

Understanding E-Health Implementation in the Democratic Republic of the Congo: A Systematic Literature Review



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ABSTRACT: The Democratic Republic of the Congo (DRC) faces an abysmal health system comprising lack of access, extreme shortage of healthcare workers, and high disease burden. The use of information and communication technologies (ICTs) in health (e-health) is a potential solution to these challenges. This systematic literature review synthesizes existing evidence surrounding e-health in the Democratic Republic of the Congo and explores the success and challenges faced during the implementation as well as the perceived potential of e-health in this complex environment. This study is a systematic review aimed at investigating and evaluating the literature on e-health implementation in DRC. The study finds that, although e-health provides great potential, its uptake, problems associated with infrastructure, human resources, funding, policy, and sociocultural factors are still developing. This paper presents the findings, highlighting key trends, challenges, and opportunities, and offering recommendations for practitioners and researchers to accelerate the effective and sustainable integration of e-health into the DRC's healthcare system.

KEYWORDS: Digital Health, E-health, Electronic medical, E-health, Telemedicine, Health Informatics, ICTs, mHealth (Mobile Health), Systematic review.

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I. INTRODUCTION

The rate of application of information and communication technology (ICT) has now become an important indicator of economic success. Several developing countries have prioritized technical innovation in their national growth plans and have made substantial expenditures in ICT. The use of information and communication technology (ICT) in healthcare services, along with patients' desire to pay greater attention to their health, have altered the healthcare system in the twenty-first century (Ráti & Ildikó, 2023). The application of ICTs in healthcare is known as electronic health (e-Health), and the researcher chose the abbreviated term in most areas of this study (Ndlanzi, 2021). eHealth is a relatively new field of research (Sneha & Straub, 2017), and it is often multidisciplinary. 'eHealth' is described as 'the application of information, communication, computing, and sensing technologies across the entire range of functions and processes forming the practice and delivery of health care services' (Sneha & Straub, 2017). According to this definition, effective eHealth deployment includes stakeholders and procedures from a wide range of health care duties (Etty, et al., 2020) and involves considerably more than just technology (Vest, 2010) (Barlow, et al., 2006). As a result, numerous scientists and institutes have varied definitions and explanations for eHealth. According to the

World Health Organization (WHO), eHealth is "the cost-effective and secure use of Information and Communications Technologies (ICTs) in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge, and research" (WHO, 2022). According to Barbarella (Barbarella, et al., 2022), eHealth refers to several health and care services provided by ICTs, such as EHRs, HMIS, telehealth, telemedicine, telecare, self-management tools, and health data analytics. Figure 1 shows the typical eHealth problems in underdeveloped nations.

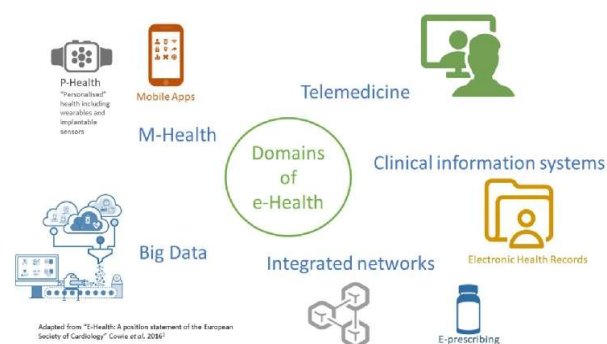


Figure. 1 What is e-Health (Khalifehsoltani & Gerami, 2010)?

Integrated healthcare applications enable eHealth, which includes computer, communication, and sensing technologies

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(Sneha & Straub, 2017). A study conducted in the Netherlands found that organizational preparedness is a critical component in implementing and accepting eHealth projects initiatives (Faber, et al., 2017). Although the authors' definition of "organizational readiness" is "the availability of the needed organizational resources for adoption" (Etty, et al., 2020), the operationalization of this term must be modified for the setting of community health care in municipalities because their study was conducted in hospitals. The electronic health card was The electronic health card (eGK), which has been available in Germany since 2013, enables for the secure storage and access of patient medical data, promoting better care coordination and information sharing (Sonnenberg, et al., 2019). The Interoperable Electronic Health Record Infrastructure (TI-EHR) effort intends to provide a statewide infrastructure for interoperable EHR systems, allowing for smooth data interchange among German healthcare providers. E-health is revolutionizing the healthcare scene in France, providing promising solutions to improve access, quality, and efficiency. By tackling existing issues and developing stakeholder engagement, France has the potential to become a global e-health leader (Raynaud, 2022). Zambia has implemented the Smart care e-health innovation, which allows patients' data to be saved on a smartcard, allowing the health institution visited by the patient to follow medical history while maintaining confidentiality (Mwiinga, 2013). Australia underwent a substantial transition by providing financial assistance to general practitioners to purchase computers, implementing systems for those who required them, and creating incentives for using electronic practices. England has made great progress, although at a modest rate. Currently, 98% of general practitioners can access an EMR from their desktops. Almost all use it for drug refills, and 30% report that their practices are paperless (Djamba, et al., 2025).

Greece, a poor country, has successfully set up an e-health system. Healthcare in Greece is provided by the national health system (NHS), and in recent years, a few e-health services have been introduced in compliance with European Union (EU) goals to reduce costs and improve services in a secure manner (Katehakis, et al., 2018). Sub-Saharan Africa has open telecommunications markets, a growing population of cell phone users, and a greater use of digital transformation technology. These improvements have been accompanied by price reductions in connectivity and the use of digital devices and services in several nations throughout the region. Digital transformation technologies have made digital health a viable solution for addressing health-care system issues and improving service quality (UNDP, 2022) (Oleribe, et al., 2019). In developing countries like Nigeria, Uganda, Zimbabwe, Rwanda, Namibia, India, Afghanistan, Malaysia, and Libya, eHealth adoption varies due to factors such as poor ICT infrastructure, insufficient electricity, inadequate health policies, and a lack of qualified personnel. Medical facilities in poorer nations face limited resources, making it challenging to provide crucial care to patients (Justice, 2017).

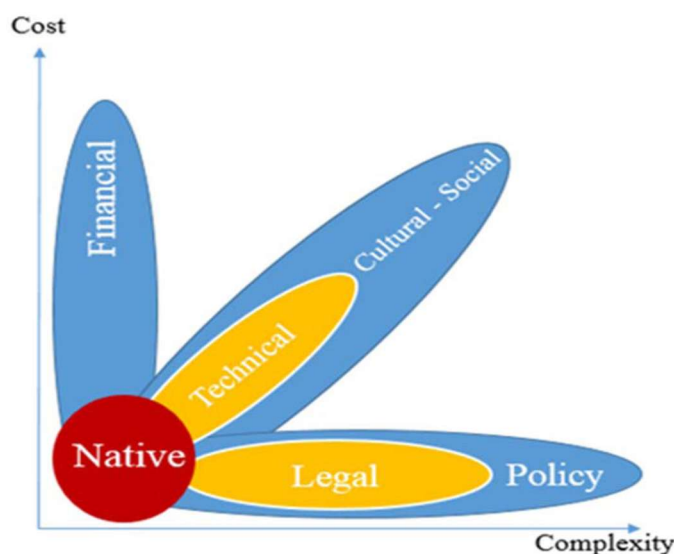


Figure 2 The model of eHealth challenges in most developing countries (Khalifehsoltani & Gerami, 2010).

