Improving resilience in developing countries: Digital health provision through telemedicine ecosystem against the pandemic, epidemics and natural disasters in sub-Saharan Africa

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List of Abbreviations

BMGF	-	Bill and Melinda Gates Foundation
CDC	-	Center for Disease Control and Prevention
CHPS	-	Community-based Health Planning and Service
EVD	-	Ebola Virus Disease
FGD	-	Focus Group Discussion
FinTech	-	Financial Technology
GHS	-	Ghana Health Service
GIFEC	-	Ghana Investment Funds for Electronic Communication
GSS	-	Ghana Statistical Service
HIV	-	Human Immune Virus
ICT	-	Information Communication Technology
KII	-	Key Informant Interview
MERS-CoV	-	Middle East Respiratory Syndrome Coronavirus
mHealth	-	Private Mobile Health
MOTECH	-	Mobile Technology
NCA	-	National Communications Authority
NDPC	-	National Development Planning Commission
NHIA	-	National Health Insurance Authority
NGO	-	Non-Governmental Organization
OPD	-	Out Patient Department
PDA	-	Pocket Digital Assistant
RAMP		
SARS	-	Severe Acute Respiratory Syndrome
SSA	-	Sub-Saharan Africa

USAID - United States Agency for International Development

WDI - World Development Indicators

WHO - World Health Organization

1. Executive Summary

Recent decades have witnessed a series of epidemics, pandemics and natural disasters across the world. African countries have not been spared the growing outbreak of pandemics and epidemics, with the most recent being the COVID-19 pandemic. Although the consequences of these pandemics and epidemics are ruinous to all countries, developing countries, and in particular Sub-Saharan African (SSA) countries are significantly affected due to their weak health infrastructure with many rural communities having little access to health facilities. SSA is faced with inadequate human capital. Most of the population in these countries live in remote communities, as a result, they hardly have access to quality healthcare in the few facilities located in the urban centers. Telemedicine ecosystems can be leveraged to expand health service delivery, particularly to the poor and the vulnerable (children, women, and the elderly) in remote communities. It is against this linchpin that the study seeks to create an understanding of the state of the telemedicine ecosystem, challenges for scale-ups, and provide recommendations to facilitate the sustainable expansion of telemedicine infrastructure and adoption in SSA.

The study examines secondary data on the topic across various SSA countries, and then concentrates on Ghana's telemedicine ecosystem using in-depth qualitative tool including community and focus group discussions to address its objectives. Primary data was obtained through one-on-one interviews with sixty-three (63) relevant stakeholders in the telemedicine ecosystem using a semi-structured questionnaire.

The results obtained from the study shows that Ghana's telemedicine ecosystem is in its early stage and even though there is improvement in telecommunication services, there are some communities in Ghana with poor network connectivity which hampers the agenda to expand telemedicine to rural communities. Generally, at the policy level, our results show that telecommunication infrastructure deficit which have created a digital divide, and policies that do not allow health practitioners in rural communities to attend to some health situations and prescribe certain medication are the hindering factors to the deployment of telemedicine in Ghana. Even though most people are not aware of the existence of telemedicine, they resorted to various digital means, such as calling friends, health workers they know etc., to seek health advice during the COVID-19 pandemic. The success of any telemedicine infrastructure in SSA will depend to a large extent on the creation of awareness and trust that the digital health services received are of the same quality as that which would have been provided at a health facility.

The study concluded that telemedicine will be an important tool for the efficient delivery of healthcare, especially to marginal communities, and therefore it is important it is integrated into the healthcare system of Ghana to supplement the quality service delivery.

Based on the findings of the research, the following recommendations are made for policy action:

- Many SSA countries do not have any telemedicine policies. As a first step, governments and health policymakers in SSA in general and in Ghana in particular is recommended to develop a comprehensive national telemedicine policy to aid in the implementation of telemedicine programs.

- Secondly, governments must incentivize telecommunication companies to expand the telecommunication infrastructure to remote rural communities. The incentives could include tax exemptions on imported telecommunication gadgets.

- Generally, governments should work with telecommunication companies to address outstanding inefficiencies such as poor communication networks.

- A successful telemedicine ecosystem will require proper training of healthcare professional. The health authorities must design and implement appropriate training modules on telemedicine to build the capacity of healthcare professionals.

- Cost of digitalization including Internet cost and computer/handset devices have to be reduced to complement the agenda of a national telemedicine ecosystem.

- Sensitization of citizens, particularly those in rural communities on the importance of telemedicine to the achievement of a holistic healthcare service provision will be imperative for the success of any instituted country-wide telemedicine system.

2. Introduction

2.1 Background

There has been a series of epidemics, pandemics and natural disasters including floods across the world in recent years. The 2003 SARS epidemic, H1N1 pandemic in 2009, Ebola Virus Disease (EVD) in 2014, and most recently, the COVID-19 pandemic are a few but outstanding health issues that ravage the world with significant economic and social impacts. African countries have not been left out of the growing outbreak of pandemics and epidemics. Research revealed that, between 2016 and 2018 alone, 87 percent of African countries experienced at least one form of an epidemic (Talisma et al., 2020). Most African countries including Ghana recorded cases of the 2009 H1H1 pandemic; South Africa was the hardest hit with 12,631 confirmed cases and ninety-one (91) deaths. Also, the continent was hit with EVD which was first reported in Guinea where bats are thought to have infected a 18-month-old boy from a small community in that country (Center for Disease Control and Prevention (CDC), 2019). Subsequently, the virus spread through the capital of Guinea (i.e., Conakry) and other countries (i.e., Sierra Leone, Liberia, Nigeria, Mali). Additionally, the continent had its share of the COVID-19 virus. At the onset of the COVID-19 outbreak in Africa, Ghana was one of the first countries to record the largest cases of the pandemic with about 24, 998 cases in the first two months. The total confirmed COVID-19 cases in Ghana as at June 2022 stood at 164,164 with 1448 deaths (Ghana Health Service (GHS), 2022). For natural disasters, research have shown that the incidence of natural disasters such as flooding, earthquakes, heat waves, drought etc., will increase due to increasing climate change in many places in Africa (Siwedza and Shava, 2020; Brown et al., 2007). Evidence further shows that natural disasters intertwined with climate change are the main risks to household livelihoods and health outcomes in Africa (Coulibaly et al., 2020; Djoumessi et al., 2022).

Although the consequences of these pandemics, epidemics and natural disasters are dire to all countries, developing countries are significantly affected due to their weak infrastructure (World Health Organization (WHO), 2010). Developing countries in general are lagging in terms of basic infrastructures, including health and telecommunication infrastructures. These infrastructure challenges are quite pronounced in SSA. These challenges range from technological infrastructure, inadequate medical equipment, and healthcare facilities, among others. According to Wamala and Augustine (2013), SSA countries have inadequate Information Communication Technology (ICT) infrastructure despite the proliferation of technological ideas and tools in the world. Research ICT Africa RIA Mobile Pricing (RAMP) Index 2020 noted that handset cost and Internet data cost remain very high in SSA countries. This partly renders the use of technology in health service provision in developing countries challenging. And yet, these countries are the ones that need the benefit of ICT in health provision the most (Mars, 2010). The lack of technological infrastructure and inadequate medical equipment have significant implications for the utilization of telemedicine in SSA (Chitungo et al., 2021).

