sustainability. Ultimately, fostering resilient education systems requires a multifaceted approach that integrates technological innovation, community engagement, and institutional reforms to prevent disruptions.

4. METHODOLOGY

This study employed a desk review approach, combining a comprehensive review of global literature with an in-depth examination of case studies from Kenya, South Africa, Rwanda, and Zimbabwe, and thematic analysis. The global literature review aimed to provide a broad understanding of the research topic, while the case studies offered nuanced insights into the specific contexts of the four selected countries. The desk review began with a systematic search of electronic databases, including Scopus, Google Scholar, JSTOR, and ScienceDirect, using specific keywords and phrases related to the research topic. This search yielded a vast array of academic journals, reports, and publications from international organizations, which were carefully screened for relevance and academic credibility.

For the global literature review, studies were included if they were in English language, published and peer-reviewed. In contrast, studies that lacked academic credibility were excluded. To document the case studies, the focus narrowed to Kenya, South Africa, Rwanda, and Zimbabwe. A manual search of organizational websites, government portals, and online libraries

was conducted to identify relevant case studies, reports, and publications specific to these countries. The selected case studies were analyzed thematically, with a focus on identifying key trends, patterns, and lessons learned within the context of each country. The analysis of both the global literature and case studies aimed to provide a comprehensive understanding of the research topic, highlighting both universal principles and context-specific insights. These two approaches enriched the study to provide a rich and nuanced narrative on the power of technology, infrastructure, collaboration and community engagement to aid the strengthening of education systems resilience post-pandemic.

5. FINDINGS

The study's findings underscore the significance of integrating technology, infrastructure, collaboration, and community engagement to foster education resilience. This integration is akin to the Social Ecological Systems (SES) theory, which emphasizes the interconnectedness of technological, infrastructural, social, and institutional factors. By applying the SES theory, this study highlights the importance of aligning these factors to enhance the resilience and adaptability of education systems.

The findings demonstrate how the intersectionality framework plays out in practice. In Rwanda, the OLPC initiative exemplifies the intersection of technology, infrastructure, and community engagement. The initiative's success relied on the strategic use of technology (laptops) and infrastructure (ICT infrastructure), as well as collaborative efforts between government, schools, and communities. However, challenges arose due to inadequate ICT infrastructure, highlighting the need for robust infrastructure to support technology-enhanced education initiatives.

Similarly, Kenya's Fort School e-learning platform illustrates the importance of collaboration and community engagement. The platform's effectiveness relied on partnerships with internet service providers and community engagement to ensure that educational materials were accessible and relevant to local communities.

The findings also emphasize the need for digital literacy and capacity building among teachers, parents, and students. Rwanda's OLPC initiative provided training for teachers, while Kenya's Fort School platform offered interactive features to support student learning. This underscores the importance of addressing the social and institutional factors that influence education resilience.

In conclusion, the integrated findings highlight the value of applying the SES theory and intersectionality framework to understand the complex dynamics underlying education resilience. By recognizing the interconnectedness of technological, infrastructural, social, and institutional factors, policymakers, educators, and stakeholders can co-create context-specific solutions that promote education resilience and social justice.

6. DISCUSSION

The literature review highlighted the valuable intersection between technology, infrastructure, collaboration, and community engagement in promoting education resilience (Tsoukas & Hatch, 2001; UNESCO, 2020). The case studies in turn demonstrated that even with technological advancements, education systems can be vulnerable to disruptions if these factors are not addressed. The case studies further provided practical examples of how these factors can be addressed in different contexts. Overall, the findings suggested that technology integration, infrastructure, affordability, community engagement, collaboration, digital literacy, and capacity building are crucial factors in promoting education resilience.

7. CONCLUSIONS

This study concludes that education resilience requires a multifaceted approach that integrates technology, infrastructure, collaboration, and community engagement. Policymakers, educators, and stakeholders must work together to address the challenges and opportunities presented by technological advancements.

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