Figure 2. highlights the need of assessing a country's or community's readiness to utilize eHealth technologies. Native point is the most cost-effective and simple approach. To successfully execute a local solution for a certain country, it's important to identify the problems that may arise. These reviews aim to improve understanding among policymakers and service providers, reduce failures, and increase the likelihood of successful system implementation (Justice, 2017).

Identifying elements such as physical infrastructure, regulations, legislation, and organizational structure during the early phases of adoption might impact the effectiveness of an eHealth system. DRC is a low- and middle-income countries (LLIC) with a National Health Care system that provides basic healthcare services to residents. In recent years, the healthcare system has deteriorated significantly. Despite health reform efforts, the country continues to experience high mother and newborn mortality rates (10%) (David, et al., 2024). The Democratic Republic of Congo (DRC) is a country with immense potential yet faces profound developmental challenges, particularly in the health sector. The healthcare system is characterized by limited access, especially in remote and rural areas, a severe shortage of qualified healthcare professionals, and a high burden of infectious and non-communicable diseases (WHO., 2023). These difficulties are worsened by a lack of leadership and the need to conduct effective health-care-system strengthening initiatives. These challenges are exacerbated by limited resources, weak infrastructure, and socio-political instability. Consequently, the DRC's health indicators are among the worst globally, with high maternal and child mortality rates and limited access to essential healthcare services (Global, n.d.).

In this context, e-health, defined as the use of ICTs to support healthcare delivery, has emerged as a promising approach to address these pressing challenges (Idoga & Mehmet, 2016).

E-health offers the potential to improve access to care, enhance the quality of services, increase efficiency, and empower both healthcare providers and patients (Bizimana, 2024). By leveraging mobile technology, telemedicine, and health information systems, e-health can bridge geographical barriers, connect remote communities with specialists, improve data management, and facilitate health education. The Democratic Republic of the Congo (DRC) is undertaking a digital transition, which includes the health sector. The DRC has expressed an interest in adopting digital, mobile, and wireless technology to help meet the country's health goals. In April 2022, Agence Nationale d'Ingénierie Clinique, de l'Information et de l'Informatique de Santé (ANICiS) was renamed Agence Nationale d'Ingénierie Clinique et du Numérique de la Santé (ANICNS). The new organization aims to digitally regulate Universal Health Coverage (UHC) and promote digital healthcare and clinical engineering in the Democratic Republic of the Congo (Agence Nationale d'Ingénierie Clinique et du Numérique de la Santé, 2023). The National Council for UHC aims (i) to enhance Congolese life expectancy by 30%, (ii) reduce maternal mortality by 50%, and (iii) lower infant and child mortality rates by 50% by 2030 (Conseil National de la Couverture Santé Universelle, 2021). ANICNS facilitates the provision of high-quality, affordable healthcare services to all Congolese people and contributes to the government's goal of Universal Health Coverage (UHC) through the implementation of the National Health Informatics Plan 2022-2024 (Plan National de Développement de l'Informatique de Santé, deuxième génération -PNDIS 2) (Volbrecht, 2019). USAID has been working with the DRC government to improve the country's health system. However, the implementation of e-health in developing countries like the DRC is complex and faces numerous obstacles. These include limited internet connectivity, unreliable electricity supply, a lack of digital literacy, financial constraints, and the absence of supportive policies and

regulations (Vasan, et al., 2019). Furthermore, socio-cultural factors, such as resistance to change and cultural beliefs, can also influence the adoption and use of e-health services.

This paper presents a systematic literature review of e-health implementation in the DRC. The review aims to synthesize existing evidence on the progress, challenges, and opportunities of e-health initiatives in the country. By systematically analyzing the literature, this review seeks to provide a comprehensive understanding of the current state of e-health in the DRC and offer recommendations for future research and practice.

II. RESEARCH METHODOLOGY

This study is a systematic review aimed at investigating and evaluating the literature on e-health implementation in DRC. The search strategy employed keywords related to e-health, telemedicine, mHealth, digital health, DRC, Congo, and related terms. Thus the propulsive RQ for this study is:

- Ø What is the current state of e-health implementation in the Democratic Republic of Congo (DRC), and what are the key facilitators, barriers, and opportunities for its successful adoption and scale-up?

Considering the nature of this topic, a systematic literature review was conducted in reference to guidelines used by Morten et al. (Morten, et al., 2016), in a systematic literature review with a health information technology perspective. the methodology is heavily influenced by Morten et al. (Morten, et al., 2016). In the sections that follow, the RQs are described and the correlating metrics for the study are presented.

A. Research questions

To guarantee that the scope is being studied in accordance with the aforementioned goal, the author of this research developed many RQs, which will be addressed in Table 1 below.

Table 1 The RQs are defined as follows:

Specifics questions		AIM/SCOPE
RQ1	<ul style="list-style-type: none"> What e-health interventions have been implemented in the DRC? 	This question focuses on what has been done and how well it has worked.
RQ2	<ul style="list-style-type: none"> What are the key challenges and barriers to e-health implementation in the DRC? 	This question explores the obstacles hindering e-health progress.
RQ3	<ul style="list-style-type: none"> What are the enabling factors and opportunities that can facilitate the successful adoption and scale-up of e-health in the DRC? 	This question investigates the drivers and potential for successful e-health development

B. Search strategy

The assessment examined four of the most widely used academic digital libraries in the field of information systems. It is important to note that the authors used the most common

databases from the information systems point of view (POV), assuming the bias of not using purely medical databases or even hybrid ones, and thus excluding important sources like Journal of Medical Internet Research, for example. More information is available in the limitations section.

- ACM Digital Library (<http://dl.acm.org>)
- IEEEExplore Library (<http://ieeexplore.ieee.org>)
- Science Direct (<http://www.sciencedirect.com>)
- Springer Link (<http://link.springer.com>)

To find hits related to the scope, the author used the primary areas of eHealth technology in the search term. This was fine-tuned by searching the selected libraries in Google Scholar's search engine (<http://scholar.google.com/>). This test resulted in the following search string, which was to be used in the library search: ("DRC" OR "Congo") AND ("implementation" OR "Adoption") AND ("eHealth" OR "medical informatics" OR "telemedicine" OR "electronic health records" OR "digital health" OR "mHealth").

C. Study selection

The study was based on current research and reported practices in the area. The papers have to be free of charge, either through an Adventist University of Goma account or as a free-to-use publication on Google Scholar. To eliminate researcher bias, the author defined the following exclusion criteria:

- Based on accessibility - Libraries that accessible in Adventist University of Goma.
- Based on publication date - Papers published before 2017.
- Based on language - Papers not written in English and French.
- Based on title - The title does not imply relation information technology.
- Based on abstract - The abstract does not describe eHealth technologies.
- Based on full text - The content is not relevant to the eHealth.