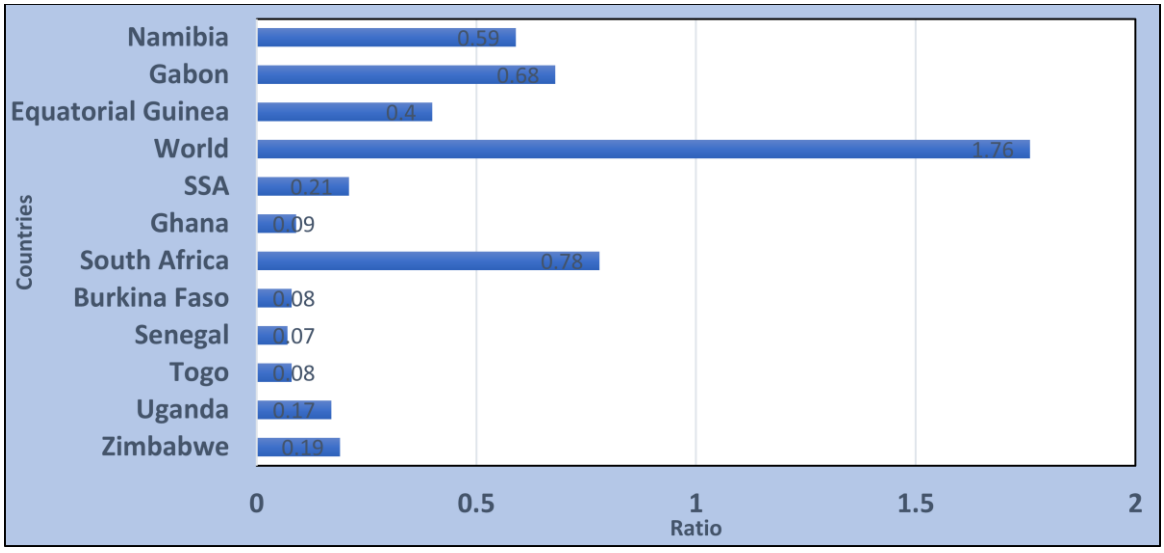
Further to the above, there is inadequate human capital in the health sector in many countries (Geissbuhler et al., 2003; Wamala & Augustine, 2013; Bhaskar et al., 2020), creating a major gap in healthcare delivery mostly in the marginalised communities.

The inadequacy of healthcare professionals in these countries to meet the healthcare needs of the population makes it difficult for rural communities to have access to healthcare. The few care professionals in these countries are mostly based in the urban centers and this makes quality healthcare delivery in rural communities challenging (Mars, 2010; Geissbuhler et al., 2003). SSA harbors thirty-three (33) of the world's poorest countries (Wamala & Augustine, 2013). About 60 percent of the population in these countries live in remote communities, as a result, they hardly have access to quality healthcare in the few facilities located in the urban centers. Diseases are prevalent in these countries (Mars, 2010; Shiferaw & Zolfo, 2012). Africa records over 90 percent of new cases of malaria yearly (Mars, 2010). Over half of the world's population living with HIV are found in SSA (WHO, 2009). There is high infant and maternal mortality. In addition, it is expected that one billion out of the 2.3 billion estimated increases in the world population by 2050 will come from Africa (Mars, 2010).

The doctor-to-patient ratio in SSA is far below the global average. Whereas the world's doctor-to-patient ratio averaged 1.8 in 2017, SSA's doctor-to-patient ratio averaged 0.2 in the same year. Specifically, Zimbabwe, Burkina Faso, Ghana, Uganda, Togo and Senegal averaged 0.19, 0.08, 0.09, 0.17, 0.08 and 0.07 doctor-to-patient ratio in 2017, respectively. South Africa (0.78), Gabon (0.68), Namibia (0.59) and Equatorial Guinea (0.4) were the only countries whose doctor-to-patient ratio was above the SSA average in 2017 (World Bank, 2020) (See figure 1).

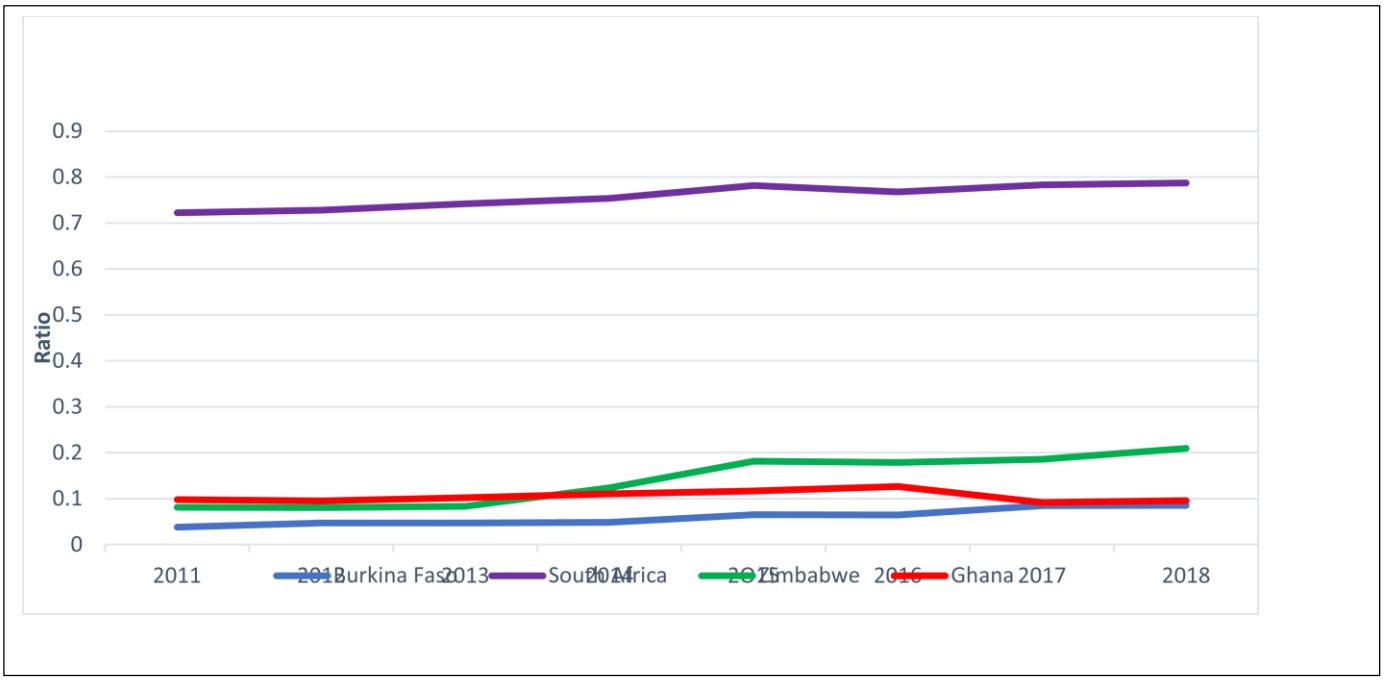
Figure 1 shows that while Zimbabwe and Uganda are close to SSA's average doctor-to-patient ratio, Ghana, Togo, Senegal and Burkina Faso are lagging behind the average in the subregion. South Africa, Gabon, Equatorial Guinea and Namibia have made progress in the subregion with regards to doctor-to-patient ratio. Figure 2.1 further shows that the averages in these countries far exceed the average in the subregion but lag behind with respect to the global average.

Figure 1: Doctor-to-patient ratio in the World



2013; Babalola et al., 2021). This has deprived most people, especially the disadvantaged communities in these countries, of access to healthcare leading to a high mortality rate (Wamala & Augustine, 2013).

Figure 2: Trends of Doctor-to-patient ratio, in Selected SSA Countries



Source: ***World Development Indicator, 2020***

Telemedicine can serve as a tool to solve the healthcare challenges that face SSA countries. Generally, telemedicine encompasses care provision where there is a distance between the receiver and provider of healthcare. It is the use of technology and telecommunications to exchange medical information to provide care at a distance, to improve and increase access to quality healthcare service (Perednia & Allen, 1995). Telemedicine and telehealth are often used interchangeably however, the former is a subset of the later. While telemedicine generally relates to remote clinical services i.e., telesurgery (the use of technology to perform surgery where the surgeon and patient are in different geographical locations), tele-radiology (the electronic transmission of radiographic images at a distance for purposes of interpretation and consultation). Thus, telehealth is a broader concept which encapsulate both clinical activities, as done under telemedicine, and also non-clinical activities such as medical/education and training (Weinstein et al., 2014).

Scholars have observed that telemedicine was the most relied upon tool within the healthcare system during the outbreak of the COVID-19 pandemic to contain the spread of the virus (Calton et al., 2020; Kichloo et al., 2020). Specifically, Kichloo et al. (2020) found that the expansion of telemedicine services helped in the provision of quality service while maintaining social distance during the outbreak of the COVID-19 pandemic. Research maintained that telemedicine is one of the solution hubs to

Africa's e-health problems where distance and inadequate human capital are well pronounced.

Though telemedicine can generally help to ameliorate the effects of pandemics and epidemics on the vulnerable, there are various challenges associated with the adoption of telemedicine. For instance, the provision of appropriate telecommunication infrastructure is important for the adoption of telemedicine. Some patients and doctors might not be capable of using telemedicine due to the lack of required knowledge and skills. Against this background, this study aims to inform and create an understanding of the challenges confronting digital health provision through the telemedicine ecosystem during the COVID-19 pandemic in SSA using Ghana as a case study.

Similar to other SSA countries, Ghana faces some infrastructure challenges (ICT, health facilities and medical equipment). The number of hospitals in Ghana compared to the population size is inadequate, there are some regions in Ghana without a regional hospital. Also, regions that have hospitals are faced with inadequate beds for the admission of patients (Drayi, 2019). In a similar manner, most of the public health facilities that are located even in urban centers do not have functional emergency teams. Only 25.5 percent of public hospitals in Ghana had a functional emergency team in 2017 and 2018 (National Development Planning Commission (NDPC), 2021). In addition, the number of Community-based Health Planning and Services (CHPS) zones in Ghana stood at 5,547 in 2020 which is inadequate to meet the health needs of the rural population. In addition, these CHPS compounds lack the technical, structural, and human capacity for the delivery of quality healthcare services in these difficult communities (NDPC, 2021). In addition, there are some communities in the rural areas without CHPS compounds, which further exacerbate healthcare provision in Ghana. It is against this backdrop that this study uses Ghana as a case to understand the challenges of the telemedicine ecosystem and proffer recommendations for policy actions.

Pandemics and epidemic are not the only situation where telemedicine can be deployed. Natural disaster is one occurrence that deploy telemedicine to provide emergency medical care to victims (Doarn, 2017). According to the United National International Strategy for Disaster Reduction (UN-ISDR), disaster is the disruption of the functioning of a society, that causes widespread human, economic, environmental, and material loss which is beyond the abilities of the affected society to cope considering their available recourses (Makawana, 2019). Natural disaster occurs naturally and unexpectedly, examples include: tsunamis, earthquakes, flood, hurricanes, cyclones, and droughts. The occurrence of natural disaster is therefore unpredictable, and hence, it important to plan and ensure that health facilities are adequately prepared to provide relief to victims when the need arises. Natural disaster usually results in loss of lives and properties and increase morbidity with significant economic impact. The past two decades have seen billions of people losing their lives others, getting injured, and some were also rendered homeless because of natural disaster (Ajami & Lamoochi, 2014). To provide medical relief to victims of a natural disasters especially (i.e., critical conditions) and mitigate the impact of these natural shocks, telemedicine is an important tool that can help in these situations.

The International Telecommunication Union (ITU) launched the *Connect2Recover initiative* to strengthen the digital infrastructure and digital ecosystems of countries in developing regions, with the objective to help these countries to leverage information and communications technologies (ICTs) to support COVID-19 pandemic recovery efforts and preparedness for a post-COVID normal and remain resilient in times ofhazards. Connect2Recover initiative launched an international competition to identity the most promising research proposals to accelerate digital inclusion during COVID-19 recovery. Consequently, 15 research teams were selected as winners of the *Connect2Recover competition*, of which this research is one of the winners.

2.2 Research Scope

The study is limited to the telemedicine ecosystem of Ghana. Stakeholders in the health, telecommunication sectors, and community members (i.e., old pilot community – communities that received previous telemedicine intervention, and vulnerable group (children, women, and the elderly)) constitute the target population. They include staff of the GHS, National Health Insurance Authority (NHIA), Ministry of Health, Telecommunication service providers, Ministry of Communication, Health Non-Governmental Organizations (NGOs), Old Pilot, and vulnerable community members. Contextually, the study concentrated on understanding the challenges associated with the deployment of telemedicine to fight against the COVID-19 pandemic in Ghana, and further, to suggest a telemedicine ecosystem to facilitate the provision of digital health in SSA. To achieve the objectives of the study, a qualitative research design was deployed.

2.3 Research Objectives

The overall objective of the study is to create an understanding of the dynamics of the telemedicine ecosystem and proffer recommendations to facilitate the sustainable adoption of telemedicine in SSA.

The study seeks to achieve the following specific objectives:

- To determine the state of the telecommunication and telemedicine ecosystems in sub–Saharan Africa.
- To examine how telemedicine has been diffused to vulnerable groups (elderly, disabled, and poor) in sub–Saharan Africa.
- To examine how the telemedicine ecosystem has been leveraged to improve resilience to pandemics, epidemics, and natural disasters.
- To determine the challenges and successes of expanding access to telemedicine in Sub-Saharan Africa.

3. Literature Review

3.1 Telemedicine and Outbreak of Pandemics and Epidemics

Even before the outbreak of the COVID-19 pandemic in 2019, healthcare providers leveraged telemedicine to provide healthcare to patients at a distance. According to

the WHO, telemedicine and other digital health were already in use in member states in the Western Pacific Region before the COVID-19 pandemic. Over the years, telemedicine has been used to extend healthcare service across the globe (Della, 2005; Enfield et al., 2015; Elliott & Yopes, 2019; Glascock & Kutzik, 2006; Kichloo et al., 2020).

The use of telemedicine during the pandemics and epidemics situation is considered helpful because it facilitates in taking care of patients who cannot access the healthcare facility, and at the same time, reduces the spread of the organisms that cause those diseases. COVID-19, the most recent pandemic is not the only disease outbreak that deployed telemedicine. The 2003 SARS epidemic in Taiwan, H1NI influenza in 2009 and the 2014 Ebola outbreak in Africa are other examples. Ohannessian (2015) concluded that the use of telemedicine in epidemic situations has a high potential of improving epidemiological investigations, disease control, and clinical case management. Enfield et al. (2015) also argued that telemedicine could be a unique tool to enhance patient care and ensure the team's safety in cases of highly contagious diseases and virulent infectious agent (such as MERS-CoV and EVD).

Sandrock (2010) noted that telemedicine was employed to provide several health facilities with clinical, technical and public health expertise during the outbreak of H1N1 in California. Specifically, the author found that aside from infection control and prevention, ventilator management, laboratory, public health support, patient consultation, and diagnostic support were the other areas of expertise provided. However, respiratory care was the most prominent expertise provided across the healthcare spectrum, thus, respiratory care was extended from emergency medical services to alternate care sites to the hospital. Gossen et al. (2020) also concluded that the incorporation of telemedicine as part of healthcare regime for patients with highly virulent contagious diseases enhanced the safety of healthcare professionals and patients, and also increased the patient's experience. According to the authors, medical education is very important and telemedicine could be considered as a medium of education during the care of patients with EVD and other highly contagious and virulent infectious diseases.