D. Study classification

Papers were classified based on keywords acquired during the early part of the investigation. Papers were sorted based on phrases in the search string, while keeping the eHealth in mind. This resulted in three categories:

- Ø Telemedicine papers focus on implementation.
- Ø Digital health papers focus on adoption.
- Ø Electronic Health Records (EHRs) are documents that share patient information among healthcare professionals.

To promote articles that focus more on the implementation of e-health than on the means to achieve it, a category was chosen for articles presenting a combination of these three.

E. Study extraction

The extracted documents' complete text was collected using a reference manager. The distribution of publication dates

shows that 2017 has the most papers, with a total of seven. The initial IEEE library search yielded almost 2000 papers, but only 100 were examined.

III. ANALYSIS AND DISCUSSION OF RESULTS

The included and excluded studies went through the same filtering process as described above. After presenting the search string and establishing exclusion criteria, papers can be found using the same methodology. The results from the search are provided in the table below (Table 1). During the screening procedure, including categorizing the papers according to title, abstract and grouping them by keywords, the author singled out 59 papers for full-text extraction. This resulted in a total of 13 papers on which to base the review. The next part contains responses to the RQs based on the literature used in the study (see Table 2).

In addition, RQ1 includes a discussion to assess if the found content meets the study's aim.

Table 2: Main characteristics of the studies included in this review

Study	Outcome measures	Contribution	Research gaps
Karemere et al.(2024) (Karemere, et al., 2024)	The study implemented Deki Reader devices piloted by IA in 144 health facilities in the provinces of Haut-Katanga, Kasai Central, and Sud-Kivu from January to December 2022, highlighting feasibility and challenges such as logistics, technical issues, and internet connectivity.	<ul style="list-style-type: none"> • Demonstration of the feasibility of IA-piloted Deki Reader devices. • Identify the logistical and technical challenges associated with implementation. 	<ul style="list-style-type: none"> • Difficulties logistical and technical during the device's operation. • Need for better planning and cooperation throughout future deployments.
Ruth, et al., (2021) (Ruth, et al., 2021)	The implementation of integrated disease surveillance and response (IDSR) in the Democratic Republic of the Congo has encountered challenges, including inadequate case definition documents, incomplete data, and incoherent reports, necessitating assistance to reduce health system levels and improve functionality.	<ul style="list-style-type: none"> • Evaluation of the implementation of the IDSR in the North Kivu province. • Identifying challenges associated with disease surveillance and response systems. 	<ul style="list-style-type: none"> • Limited implementation of electronic disease surveillance systems. • The inconsistency of data related to health-care facilities has an impact on the accuracy of reports.
Rosine, et al., (2024) (Rosine & Mamothena, 2024)	The implementation of maternal and neonatal health policies in the Democratic Republic of the Congo faces challenges such as financial constraints, political influences, conflicts, and gender disparities, necessitating personalized community strategies, political engagement, and women's autonomy to improve health outcomes.	<ul style="list-style-type: none"> • Highlights the challenges associated with prioritizing maternal and newborn health policies. • Highlights the need for appropriate community strategies and women's empowerment. 	<ul style="list-style-type: none"> • Concurrent health and security emergencies disrupt priority hierarchy. • Financial constraints and governance issues both have an impact on implementation.
Alix et al.(2024) (Alix, et al., 2024)	The implementation strategy, VANISH-BD, was developed through a mapping of interventions aimed at improving the rapid use of vaccines at birth in the Democratic Republic of the Congo, with a focus on contextually relevant, locally produced, and long-term solutions based on a needs assessment in the province of Kinshasa.	<ul style="list-style-type: none"> • Developing a strategy for implementing fast vaccination doses at birth. • A context-appropriate and long-term intervention for the RDC. 	<ul style="list-style-type: none"> • There is a lack of documentation on reasonable approaches to newborn vaccination in sub-Saharan Africa. • Limited understanding of programmatic challenges associated with fast vaccine administration.
Chloe et al.(2022) (Chloe & Eric, 2022)	The article explains how mobile big data analyses, specifically those of mobile operators, have been used by Congolese public health authorities to improve decision-making and policy responses in the event of a pandemic, highlighting the potential of mobile health in low-income countries such as the Congo.	<ul style="list-style-type: none"> • A debate has begun between the public and private sectors to gather information about mobile data. • MBD analysis has contributed to increased preparedness for future pandemics. 	<ul style="list-style-type: none"> • There is limited evidence that governments have adopted information on mobile big data. • During emergencies, it is necessary to implement effective public health measures.
Nancy, et al. (2018) (Nancy, et al., 2018)	Mobile learning, particularly through the Safe Delivery application, has been deemed feasible and acceptable in the Democratic Republic of the Congo, significantly improving the knowledge and confidence of health agents in the management of obstetric and neonatal emergencies, thereby addressing training gaps in difficult-to-access areas.	<ul style="list-style-type: none"> • Improved knowledge and self-confidence among BeMonc's health agents. • The feasibility and acceptability of RDC mLearning. 	<ul style="list-style-type: none"> • The small size of the sample reduced the study's power and results. • There were differences in gender and experience among the groups.