Vidal-Alaball et al. (2020) found that during the COVID-19 pandemic, telemedicine was the doctors' first line of defense to slow the spread of the coronavirus and keep social distancing. They also noted that services were provided via phone or videoconferencing for mild to focus personal care and limited supplies to the most urgent cases. Similarly, Monaghesh and Hajizadeh (2020) observed that telehealth was appropriate in minimizing the risk of COVID-19 transmission for healthcare providers and patients who were self-isolating. The authors believed that telehealth has the potential to prevent any kind of direct physical contact, provide continuous care to the community, and finally, reduce morbidity and mortality in the outbreak of the pandemic.

Gao (2020) reviewed articles on the application of telemedicine during the COVID-19 pandemic. Some of the studies demonstrated that telemedicine can be used to screen the suspected patients and provide advice. Also, during the SARS epidemic, the proportions of people asking for consultation for symptoms, prevention and therapy, and psychological problems were 35.0, 22.0, and 23.0 percent respectively (Gao,

2020). From a review of literature, Kichloo et al. (2020) noted that telemedicine was deployed to expand the delivery of quality healthcare in the US amidst the practice of social distancing during the COVID-19 pandemic. Keshavardoost et al. (2020) argued that based on the lessons learnt from SARS and MER-CoV, both developed and developing countries can improve their healthcare system by resorting to telehealth in the management of COVID-19 cases.

Scholars have argued that the deployment of telemedicine during the outbreak of the COVID-19 did not only help to curb the spread of the virus but also provided comfort for patients and the healthcare professionals. Additionally, telemedicine helped to reduce the queuing system at the hospital and ensured that healthcare professional discharge their duties smoothly without interference (Benis et al., 2012; Haleem et al., 2021).

3.2 Deployment of Telemedicine in Developing Countries

The proliferation of ICT is encouraging the deployment of telemedicine in developing countries. This serves as an opportunity to provide healthcare service to the underserved and numerous deprived communities. Scholars have argued that, the sustained use of technology, has supported the effective and efficient delivery of healthcare in poor countries.

Bhaskar et al. (2020) observed that there is an improvement in healthcare provision across the world due to the increasing uptake and implementation of telemedicine. The authors noted that in a bid to prevent the spread of the COVID-19 pandemic, healthcare workers across the globe turned to the use of technology for healthcare provision.

In a similar vein, Wamala and Augustine (2013) studied the impact of telepathology in improving professional performance in healthcare delivery to achieve the health target of the Millennium Development Goals (MDGs). The authors observed that most SSA countries are appreciating the need to leverage on the use of technology in healthcare provision.

Consistent with Wamala and Augustine (2013), Glascock and Kutzik (2006) found that patients received better care, retained more independence, and have a greater sense of well-being by using behavioral monitoring technology, based on smart-home and telemedicine applications. The authors further observed that through the use of the behavioral monitoring technology, the functional abilities of patients are assessed in their home without patients visiting the health facility or care givers visiting the homes of these patients. Also, patients communicate regularly with their care givers or nurse with regards to their treatment and the medication they have to take.

The Mali University Medical School piloted a telemedicine project known as Keneya Blown (“health vestibule”). The project (Keneya Blown) used Internet-based technologies for distance learning and teleconsultation and was financed by the Geneva University Hospitals and the Switzerland government. Geissbuhler et al., (2003) evaluated the project and found that telemedicine plays an important role in the effective and efficient delivery of healthcare. The authors also noted that though

the project did not achieve its objectives, it served as the basis for the launch of a telemedicine project involving twelve (12) French speaking African countries dubbed the RAFT (Réseau en Afrique Francophone pour la Télémédecine) project.

The RAFT project was extended to 10 other French-speaking African countries. This is an interactive online course that ensured the sharing of knowledge among care professionals or expects in different countries and was coordinated by the Geneva University Hospitals. RAFT dealt with teleconsultations, videoconferences, support for medical laboratories' quality control, collaborative knowledgebase development and the evaluation of telemedicine in the rural areas via satellite connections in the context of multi-sectorial development (Wamala & Augustine, 2013).

Despite the implementation of telemedicine in some African countries, Babalola et al. (2021) found that the concept is still in its infant stage in SSA. Bradford et al. (2015) observed that although telehealth services were used in Australia, participants in the rural areas were not aware of the concept and its existence. While some SSA countries (namely, South Africa and Ethiopia) have made progress with the implementation of telemedicine, others (such as, Nigeria and Burkina Faso) are slow in adopting telemedicine (Wamala & Augustine, 2013). Wamala and Augustine (2013) argued that there is slow adoption of telemedicine in countries like Burkina Faso and Nigeria due to the lack of political support. Similarly, Sani et al. (2020) noted in Nigeria that telemedicine has not received the necessary attention because there is the lack of political will.

3.3 Constraining Factors to the Effective Deployment of Telemedicine in SSA

Despite the ability of telemedicine to positively influence the health of the population and the quality of service in the health systems of developing countries, a number of factors continue to hinders its adoption. SSA countries face the challenges of inadequate ICT infrastructure, technological illiteracy, low Internet quality, erratic power supply, high cost of Internet, inadequate human capital and technical support. This has militated against the adoption and implementation of a telemedicine program. The WHO cited inadequate human capital in the health, power supply interruption, low budget for ICT and infrastructure constraints in the health sector as the key barriers to the adoption of telemedicine in Africa (WHO, 2010). Wamala and Augustine (2013) noted that the inadequate ICT infrastructure in SSA creates a sub-optimal application of telemedicine in the subregion. Also, Sani et al. (2020) found in Nigeria that inadequate ICT infrastructure, inadequate technical, financial and "political support" serves as the major hindrance to the adoption of telemedicine.

Consistent with Sani et al. (2020) and Wamala and Augustine (2013), Bali (2018) also found that inadequate ICT, infrastructure ICT illiteracy, high cost of initial ICT infrastructure start-up, high cost of replacing old technology and low Internet connectivity are challenges to the deployment of telemedicine in developing countries. Bali (2018) further noted that a reliable and high-speed Internet bandwidth is required for the smooth running of most telemedicine applications (i.e., emergency consultations, telesurgery and tele-radiology).

However, SSA countries especially rural dwellers have little or no access to reliable Internet. This deprives them access to telemedicine service even if they are available. The telecommunication companies who are entrusted with the provision of Internet service in these countries mostly shy away from Internet provision in the rural area. According to Perkins, (2018) telecommunication companies invest little or does not invest at all in rural Internet provision because it is not profitable. Shiferaw and Zoloft (2012) conducted a study to assess the success, challenges and failure of the setup and implementation of a telemedicine program in Ethiopia. They noted that telemedicine delivery in most SSA countries is hindered by the problem of slow Internet connection, low bandwidth and high service charges (Shiferaw & Zoloft, 2012).

Despite the penetration of technology in Africa, most SSA citizens are not technologically inclined, which then make service delivery involving the use of technology a difficult task in this subregion. Triana et al. (2020) found that patients could not honor their virtual doctor's appointment during the heat of the COVID 19 pandemic due to limited knowledge in technology. Shiferaw and Zoloft (2012) shared the view of Triana et al (2020) as the authors observed that prior to the implementation of the telemedicine program in Ethiopia, most of the participants are not technologically inclined. Specifically, they note that 25 percent of the sample has average knowledge in computer, 65 percent has minimal computer knowledge, while 10 percent has no knowledge at all on how to use computer (Shiferaw & Zoloft, 2012). Ajuwon and Rhine (2008) conducted a study to assess the utilization of ICT and electronic resources and Internet access among health information professionals in Africa, and they found that about 87 percent of the respondents need further training in ICT.