Simon,et al.(2018) (Simon, et al., 2018)	Telemedicine in the Democratic Republic of the Congo entails the use of telecommunications technologies for remote patient surveillance in order to address access issues in rural areas. The proposed evolutionary architecture includes low-cost sensors and uses existing GSM and GPRS networks for data transfer.	<ul style="list-style-type: none"> • Using various communication methods for telemedicine. • Development of evolving and low-cost health surveillance sensors. 	<ul style="list-style-type: none"> • There are limited options for resolving all medical issues in the Congo. • It is necessary to continue research on the strategies for implementing telemedicine.
Fuamba, et al.(2023) (Fuamba & Badibanga, 2023)	The article discusses the potential of information and communication technologies (ICT) in health services in the Democratic Republic of Congo, emphasizing that telemedicine is a critical opportunity to improve health care delivery, particularly in remote areas affected by conflict and economic challenges.	<ul style="list-style-type: none"> • Accelerate the implementation of information and communication technology in healthcare services. • Promote the entrepreneurial spirit using medical drones. 	<ul style="list-style-type: none"> • There is a lack of standardization in the development of ICT in the healthcare sector. • Insufficient human resources for online health projects.
Jean-Robert,et al. (2017) (Jean-Robert, et al., 2017)	The Democratic Republic of the Congo has implemented iHRIS, an open source information system on human resources, to manage data on health personnel, allow for the precise recension of over 11,500 health agents, combat phantom workers, and redistribute funds to underpaid healthcare agents.	<ul style="list-style-type: none"> • Implemented iHRIS, a human resource information system, to manage healthcare personnel. • Re-allocation of funds to compensate health-care workers who were previously unpaid. 	<ul style="list-style-type: none"> • A lack of integration between iHRIS and payment systems. • Limited analysis of non-governmental compensation for health-care workers.
Itulelo, et al., (2017) (Itulelo, et al., 2017)	The document proposes a mobile health intervention in the Democratic Republic of the Congo to raise awareness about cholera prevention, enable community health agents to detect outbreaks in real time, and facilitate access to therapeutic directives in order to combat recurring disease outbreaks in the South Kivu.	<ul style="list-style-type: none"> • Investigate the use of TIC for cholera prevention and awareness raising. • Makes it easier for healthcare staff to access treatment guidelines. 	<ul style="list-style-type: none"> • Weak theoretical grounding • Limited focus on user needs and context • Lack of rigorous evaluation • Challenges related to data security and privacy
Akilimali, et al., (2023) (Akilimali, et al., 2023)	The text does not specifically address mobile health in the Democratic Republic of the Congo. It focuses on the "One Health" approach and its challenges in the region, particularly socioeconomic factors and the scarcity of health specialists, which have an impact on collaborative efforts in health.	<ul style="list-style-type: none"> • Collaboration among local communities • Efforts to implement the notion of "One Health" 	<ul style="list-style-type: none"> • One Health's limited operation in the Democratic Republic of Congo. • Difficulties in collaborating between different socioeconomic communities.
Saleh et al.(2018) (Saleh, et al., 2018)	The text does not specifically address mobile health in the Democratic Republic of the Congo. It focuses on the evaluation of the national health information system between 2009 and 2015, highlighting issues with data management and dissemination.	<ul style="list-style-type: none"> • Improving the quality and understanding of health indicators. • Data transmission has improved due to the rise of the mobile network and the Internet. 	<ul style="list-style-type: none"> • Health-related information that is reliable and limited in real time to make decisions. • Inadequate integration of critical indicators into health program.
Ranit, et al., (2017) (Ranit, et al., 2017)	MediCapt, a smartphone application developed for the Democratic Republic of the Congo, aims to standardize the documentation of evidence of sexual violence. It fills gaps in medical-legal documentation, improving communication among health professionals, lawyers, and those applying the law in low-resource settings.	<ul style="list-style-type: none"> • MediCapt was developed to document cases of sexual violence. • Eliminate barriers to implementing digital health in low-resource settings. 	<ul style="list-style-type: none"> • The small number of participants limits the generalisability of the results. • is no comparison with typical methods of data collection on paper.

A. RQ1 - What e-health interventions have been implemented in the DRC?

In the Democratic Republic of Congo (DRC), e-health interventions have become established to overcome barriers to access, quality, and outcomes in healthcare, especially in remote and underserved areas. These interventions utilize:

- Mobile health (mHealth) and telemedicine span the spectrum of electronic health records (EHRs) and address read more. For instance, new mHealth platforms for cholera prevention can empower community health agents to help identify outbreaks in real time as well as provide access to the therapeutic directive necessary to counter enduring disease outbreaks in the South Kivu (Itulelo, et al., 2017). Similarly, the MediCapt system, a smartphone application developed for the Democratic Republic of the Congo, aims to standardize the documentation of evidence of sexual violence. It fills gaps in medical-legal documentation, improving communication among health professionals, lawyers, and those applying the law in low-resource settings (Ranit, et al., 2017). Mobile phones are widely used to communicate health information, especially in remote areas. Initiatives frequently focus on sending SMS alerts for vaccination campaigns, maternal health reminders, and disease prevention messages (Kidiamboko, et al., 2008).

- Telemedicine has also been introduced to connect rural healthcare providers with specialists in urban centers. For instance, the *Telemedicine Network of the DRC* has enabled remote training for healthcare workers, improving the quality of care in resource-limited settings [3]. Additionally, the use of artificial intelligence (AI)-driven Deki Reader devices in the Democratic Republic of Congo. The devices were deployed in 144 health facilities across Haut Katanga, Kasai Central, and Sud Kivu provinces from January to December 2022. Healthcare providers performed malaria diagnostic tests using RDTs and reported the results through the routine system. In addition, they used the Deki Reader device, which automatically read, recorded, and transmitted the AI interpretation into a cloud database (Djamba, 2022) (Karemere, et al., 2024).

- Also, the adoption of EHRs in hospitals like the *University Clinics of Kinshasa* has enhanced patient data management, leading to better clinical decision-making and reduced medical errors. Some DRC hospitals are using technology to improve the speed, precision, and quality of care. However, much work remains to be done in terms of incorporating technology in healthcare facilities around the country. Here are few examples (Ruben, et al., 2024):

- Bukavu Provincial Hospital (Bukavu) uses computer systems to manage medical information and appointments, leading to more efficient and precise care.
- Kananga Reference Hospital (Kananga), located in Kasai-Central province, utilizes medical imaging equipment and scanners to diagnose and treat patients.

- Kisangani General Hospital (Kisangani) utilizes cutting-edge medical technology, including imaging and monitoring equipment, to provide high-quality healthcare.
- Cinquantenaire Hospital, one of Kinshasa's main hospitals, has introduced modern technologies for better patient care and management.
- HJ Hospital utilizes a website and electronic medical record system to track patient information and schedule appointments.

Evidence of the effectiveness of these interventions is emerging. Studies indicate that mHealth programs have increased healthcare access by 20-30% in targeted regions, while telemedicine has reduced referral times by 50% in some cases (World Health Organization, 2023). However, challenges such as limited internet connectivity, inadequate infrastructure, and low digital literacy persist, hindering scalability and sustainability. E-Health adoption in the Democratic Republic of the Congo is still in its early stages, but there is significant potential for growth. According to [32], effective e-health solutions should be customized for local circumstances and success stories. Contextual elements are critical for the successful adoption and sustainability.

B. RQ2 - What are the key challenges and barriers to e-health implementation in the DRC?

The Democratic Republic of the Congo (DRC) confronts substantial hurdles in implementing e-health solutions, despite their potential to improve healthcare access, quality, and results. These barriers are multifaceted, encompassing infrastructural, financial, cultural, and regulatory issues. The World Health Organization has identified ten digital initiatives to strengthen health systems and contribute to Universal Health Coverage (WHO, 2019). The proposals enhance the availability of commodities and equipment, as well as the continuity, accountability, and efficacy of healthcare delivery. Barriers include inconsistent internet connections, low mobile penetration, poor data quality, inadequate ICT training for human resources, political instability, and limited mobile and internet coverage in the country. Understanding these challenges is critical for designing effective strategies to overcome them and ensure the successful adoption of e-health technologies.

A. E-Health Infrastructure and Lack of Connectivity Challenges

To offer a platform for e-health systems, a nation usually needs a strong ICT infrastructure (Kovačić, et al., 2022). In addition to satellites, earth stations, and teleports, the ICT platform mainly consists of telephone lines, fiber trunks, submarine cables, T1, T3, OC-xx, ISDN (integrated services digital network), DSL (digital subscriber line), and other high-speed services utilized by enterprises. For e-health frameworks to be successful, each nation must have a clearly defined infrastructure platform. Such platforms ought to likewise encompass telecommunications, electricity, access to computers, Internet hosts, ISPs (Internet service providers),

and available bandwidth and broadband access (BOORE, 2018). In order to offer rich e-health experiences and high-quality multimedia content, organizations typically require large bandwidth. In order to deliver rich e-health experiences and high-quality multimedia material, organizations typically require large bandwidth.