Political influence and support create an enabling environment for telemedicine to thrive in a country. In addition to the developmental needs of a country, NGOs and international development organizations consider the political atmosphere and laws governing a country before embarking on projects within that country. Sain et al. (2020) studied the factors affecting the adoption of telemedicine in Nigeria. The authors found that one major factor affecting telemedicine adoption in Nigeria is inadequate political support. Similarly, Shiferaw and Zoflo (2012) found that in Ethiopia aside from technology, telemedicine implementation depends on other factors such as the government's enabling policies. Shiferaw and Zoflo (2012) specifically found that enabling policies, e-government readiness, capacity building and multisectoral involvement are also barriers to telemedicine adoption in Ethiopia.

However, some scholars believe that there are other organizational and behavioral factors that affect the adoption of telemedicine in developing countries. Pagalday-Olivares et al. (2017) found that poverty, cultural beliefs, organizational issues, connectivity, and lack of human capital are the main challenges to the implementation of eHealth. Also, Isabalija et al. (2011) observed in Uganda that the lack of telemedicine policy, knowledge and skills and resistance to change by members of staff in the hospitals are key factors affecting telemedicine adoption. Sharing in the views of Pagalday-Olivares et al. (2017) and Isabalija et al. (2011), Sagaro and Amenta (2020) also, reported that aside from infrastructure cost, staff resistance to change and staff turnover are critical barriers to telemedicine implementation in Ethiopia.

3.4 Telemedicine Projects in Ghana

A number of telemedicine projects have been initiated in Ghana. Some were piloted projects funded by developmental partners while others are initiatives taken by local organizations. Some communities benefited from the piloted projects. Below are some of the telemedicine projects implemented in Ghana and their impact in the beneficiary communities:

Vodafone Healthline Project*:* This project is an initiative of Vodafone Ghana to educate and inform Ghanaians on health-related matters and lifestyle practices. Medical experts are hosted on a television show to throw more light on health issues, debunk health myths and to answers health questions from the public. Over the years, this project hosted shows that discussed issues such as, pregnancy, diabetes, cancer, high blood pressure, tumors, mental health, bones and sex (Tchao et al., 2019, Afarikumah, 2014).

Mobile Technology for community health (MOTECH) was initiated by the Grameen and the GHS. The project seeks to use mobile technology to improve the health of pregnant women, newborn babies and their mothers. It first started in the Kassena-Nankana district in the Upper East region and was later scaled up to six (6) other districts with the help of funding from the Bill and Melinda Gates Foundation (BMGF) and USAID (Willcox et al., 2019). This platform consists of two applications known as the “Client Data Application” and the “Mobile Midwife”. With Client Data Application, frontline health workers record and monitor women and infants in the area that are due or overdue for care. Also, care given to patients are digitally recorded to improve data reporting process.
For the “Mobile Midwife” application, mothers of children under the age of one (1) and pregnant women receive care and education via pre-recorded audio messages or SMS on their phones timed to their gestational period or the age of the child (Willcox et al., 2019, Dodoo et al., 2021).

Sene Pocket Digital Assistant (PDA) is a mobile health concept introduced in 2004. It uses information technology to improve healthcare delivery in the Community-based Health Planning and Service (CHPS) centers. The introduction of this project helped in the accurate and effective generation of reports used by the District Health Manager and Community Health Officers through the use of technology. In addition, time spent on generating these reports are reduced significantly. The project helped to reduce the dropout rate of mothers and children enrolled on the save motherhood and immunization services (Ofosu & Nyonator, 2013, Willcox et al., 2019).

Family Health Hospital Telemedicine**:** This project was set up as a collaboration between Family Health Group Apollo Hospital and Airtel Ghana. The center was launched by the Family Health Hospitals in Accra to improve medical education in Ghana and to grant patients access to medical experts. To enhance medical training in Ghana, the facility is equipped with monitors and video-conferencing systems. The facility helps patients to have live access to medical consultation with doctors in India

and USA. This reduced the travelling of patients out of the country for specialist consultation (Tchao et al., 2019).

***Norvartis*:** In collaboration with Colombia University Earth Institute's Millennium Promise, Ghana Health service, Ministry of Health Ghana, Ambulance Service of Ghana and the Ghana National Health Insurance Authority, Novartis piloted a health project in the rural areas. This project seeks to grant rural and remote area dwellers access to quality health care whiles reducing their transportation cost. Health workers in the rural communities are connected to healthcare experts in 24-hour teleconsultation centers via mobile technology. Based on the professional advice and guide from the experts, community health workers are able to improve on the quality of healthcare received by their patients. With this system, there is immediate support in cases of emergencies and also the elimination of unneeded referrals (Novartis Foundation, 2016, Tchao et al., 2019).

3.5 Telemedicine and Natural Disasters

Deploying telemedicine in crisis and natural disaster situation has been necessitated by the dire consequences of the occurrence on its victims and the society. The consequences of natural disasters include but not limited to physical, social, economic and psychological (Novia, Hariyanti & Yuliatun, 2020). The events cause death of some victims while surviving victims are left with unpleasant condition such as injuries, fears, depression, loss of identity and homelessness (Ajami & Lamoochi, 2014; Novia et al., 2020).

Studies have found various social, economic, environmental and financial repercussions on victims of natural disaster and the society (Boustan et al., 2020; Kiel & Matheson 2018; Rodriguez-Oreggia et al., 2013;). Kiel and Matheson (2018) examined the effect of the Fourmile-Lefthand Canyon Forest fire on housing prices in vulnerable neighboring areas. The authors found that buyers in high risk areas were most likely to change their perception on the purchase of housing in response to fire leading to a 21.7 percent decline in sale price compared to houses in non-risky areas. Similarly, Boustan et al., 2020 found in the U.S that severe natural disaster is associated with out-migration and falling housing prices that leads to a reduction on labour demand and low productivity. Also, Rodriguez-Oreggia et al., (2013) observe in Mexico that natural disaster increases poverty levels as well as human development. Their finding further showed that droughts and floods has severe effect compared to other hazards (Rodriguez-Oreggia et al., 2013).

Scholars have argued that if victims of natural disasters are not given the necessary medical and psychological attention and treatments they require, in the long run they may either die due to poor medical treatment or develop severe psychological disorders. (Makwana, 2019; Novial et al., 2020;). Makwana (2019) posited that psychological interventions provided to disasters victims helped improve conditions of the victims over time. The author concluded that effective interventions should be given pre-, peri- and post-disaster periods to improve the adverse mental effect of the victims. Also, Navial et al., (2019) conducted a systematic review to identify the effect of post-natural disaster on the survivors' soul health. The authors found that the psychological impact experienced by victims after natural disaster events are