According to Caroline (BOORE, 2018), many health sectors worldwide rely on e-health systems for better healthcare service delivery (Usak, et al., 2019). Patients no longer rely solely on doctors and in-person visits to the clinic, and physicians and other service providers do not need to be physically present all the time. E-health systems require sophisticated and modern information systems and technologies that enhance big data capturing, storing, and sharing of information for transparent and easy accessibility of health information (Wynn, 2020). Mutasa highlight that the 'virtual medical process' can be carried out whereby for instance, the doctor is contacted online and gives diagnosis without meeting the patient. This is only possible if the right infrastructure is put in place as part of the e-health and e-governance effort (Mutasa, 2022). ICT infrastructure is therefore unquestionably a crucial prerequisite for the deployment of e-health. In order for healthcare organizations to share and exchange health information, networks are increasingly a crucial component. Therefore, the internet is one of the practical and affordable ways that healthcare practitioners can look for patient information online (Haleem, et al., 2022). Overall, DRC has advanced remarkably over the past ten years. The Ministry of Health (MoH) has initiated the development of a national e-health implementation to align existing and future ICT implementations with the National Digital Plan, Horizon 2025 and National Health IT Development Plan 2020-2024 (PUBLIQUE MINISTERE DE LA SANTE, 2021).

Electricity: In the Democratic Republic of the Congo, just 20,8% of the population has access to electricity. Urban regions have 43.8 percent access, while rural areas have only 1%.³⁵ The National Rural and Peri-urban Electrification and Energy Services Agency (ANSER) aims to improve access to electricity in rural and peri-urban areas, with a goal of 15 million new connections by 2025. Electricity is mostly distributed in metropolitan regions of the country, and it is characterized by load shedding and untimely outages. Some health facilities use generators as backup power sources during blackouts, although this only applies to strategic departments due to high operating expenses (USAID, 2023). The high cost of generator electricity raises the running costs of health facilities due to frequent power outages. Solar energy is an alternative power source for health facilities and offices. For example, RTI gave solar panels to Haut Katanga's health information office. The World Bank provided solar kits to Kasai's Provincial Health Division for distribution in health zones. The solar kits have been in use for over five years and are beginning to fail, rendering them inefficient. Many health institutions in North Kivu rely completely on solar energy, including the Sacred Heart Health Center in Walikale and the Karisimbi health zone. Solar panels require regular cleaning (two to four times a year) to extend their longevity and ensure maximum efficiency, despite the significant capital

commitment. One disadvantage of solar is that some health institutions may have power outages during the rainy season (Verheyden, 2024).

Internet and mobile coverage: In the Democratic Republic of the Congo, there are four mobile network operators (Airtel, Vodacom, Africell, and Orange) and ten main internet service providers. Mobile networks, fixed broadband, WiMAX, and VSAT are the most common delivery methods for internet services. The fixed broadband subscription costs only 0.03 per 100 persons (The World Bank, 2023). Mobile cellular networks serve around 73% of the population. Although there are more than 49 cellular network subscribers per 100 people, only 24 have active mobile subscriptions (ITU., 2023). Only 23% of the population is believed to utilize the internet (The World Bank, 2023). 500 MB of data-only mobile broadband costs 6.55 percent of GNI per capita (Internet Alliance for Affordable, 2021). The 4G network covers 40% of the population, whereas 3G covers 55%. Using Unstructured Supplementary Service Data (USSD) codes to communicate health data over mobile may be a viable solution due to its higher coverage than internet. The USSD coding system is a global protocol for sending text messages to mobile network operators without the need for a smartphone or internet connection (Verod-Kepple., 2023). However, getting USSD codes for a specific number is expensive, costing \$35,000 USD (World Bank Group, 2020). By 2020, the country has four secure internet servers per million people.⁴³ The Democratic Republic of the Congo has three submarine cables: the West Africa Cable System, which was deployed in 2012, the 2 Africa, which arrived in 2023, and Google's Equiano (Connor, et al., 2020). For places with internet access, the average speed is approximately 25 KB/S, which is insufficient to provide crucial health infrastructure for services such as telemedicine. A 4G internet connection is insufficiently stable to provide crucial health communications. Despite the hurdles, there is potential to improve internet access by establishing a nationwide fiber-optic network across the country, increasing the quality and coverage of internet services in the DRC.

Poor and inconsistent internet connections, combined with uneven access to stable electricity, undermine digital health in the DRC. Healthcare personnel' working capability is limited due to internet unreliability. Even with technically sound devices, internet connectivity might render them inoperable. In metropolitan locations, internet challenges are more common in the form of interruption, but in rural areas, they are more commonly associated with connection unavailability. More than two-thirds of the health areas in Kongo Central, particularly Kimura and Kwimba, do not have internet access due to a lack of coverage. As a result, health ICT professionals must travel many kilometers to find an internet connection in order to transmit health information (Verheyden, 2024). Development partners have provided health personnel with ICT equipment to boost digital health. Some examples: The United Nations Children's Fund (UNICEF) and RTI International have provided tablets and phones for health zone workers to report epidemiological data in Haut Katanga. USAID's Integrated Health Program also provides tablets, Very Small Aperture Terminals (VSAT)

installation, and data bundles to health workers. The Global Fund has supported the deployment of VSAT infrastructure in Kongo Central. The use of VSAT to transmit information has boosted information access from the zonal to the national level through the use of DHIS2 software, resulting in improved reporting timeliness (Verheyden, 2024).

Additionally, poor road networks and transportation systems hinder the delivery of equipment and maintenance services to remote areas.

B. Financial Constraints

The high cost of implementing and maintaining e-health systems is another significant barrier. The DRC's healthcare system is underfunded, with limited government investment in digital health infrastructure (Ranit, et al., 2017). Many healthcare facilities cannot afford the initial costs of purchasing hardware, software, and training staff. Furthermore, the ongoing costs of internet access, software updates, and technical support are often unsustainable for resource-constrained settings (Verheyden, 2024).

Digitization makes it easier to acquire health data at a lower cost while also improving information flow. While the study did not address the price of digital health information systems, some development partners raised concerns about the expense of maintaining community-based systems like CommCare (Verheyden, 2024). The high operational cost of maintaining the program in an enterprise environment is a significant barrier to its long-term viability (Mutasa, 2022). To reduce these expenditures, the Democratic Republic of the Congo must strengthen staff infrastructure and technical capacity, as well as host health data in-country. Cloud hosting increases costs, particularly when charging is done by transaction or client, limiting the scalability of digital health systems. Alternative community health digital health solutions such as Open Smart Register Platform (OpenSRP) and the Community Health Toolkit that offer more affordable capital and operational costs ought to be considered given learnings from other countries.

Sustaining digital health capital investments is still a challenge in the DRC due to the limited public funding for digital health.