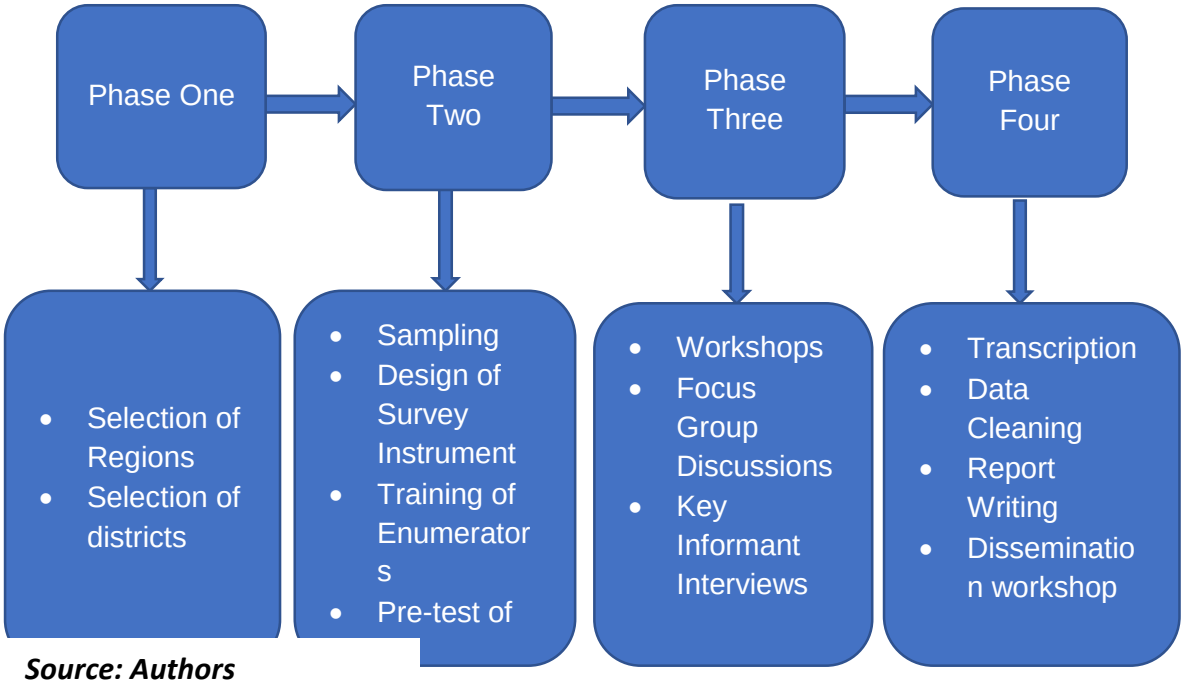
depression, post-traumatic stress disorder (PTSD), fear, suicide experiments, and other mental health disorders such as mood changes and a loss of interest in an activity. Natural disasters can hurt the mental health of the victims.

Telemedicine has now become critical in the provision of healthcare to victims of disaster. Fire personnel, Red cross and the military have technologies that enable them to communicate to provide emergency medical care to victims of a disaster. Scholars have argued that that deployment of telemedicine in crisis and disaster situation help provide medical relief to victims and increases their chances of survival (Nejadshafiee et al, 2020). Nejadshafiee et al., (2020) concluded that disasters and incidents are an increasing cause of crises in Iran and other countries all over the world. The integration and application of communication and information technologies in disaster management may not prevent disasters but offer a significant tool for responding to them for the public good.

4. Research Methodology

A primary field research approach was employed in the study to collect data for analysis. The study was carried out using a four-phased sequential approach. Phase one of the study details the selection of regions and districts. Phase two focused on the selection of participants, design of data collection instrument, training of enumerators and piloting of survey instrument. The third phase was devoted to Workshops, Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). The final phase of the study concentrated on transcription, cleaning of data, report writing and dissemination workshop. (See Figure 4.1)

Figure 3: The four-phased approach to implementing the study



Source: Authors

4.1 Selection of Regions and Districts

Ghana has sixteen administrative regions. The entire country can be classified into three broad categories, the southern, middle and northern belts (Sarfo & Karuppannan, 2020). This study was focused on the middle and southern belt of the country because most COVID-19 cases in Ghana were recorded in this part of the country. The Central and Eastern regions were chosen to represent the southern and middle belts respectively because some districts within these regions have had some telemedicine interventions. This will allow participants to come out with evidenced-based challenges of the telemedicine ecosystem. In addition, these regions have a lot of rural communities and most people that live in these communities are vulnerable (Ghana Statistical Service (GSS), 2014). Greater Accra was also included in the study because it is the seat of Government and most institutional headquarters including the GHS, Chamber of Telecommunication and NHIA are located in this region. Specifically, KIIs were conducted in the Greater Accra Region. Six districts were randomly selected from the Central and Eastern regions, (i.e., three districts from each region). Selected districts in the Central regions include Gomoa West, Assin North and Twifo Attimorkwa districts whiles Akwapim South, Asuojaman and Upper Manya Krobo districts were selected in the Eastern region. Two districts, one from each region (i.e., Gomoa West and Upper Manya Krobo from central and Eastern regions, respectively) have had some telemedicine interventions.

4.2 Sample and Data Description

A qualitative research design was employed focusing on the telemedicine ecosystem of Ghana. This allowed for realistic accounts on the use of telemedicine and an objective view on the challenges of the telemedicine ecosystem in Ghana. Primary data was obtained through one-on-one interviews with sixty-three (63) relevant stakeholders from Ghana Health Service, Ministry of Health, Ministry of Communication, telecommunication companies, NHIA, Private Mobile Health (mHealth) companies, Health NGOs, telemedicine pilot communities and vulnerable communities.

4.2.1 Instrument Design and Pre-test

A semi-structured interview guide was designed based on insight from the literature review to help in gathering data from respondents. The interview guide is in three parts. The first and second parts have questions that are centered on telemedicine and technology ecosystem; they focused on respondents from the health sector, telecommunication sector and other key informants, while part three have questions that targeted community members especially the vulnerable groups.

Two essential components of the pre-test that must be carried out before the real fieldwork are testing the methodology of data collection and evaluating the flow of the questionnaires. The clarity of the questions posed should be taken into account when constructing questionnaires. This is vital to reduce or completely eliminate field issues and lessen the burden on respondents. The questionnaires were pre-tested before the primary fieldwork, this provided important information about the workload of interviewers and respondents. The pre-test exercise also functioned as a practical training session for the four enumerators who eventually gathered the study data.

4.2.2 Workshops

Two separate workshops were held (i.e., inception and community workshops). The inception workshop was held from the 8th – 9th April 2022 at Akosombo in the Eastern region. Participants of the inception workshop were regional and district health directors. Even though these participants are not involved in the direct provision of medical services to patients, they were included in the workshop because they are responsible for health promotion and implementation of clinical and public health interventions in the districts and regions. They expressed their knowledge on telemedicine and how it has been diffused especially to the vulnerable groups in Ghana in their respective districts and regions.

The community workshop took place on the 12th – 13th April 2022 at Twifo Praso in the Central region of Ghana with vulnerable community members, opinion leaders, over-the-counter medicine sellers within the community and local medicine sellers. This group shared their views on their access to healthcare delivery and the challenges they faced to access healthcare services, prevalent diseases in the community and the kind of services telemedicine should focus on. Participants of both the inception and community workshops were interviewed after the workshop.

4.2.3 Focus Group Discussions (FGDs)

There were two separate FDGs made up of ten (10) participants each in two districts (i.e., Gomoa West and Upper Manya Krobo districts). These two districts were selected because they have had some piloted telemedicine intervention in the past. Participants from these districts shared their experiences, highlighted the challenges of the system, and suggested possible solutions to address the challenges before implementing another telemedicine interventions. The participants of the FGDs included physicians, nurses, disease control officers, professionals within the health facilities, and community health volunteers.

4.2.4 Key Informant Interviews (KIIs)

One-on-one KIIs were held with senior staff of the NHIA, Ministry of Communications, Health NGOs, telecommunications companies, FinTech organizations, and private mobile insurance companies. Interviews were conducted at their workplaces and some were also conducted via Zoom due to the busy schedules of some respondents.