C. Low Digital Literacy

A lack of digital literacy among healthcare workers and the general population poses a significant challenge to e-health adoption (Mutasa, 2022). Many healthcare providers in the DRC are not trained to use digital tools, leading to resistance and inefficiencies in implementation. Similarly, patients in rural areas may struggle to use mHealth applications or telemedicine platforms due to limited familiarity with technology (Kidiamboko, et al., 2008).

D. Cultural and Linguistic Barriers

The DRC's diverse cultural and linguistic landscape complicates the design and implementation of e-health solutions. Many e-health programs are developed in French or English, which are not widely spoken in rural areas. This limits their accessibility and effectiveness for local populations. Additionally, cultural beliefs and mistrust of technology can hinder the acceptance of digital health

interventions, particularly in traditional communities (Verbeke, et al., 2014).

E. E-Health Standards and E-legislation Gaps

Ø **E-legislation:** The primary distinction between traditional face-to-face healthcare delivery and e-health is the use of ICT networks tactics. As a result, security, privacy, and confidentiality are important concerns while implementing e-health. Additionally, it is concerning when patients' data is transmitted online via the internet. When patient care is transferred remotely or through a network, privacy, discretion, and safety concerns subsequently surface (Ahmed, et al., 2024). Accordingly, the web is thought to play a crucial role in the management of e-health. Therefore, Sivan point out that secrecy, security, and protection are important factors affecting the industry's adoption of e-health (Sivan & Zukarnain, 2021). Many underdeveloped nations are undoubtedly ill-equipped to maintain basic standards of patient data privacy. There is widespread recognition that e-health is a highly data-sensitive activity. Most physicians believe that maintaining patient confidentiality is essential to ensuring that the patient's trust in them is maintained when they share personal information (Zakariae, 2021). Few publications discuss protection, privacy, standards, and security in developing nations, while a few e-health periodicals emphasize the necessity of implementing security and standard policies. According to Caroline (BOORE, 2018), security and confidentiality articles are relatively new and scarce in developing nations. Unquestionably, the majority of the papers that are now available have drawn attention to ICT administration in general and the experiences of industrialized countries. The majority of these problems necessitate starting a process to address the dangers, especially those related to their use in e-health systems. The protection of discretion, dependability, accessibility, and liability of the frameworks are then defined as the main concerns of e-health security frameworks. Generally, all e-health providers, patients, and various partners have serious concerns about the security and confidentiality of electronic health transactions via networks (WHO, 2013). In essence, the DRC's adoption of e-health has been negatively impacted by the absence of electronic enactment for a case in point.

In the Republic Démocratique du Congo (RDC), the information and communication technology (TIC) sector is governed by a set of laws and regulations that aim to enshrine its development, protect users, and encourage competition.

Ø **E-Health Standards:** The inability of health data frameworks (HISs) to work together with a stated end goal to share data is one of the main obstacles to the adoption of e-health. It is believed that a standard is essential to achieving interoperability. Despite this,

there are many challenges in the field of e-health standards, chief among them being the vast number of available standards, many of which conflict and overlap with one another (Uddin, et al., 2024). A standard is an established, repeatable process for achieving a goal. It is essentially thought to be the secret to achieving e-health data framework interoperability. Formal, exclusive, or open standards are all possible (Uddin, et al., 2024). One of the most important concerns for the successful development of e-health frameworks is standards. This is due to the fact that many standards are developed independently of the organization that first established them. Additionally, the operation of an open, standardized setting is linked to numerous challenges regarding the creation of policies and fundamental leadership for the implementation of e-health frameworks (Mekonnen & Chanyalew, 2024). The environment of healthcare facilities, the drive for innovation, and the varied interests of the standout performers are all factors that must be considered in order to determine the capacity of e-health standards. Regarding official standards, actual models, and private solutions, any unique organization or venture needed in e-health applications must make its own decisions. The Open Systems Interconnection (OSI) principles cover a wide range of topics for all e-health framework customers, including protocols, security, capacity, and transmission rates. Security standards for e-health data frameworks are also essential for ensuring patient data privacy and dependability. However, in terms of standards and stability, e-health differs from other technologies. Standards for the administration of e-health frameworks in particular should be developed in light of the wide range of innovations and applications used (BOORE, 2018). Therefore, continuity is necessary to provide a quality of patient care that is reliable, competent, secure, and outstanding. Furthermore, a reliable electrical power infrastructure and telephone links are required. However, previous research on the adoption of e-health standards has shown that a few factors contribute to the moderate rate of standards adoption in both industrialized and developing nations. The vast array of standards being developed by the various countries is incorporated into these categories. This is undoubtedly made worse by the fact that e-health standards only address a single area of innovation (Korpela, et al., 2013). In addition, there are conflicting and excessive guidelines. The issue of combining standards from different countries is another, as is the growing. Additionally, there is the problem of consolidating standards from various nations as well as the increased cost of changing over to new standard-based solutions (BOORE, 2018). Furthermore, developing countries have not yet established sufficient criteria for diagnostic imaging, interoperability, programming, transmission, infrastructure, engineering, health informatics, and

bioinformatics (Grobler, 2020). Like many developing nations, the Republic Démocratique du Congo (RDC) is working to implement a digital health system to increase access to care and the caliber of services provided. However, putting such systems into place required a strong regulatory framework, particularly with regard to electronic health standards.

F. Human Resource Limitations

The DRC faces a severe shortage of trained healthcare professionals, particularly in rural areas. This shortage is exacerbated by the brain drain of skilled workers to urban centers or other countries. Even when e-health tools are available, the lack of trained personnel to operate and maintain them limits their effectiveness (Verbeke, et al., 2014) (Verheyden, 2024). In the DRC current context, we have noticed that, there is (PATH, 2022):

- **Inadequate digital health competence:** The DRC's health system lacks the necessary personnel and knowledge to undertake sophisticated digital health tasks. Both development partners and government authorities expressed concern about the shortcomings. Digital Square is helping ANICNS build its institutional ability and implement its digital health investment agenda.⁴⁸ To help reduce the digital gap, development partners provide basic ICT training before launching a new digital health initiative in the provinces. Importantly, the existing digital health capacity is unevenly distributed, with more professionals concentrated in metropolitan regions.
- **Low motivation among healthcare workers:** In general, healthcare workers are less motivated due to low pay. Poor ICT infrastructure and unavailability might lead to low motivation in digital health initiatives. Application downtime disturbs processes and ignores the role of information and communication technology in data management. Health professionals in places with limited internet connectivity, such as Kimvula and Kwimba in Kongo Central, may travel long distances to submit data. The weak road network and geographical limitations make mobility difficult for health personnel.
- **Insufficient digital literacy among healthcare workers:** Undergraduate students in healthcare institutes do not receive digital health training as part of their curriculum. The low availability of digital health curriculum at the postgraduate level leads to a lack of knowledge in this field. Because of their little training, community health professionals have lower levels of digital literacy. Insufficient health informaticians at the health zone level adds to the workload of already understaffed professionals in healthcare facilities.

G. Sustainability and Scalability Issues

Many e-health initiatives in the DRC are pilot projects funded by international organizations. While these projects often

show promising results, they frequently fail to scale up or sustain their impact once external funding ends.

The sustainability of digital health applications is uncertain due to their reliance on development partners for funding. UNICEF discontinued sponsorship for OpenSRP in Kinshasa because of high expenses associated with internet bundles, tablet maintenance by beneficiaries, and lack of technical support. Multisectoral sustainable models that consider maintenance, energy supply, security, and internet availability must be developed, with local communities and authorities driving the agenda (Verheyden, 2024).

This highlights the need for greater local ownership and long-term investment in e-health infrastructure.

C. RQ3 - What are the enabling factors and opportunities that can facilitate the successful adoption and scale-up of e-health in the DRC?

E-Health comprises of various applications that underpin patient management and care. EMRs, Telemedicine, Health Knowledge Management, Consumer Health Informatics (CHI), M-Health, and Healthcare Information Systems (HIS) are some of the applications. Telemedicine is the exchanging of medical data between two groups positioned at various geographical locations using a media transmission link (WHO, 2012). Telemedicine includes video conferencing, where data exchange between health workers and patients is done via a video link (Baker & Stanley, 2018). In the same context the author (Bhatia, 2014) says that Telemedicine refers to the use of ICT technologies to overcome barriers such as time constraints in the treatment of certain illnesses.

According to (Mbarika, et al., May 2012), when implemented correctly, telemedicine can be an economical technique of developing competency in various countries' health care frameworks. Health information systems, often known as health management information systems (HMIS), are systems that collect, analyze, retain, retrieve, and evaluate health information. According to (WHO, 2011), a health management information system integrates data and provides access to promote and safeguard population health. According to (Lazaro, 2013), the goal of the Health Management Information System is to consistently monitor service quality by comparing specified requirements to perceived service delivery. The author (Avgerou, 2008) defines mobile health as the use of mobile communications to enhance healthcare service delivery. The author (Mishra, 2007) says that the internet and mobile devices offer new opportunities for health promotion and management. Furthermore, these tools can be utilized to improve access to multiple sources of knowledge for all parties involved, including patients, health care practitioners, and the general population.

Electronic Medical Records (EMR) also commonly referred to as Electronic Health Records (EHR) are applications that are used to keep patient's clinical history and support medical activities by healthcare specialists. They include information such as laboratory results, treatment and general patient medical history. Thus electronic health records provide the storage, and facilitate communication of patient information among different healthcare specialists. Moreover, the care givers can access the patient information electronically through use of certain authorization (Anwar, et al., 2012).

According to (Eysenbach, n.d.), Consumer Health Informatics (CHI) is a branch of health informatics that involves analyzing customers' information demands, studying and implementing consumer-accessible information strategies, and modeling and integrating customers' preferences into medical information systems. Consumer Health Informatics (CHI) disseminates knowledge to the broader population with the ultimate goal of fostering healthy behaviors, self-care, informed decision-making, and peer information sharing (Hedström & Andersson, 2012). However, health knowledge management solutions offer excellent assistance in utilizing the vast amounts of health-related knowledge and data.



Figure 3 eHealth: The need to go beyond the global health approaches (Khalifehsoltani & Gerami, 2010).

The Democratic Republic of Congo (DRC) faces significant challenges in healthcare delivery due to its vast geography, limited infrastructure, and political instability. However, e-health (the use of information and communication technologies for health) presents a transformative opportunity to improve healthcare access, quality, and efficiency. Below is a synthesized literature review on the enabling factors and opportunities for the successful adoption and scale-up of e-health in the DRC, including innovative technologies, strategic partnerships, community engagement, and supportive policy environments (Verbeke, et al., 2014).

A. Innovative Technologies

Innovative technologies such as mobile health (mHealth), telemedicine, and electronic health records (EHRs) are critical enablers of e-health in low-resource settings like the DRC. Mobile phone penetration has increased significantly in the DRC, with over 40% of the population having access to mobile devices (ITU., 2023). This provides a foundation for mHealth initiatives, such as SMS-based health education, appointment reminders, and remote consultations. Using Unstructured Supplementary Service Data (USSD) codes to communicate health data over mobile may be a viable solution due to its higher coverage than internet. The USSD coding system is a global protocol for sending text messages to mobile network operators without the need for a smartphone or internet connection (Verod-Kepple., 2023).

- *Telemedicine:* Telemedicine can bridge the gap between rural and urban healthcare services (WHO,

2012). For example, the management of chronic diseases, such as cardiac insufficiency, by allowing remote monitoring and early detection of problems. Projects like as E-care and PRADO INCADO demonstrate the integration of telemedicine with point-of-care technologies, improving patient care and potentially reducing hospitalizations (Kalala, 2022).

- **EHRs:** The adoption of EHRs can improve data management and patient care coordination. In Kenya, the implementation of EHR in rural health centers has shown significant improvements in healthcare delivery (BOORE, 2018). Similar approaches could be adapted for the DRC.
- **Mobile Health (mHealth):** Mobile technology has demonstrated significant potential in improving healthcare access and delivery in low-resource settings. mHealth interventions can support various healthcare needs, including maternal and child health, disease surveillance, and health education. In the DRC, where mobile phone penetration is increasing, mHealth can be leveraged to bridge geographical barriers and reach remote communities (Djamba, et al., 2025).
- **Health Information Systems (HIS):** Robust HIS are crucial for collecting, storing, and analyzing health data, enabling evidence-based decision-making. Implementing interoperable HIS can improve coordination among healthcare providers and facilitate the tracking of disease outbreaks (Verheyden, 2024). Open-source platforms, like DHIS2, offer cost-effective solutions for developing and implementing HIS in resource-constrained settings.

B. Strategy and Investment

Ø Investment

Low public financing for digital health: The DRC government has committed to spending \$8 million to support the cost-effective investment roadmap for digital health transformation. However, this funding falls short of the required US\$ 36.6 million for the digital health transformation roadmap. To demonstrate political intent for digitally reforming the health industry, the government's 22% contribution to the US\$ 36.6 budget has space for improvement. An increase in financing will boost ownership of digital health initiatives.

Delay in receiving donor funds: Both the national and provincial Health Divisions have reported delays in receiving financing to implement annual operational plans. Digital health support can be directed at the national level (ANICNS and HMIS directorate) or directly to Provincial Health Divisions, depending on the donor's funding mechanism. Delays in funding induce delays in work plan implementation.

Sustainability of capital investments: Donors and partners have contributed to costly capital initiatives in digital health, such as establishing health ICT infrastructure, supplying

laptops and tablets, and providing data packages to health workers. However, there is no long-term plan for recurring investments. Non-operational ICT infrastructure has been reported and observed in health facilities. As much as donors can mobilize resources for digital health, some have voiced reluctance to invest due to a lack of openness in expenditure rules.

Ø Strategies

Strategic partnerships between governments, non-governmental organizations (NGOs), private sector actors, and international organizations are essential for scaling e-health initiatives. These partnerships can provide the necessary funding, technical expertise, and infrastructure.