4.3 Data Collection

As stated above, respondents of the study are staff from Ghana Health Service, Ministry of Health, Ministry of Communication, telecommunication companies, National Health Insurance Authority, private mobile health (mHealth) companies, Health NGOs and people from communities which received previous telemedicine intervention previous, vulnerable community members (children, women, the poor, and the elderly). To ensure the pursuance of the fundamental line of enquiry, a semi-structured questionnaire was used and inputs were also offered during the interviews to ensure the dialogue moved forward. Each interview session lasted between 10 and 30 minutes and was conducted in English and Twi, which is the widely spoken local language in Ghana. All the recognized stakeholders consented to the interview and the field data collection lasted for two months. Data collection started on 8th April and ended on 31st May, 2022.

4.3.1 Model and Analysis Technique

Audio recorders were used to record the qualitative interviews. The recorded interviews were transcribed and evaluated by experts. A codebook was then created to keep participants anonymous and minimize their individual biases. Codes were given to regions, districts and each respondent. The data was grouped into themes using the conceptual aspect of the interview guide and the themes emerging from the data to allow for thematic analysis. The results of the study were presented in themes, and relevant and direct quotes were also used to support each theme, where necessary.

4.4 Dissemination Workshop

The findings of the study were presented in a dissemination workshop. This allowed stakeholders to make additional inputs for further enhancement of the research findings.

The dissemination workshop was held in Cape Coast in the central region of Ghana. The workshop allowed stakeholders to validate the report and make additional inputs to further enhance the research findings. Participants of the dissemination workshop were district and regional health directors, some players in the telecommunication industry, members of health NGOs, community members and the media. The findings of the study were presented, and participants were asked to provide input and ask questions. Below are some of the statements made by the participants at the dissemination workshop:

"…*The findings are quite elaborate and informative, but I am foreseeing staff commitment as a challenge; because health officials engaged in telemedicine delivery may want additional remuneration for the additional responsibilities that come with telemedicine."* (Participant 001)

"The authorities at the health facilities should identify staffs who are committed to work and train them to be in charge of telemedicine. This will ensure that there is always someone to provide care via telemedicine." (Participant 006)

"The district assembly and other opinion leaders should be involved in the implementation of telemedicine. They will then disseminate the information and help community members understand and use telemedicine services." (Participant 016)

Participants in the workshop already engaged in sub-group discussions on how telemedicine can be leveraged to solve their district's specific challenges, like teenage pregnancy, which is increasing, and the delivery of HIV treatments and medications. Other teams in the workshop highlighted the potential of piloting and evaluating telemedicine for antenatal care for pregnant women. Overall, stakeholders highlighted the potential benefits of telemedicne and indicated their preparedness to collaborate and pilot some of such innovations in the districts in the future. Concerns were, however, raised regarding funding sources for such pilots.

5. Results Table

Emerging themes from the data were grouped into two categories. The first category includes themes that responded to the objectives of the study (i.e., the state of the telemedicine and telecommunication ecosystem, how telemedicine has been diffused to the vulnerable groups, how telemedicine was leveraged to improve resilience during the COVID-19 pandemic, and challenges and success of expanding access to telemedicine in Ghana). The second category deals with other themes that emerged which are not directly related to the objectives of the study, but for which the policy actors think telemedicine can be leveraged to address other prevalent diseases such as malaria, typhoid fever, diarrhoea, dysentery, cholera buruli ulcer, HIV, and syphilis in Ghana. The main themes from the two categories were further grouped into sub themes. Table 5.1 presents the various themes that emerged from the study.

Table 1. Themes that Emerged from the Data

Categories	Main themes	Sub themes
Relating to the main study objectives	The state of the telecommunication and telemedicine ecosystems	• Status of Ghana's telemedicine ecosystem • Status of Ghana's telecommunication sector
	Mode of diffusing telemedicine to the vulnerable group	• Voice calls • Video calls • Pre-recorded voicemails in the local dialects • Community sensitization • Opinion leaders
	How the telemedicine ecosystem has been leveraged to improve resilience to pandemics, epidemics, and natural disasters.	The telemedicine ecosystem and COVID-19 pandemic
	Challenges and successes of expanding access to telemedicine	Success factors • Digital penetration • Trust • Convenience • Structure of the country Challenges • Poor network (road and telecommunication) and infrastructure deficit • Low ICT literacy and low capacity of healthcare professionals • Financial constraints
Other themes not relating to the main objectives of the study	Prevalent disease in Ghana	• Malaria • Tuberculosis • Typhoid fever • Diarrhoea • Cholera • High mortality rate • Malnutrition • Anaemia • High blood pressure and diabetes • HIV-AIDS and kidney-related diseases • Teenage pregnancy
	Focal areas for upscaling telemedicine	• Emergency services • Antenatal services and child health

		• OPD consultations • Tuberculosis • Tropical disease (malaria)
	Sources of financing telemedicine	• Government • NGOs and philanthropists • Collaboration among stakeholders

Source: Authors

5.1 The state of the telemedicine and telecommunication ecosystem in Ghana.

5.1.1 The telemedicine ecosystem in Ghana

The telemedicine ecosystem in Ghana is in its infant stage despite the fact that some telemedicine interventions have been piloted in the country. Some patients informally call healthcare professional when they have medical challenges to seek clarification. Similarly, some healthcare professionals use various digital means to make enquiries and seek clarifications from their superiors and experts in the medical field. However, there is no official structure of telemedicine in the country. Almost all participants agreed that there is no clearly defined structure for telemedicine in Ghana even though it has been piloted in some districts.

"To the best of my knowledge, I know telemedicine is a driving area, an area with a lot of opportunities. Ghana Health Service has been piloting different telemedicine models for some time, but it has not been very successful. We started talking about telemedicine when I was a medical officer in the consulting room. Now, I am more into public health and still, we are not there yet. There are some challenges that need to be addressed." (Respondent, DR001)

"Telemedicine ecosystem in Ghana, I think we have had some being piloted in some part of the Country but the issue has been sustainability. The training and the piloting will be perfectly done however, sustainability in the areas of service delivery and the will to do has been the challenge over the years. Right now, we don't have them; I don't think we have them working in Ghana here." (Respondent, DR003)

Although some healthcare professionals reached out to experts to seek their advice and clarifications using digital means, the actions were done using their personal electronic devices at their own cost. Infrastructure challenges are associated with the telemedicine ecosystem in Ghana. Respondents were unanimous in the state of infrastructure in the telemedicine ecosystem in Ghana.

"… It was a piece of welcoming news but it has its issues, in terms of sustainability. Right from the onset, the enthusiasm was very high but challenges such as infrastructure, logistics, and commitment affected the smooth implementation of telemedicine in the piloted facilities." Respondent, DR004)

"We need to make the infrastructure available. We need to get clear billing or payment structure; we should be able to get these things done." (Respondent, DR001)

The telemedicine ecosystem in Ghana is not different from other SSA countries, and this is the belief of most of the participants. Below are some respond from participants:

"If it is SSA then Ghana is not an exception, I think it will cut across." (Respondent, DR004)

"In one of our workshops (telemedicine train-the-trainers), Uganda and Liberia came to learn from us in terms of telemedicine. So, I think something may be happening somewhere which is not too different from that of Ghana which we may not be aware." (Respondent, DR003)

"The telemedicine ecosystem in Ghana might be similar to other SSA countries." (Respondent, DR005)

5.1.2 Telecommunication ecosystem in Ghana

The telecommunication ecosystem in Ghana has witnessed some progress over the years. There is mobile network connectivity in every district capital in the country. Voice calls can be made without any hindrance in those communities. However, there are still places in the country, most especially the rural areas where there is no network connectivity at all or there is poor network coverage. In these communities, where even making a normal voice call is a challenge, accessing the Internet is non-existent.