- **Public-Private Partnerships (PPPs):** PPPs can leverage private sector innovation and resources to support e-health initiatives.
- **International Collaboration:** Organizations such as the WHO, UNICEF, and the World Bank have supported e-health initiatives in the DRC.
- **International Organizations and NGOs:** International organizations and NGOs play a vital role in providing technical and financial support for e-health initiatives in the DRC. They can contribute expertise in program design, implementation, monitoring, and evaluation, as well as facilitate knowledge sharing and capacity building (World Health Organization, 2023).
- **Research Institutions:** Collaboration with research institutions can generate evidence on the effectiveness of different e-health interventions and inform policy decisions. Local research capacity building is crucial for ensuring the sustainability of e-health initiatives.

C. Community Engagement

Community engagement is critical for the successful adoption of e-health solutions. Involving local communities in the design and implementation of e-health initiatives ensures that solutions are culturally appropriate and address real needs.

- **Health Education and Awareness:** Community health workers (CHWs) can play a pivotal role in promoting e-health solutions. In the DRC, CHWs have been trained to use mobile devices for data collection and patient follow-up, improving healthcare access in remote areas.
- **Local Ownership:** Engaging local leaders and stakeholders fosters trust and encourages the adoption of e-health technologies.

D. Enhanced digital health human resources

Inadequate digital health resources have led to an imbalance in the number of healthcare workers between urban and rural areas (Westbrook, et al., 2015). Furthermore, health staff are less motivated due to low pay. Government pay scales do not

cover digital health personnel, including data managers, system developers, and security specialists at the provincial and health zone levels. Advocating for inclusion of various digital health cadres in government payroll systems is crucial. Specialized skills in digital health, information security, and cyber security should be developed in the workplace. PATH provides Enterprise Architecture certification training to ANICNS staff, while IMA World Health supports training, technical support, and the roll-out of DHIS2 in the Democratic Republic of the Congo (DRC).

E. Digitization of the Health System

Digital health systems are less costly than paper-based solutions. Digitization reduces data collecting errors and increases the performance of the healthcare sector. Electronic data collecting allows for real-time report generation and decision-making. While digitization in the health sector is evolving, funders such as The Global Fund have observed long-term cost savings when deploying digital solutions instead of paper-based data reporting systems (The Global Fund, 2022). UNICEF, notably at the community level, has begun steps to transition from paper to electronic formats. National authorities, such as the Congolese National Authority for Pharmaceutical Regulation (ACOREP), have begun digitizing pharmaceutical import and export. The ANICNS plans to establish computerized patient records in 300 health facilities in Kinshasa (ANICNS, 2023). ENABEL has initiated a trial digitalization project at Saint Joseph Hospital in Sud Ubangi. To minimize data silos, all digitization activities must be aligned with the Health Enterprise Architecture in order to promote interoperability and information flow between systems. In places where only digital systems are used, the internet and electricity must be completely operational, as well as all software and hardware systems.

F. Improved Internet connections

There have been occasional efforts by development partners to improve internet access in the DRC. The UK Foreign, Commonwealth & Development Office (FCDO) and the Global Alliance for Vaccines and Immunization (GAVI) helped deploy over 600 VSATs in health zones (ANICNS, 2023). After installation, the government was unable to stably afford the subscription costs, and the VSATs were abandoned. The ANICNS, in collaboration with the Ministry of Digital Affairs and the Ministry of Posts, Telecommunications, and New Technologies (PTNTIC), shall coordinate all development partners' efforts to agree on a long-term plan for addressing internet access concerns, particularly in rural communities. Telemedicine applications, particularly imaging, require more bandwidth than data transfer. This further calls for having dedicated transmission channels for critical digital healthcare services.

G. Improved stability and reliability of energy sources

Given the national infrastructure challenges of hydroelectric electricity, it is necessary to embrace sustainable alternatives. Some health facilities run essential health departments on

generator power during outages of the main hydroelectric source, although this is extremely expensive. While solar is an option, installation and upkeep remain pricey and challenging. The Lubumbashi health zone featured solar panels that powered the entire office; unfortunately, the converter was damaged, and the batteries eventually stopped working. In some health-care institutions, solar energy is employed to keep vaccines at approved temperatures. Power banks can also be used to store electricity and charge devices (Djamba & Irene, 2024). Increased energy coverage leads to better mobile connectivity (Georges, et al., 2021).

H. Equipping healthcare institutions with ICT equipment

After addressing the energy and internet connectivity difficulties, it is critical to supply ICT equipment to health facilities and community health workers. Maintenance, which is an issue of long-term technology use, can be solved in part by employing computer-aided maintenance management (CAM). The ANICNS evaluated the existing ICT infrastructure and found shortcomings in healthcare facilities. The procurement of ICT equipment for over 300 health facilities in Kinshasa is complete. To reap the national benefits of digitization, all health facilities must have fully operational ICT technology (ANICNS, 2023).

IV. RESEARCH GAPS

E-health, leveraging information and communication technologies (ICTs) to improve healthcare delivery, holds immense potential for strengthening health systems in resource-constrained settings like the Democratic Republic of Congo (DRC). While e-health initiatives have shown promise, their successful implementation faces numerous challenges, hindering widespread adoption and impact. Identifying and addressing these research gaps is crucial for maximizing the effectiveness of e-health interventions in the DRC. The Table 2 below, highlights key areas where further research is needed to inform policy and practice, ultimately contributing to improved health outcomes for the Congolese population

V. LIMITATIONS

This survey encompasses all material available in non-medical libraries. The goal is to provide an ICT perspective, hence publications from libraries such as JMIR (www.jmir.org) and PubMed (www.ncbi.nlm.nih.gov/pubmed) are not included. Another observation from the author is that the pattern of publication dates shows a noticeable increase in relevant material since 2015. At the time of writing, 2016 reportedly has an increasing amount of research on eHealth technologies, with a projected increase in reported mHealth solutions by the end of the year.

VI. CONCLUSION

This systematic analysis has provided a detailed assessment of the current state of e-health implementation in the Democratic Republic of the Congo (DRC), emphasizing both progress and considerable problems that remain. While promising projects are emerging, particularly in maternal health, disease surveillance, and health information systems, the broad and

long-term adoption of e-health solutions is impeded by a complex interaction of variables. Our findings emphasize the persistent impact of infrastructure constraints such as power outages, poor internet connectivity, and a dearth of skilled staff. Furthermore, socio-cultural barriers, such as varying levels of digital literacy, language diversity, and traditional healthcare practices, must be carefully considered to enable successful adoption. The study also shows that there aren't enough thorough evaluation studies, which limits our ability to determine with certainty the effectiveness and affordability of a lot of e-health projects. A more strategic and coordinated approach is needed going forward. Prioritizing infrastructure spending, developing locally applicable and user-centered solutions, supporting capacity-building initiatives, and carrying out exhaustive assessments are all part of this. Collaboration among stakeholders, including government agencies, NGOs, researchers, and local communities, is essential for ensuring that e-health programs are aligned with national health priorities and successfully address the Congolese population's unique requirements. By learning from previous experiences and adopting a collaborative, evidence-based approach, the DRC may leverage e-health's revolutionary potential to strengthen its health system and improve citizens' health and well-being.

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