"For us as a country now, in all the district capitals, MTN and Vodafone have 4G facilities in those places. For all the others, Airteltigo, and Glo in addition, will be able to provide 3G. So, there is 4G penetration now fairly spread throughout the country. But then there is a pocket of those who are underserved, and unserved." (Respondent CM001)

"In terms of technology generations, Ghana currently is having the 4G and it is better than the 2G and 3G." (Respondent FN001)

"The telecommunication industry is very interesting and is changing in a very fast space. I think the way the industry is, there will be some consolidation because a lot of the players are not making money." (Respondent CM001)

Notwithstanding the progress made in the telecommunication industry, the sector is faced with challenges that prevent the smooth operation and provision of service. The challenges range from input cost to laws and regulations, and attitudes of citizens. The cost of investment required to extend telecommunication service is huge, hence the service providers do not extended services to communities where they are less likely to recoup their investment. Participants from the telecommunication industry agreed that the laws and regulations pertaining to the sector are not favorable and more taxes have been imposed on the sector. Also, the attitudes of contractors affect the industry significantly. Where there is road construction, a lot of optical fibers are cut which create connectivity challenge.

"The input cost itself; in our systems, policymakers, and the government will sell the spectrum at a very high cost. 4G was sold to MTN some number of years ago at 67

million for 2 by 10, while the same 2 by 10 is sold in Tanzania, a market bigger than ours by about 20 million. When 4G was sold to Vodafone some years after MTN, they sold 2 by 5 to them, it was sold at 30 million." (Respondent CM001)

"Another challenge that bedevils the industry: so, when the infrastructure has been set up, now the major challenge is the issue of a fiber cut. Where people are constructing roads, drains, and building fuel stations - the optical fiber that is laid, they are cutting them." (Respondent CM001)

5.2 How telemedicine has been diffused to the vulnerable

The vulnerable in society have mostly experienced telemedicine services through voice calls. From the FGDs that were held in districts where there has been some form of telemedicine intervention, participants put across that the telemedicine that was piloted in their districts used a voice call system.

"We had a telemedicine pilot in 2018 where the regional hospital was made the telemedicine health center. If there are challenges in the lower facilities, the staff of these facilities call the telemedicine dedicated numbers and they are linked to a specialist to assist." (Respondent CT034)

"There was an NGO that was piloting telemedicine in this district, we went for a workshop on that and started practicing it. Each staff was assigned to a one-hour duty to receive calls and attend to clients on the telemedicine platform." (Respondent CT019)

"There was a child that was running temperature in my house and I had to call a nurse and we were given instructions on what to do before taking the child to the hospital." (Respondent CT020)

"*Some of the community members have contact with the health workers. If they are not feeling well, they sometimes call the health workers on what to do before going to the hospital."* (Respondent CT020)

In addition to voice calls, participants suggested other means through which telemedicine can be diffused to the vulnerable. Most of the suggestions centred on community sensitization, pre-recorded voicemails in the local dialect and the use of WhatsApp platforms.

"…phone calls will do in some communities. For others we can use videos call and also create a WhatsApp platform for information dissemination." (Respondent, DR003)

"…voicemail will help because most people use that." (Respondent, HI001)

"There should be education and sensitization of the patients on both telemedicine and the use of technology itself. The healthcare providers should also be educated on the use of technology to enhance the success of telemedicine." (Respondent, HI002)

5.3 How the telemedicine ecosystem been leveraged to improve resilience to the COVID-19 pandemic

During the COVID-19 pandemic, movement restrictions (lockdown) were imposed in Ghana to curb the spread of the virus. Visits to health facilities reduced due to the lockdown and also due to the fear of contracting the virus at the hospitals. Even though telemedicine was not formally in place, people used various digital means to address their health challenges and seek clarifications with regards to some symptoms they were feeling. Some participants shared their experiences with regards to the use of telemedicine during the COVID-19 pandemic.

"COVID-19 came and we all saw what happened. People could not go to the hospitals. Not that people could not go, but access to certain health facilities was restricted because of the pandemic, so stay home." (Respondent, CM001)

"During COVID-19 there was a friend of mine who was experiencing some symptoms so I called the nurse and she asked that we come to the clinic. However, when we got to the clinic and he was examined, it was something else and not COVID-19." (Respondent, CT020)

"… I receive calls from people about their health issues, and also during COVID-19 people called with various symptoms and I had to direct them to go to the clinic for testing." (Respondent, CT021)

"I had an experience during COVID-19 where I called to sort out for advice. During the COVID-19 period, being an opinion leader, I use to visit people and when I see symptoms of disease, I sometimes call the medical to seek their advice." (Respondent, CT003)

"… during COVID-19 I also received calls from clients about some symptoms they are feeling." (Respondent, CT019)

"During COVID-19, people called me for education on the prevention protocols." (Respondent, CT022)

In addition, participants were of the view that COVID-19 reiterated the need for a telemedicine ecosystem in Ghana. They believed that if the telemedicine ecosystem was fully functional in Ghana, it could have helped to reduce the spread of the virus and also the workload on the medical professional at the time. Below are what some participants had to say:

"The restrictions of movement during COVID-19; if we had telemedicine functioning across all, you will only need to communicate your signs and symptoms to the health provider and they can easily attend to you without you having to go all the way. Telemedicine will also help to reduce the pressures on the health system." (Respondent, DR003)

"… then also COVID-19 hit us and it exacerbated the need for us to deploy telemedicine because then, coming to the hospital was a place nobody wanted to

come. You are afraid that if you have some condition, you will go and pick some COVID-19." (Respondent, CM001)

"If we had telemedicine, a lot of people wouldn't have died during the COVID-19 pandemic because I can easily speak to my tele-doctor on what to do and it would have helped." (Respondent, HI003)

"It is very important during periods of pandemics. If telemedicine had already been established very well in Ghana, we wouldn't have had health issues during this COVID-19, when the health-seeking behavior of people was very low. People were not willing to go to the health facilities for fear of contracting COVID-19. If telemedicine was in place, people in their comfort zones, the health professionals can be doing teleconsultation that could have helped." (Respondent, DR004)

"… if not anything, telemedicine has offered an opportunity to triage the patients amid a pandemic where everyone is supposed to stay away." (Respondent, DR001)

5.4 Success Factors and Challenges for Implementing Telemedicine

5.4.1 Success Factors for Implementing Telemedicine

The benefits of telemedicine are abound especially to the vulnerable communities who have challenges with regards to access to quality healthcare. This then intensifies the need to establish such a system in our communities. Telemedicine rides on the backbone of certain factors to thrive. Respondents provided responses that certain existing factors in Ghana will help in the successful implementation of telemedicine. Some of these factors include but are not limited to the structure of the country, digital penetration, trust and convenience. Below are some responses by some respondents to the question (***What do you consider to be the main critical success factors for the delivery of a telemedicine ecosystem to the vulnerable in society****?)*

"I think the biggest factor is the fact that we have increased digital penetration in the country. I mean, now almost every corner you go people have access to a telephone, and in many places, you don't need to climb a tree before you can make a call even though we have some gray areas. Generally, the fact that the digital penetration is relatively good is an opportunity to do more." (Respondent, DR001)

"I think that the way we are structured as a country itself, the availability of recourses, and the distribution of the resources, make it imperative for telemedicine to occur. Because we have medical resources situated at the center and the people at the periphery do not have access to it. The only way you will be able to get a more equitable distribution (rather than allowing people to travel long distances and come) is to be able to use telemedicine." (Respondent, CM001)

"When the community members trust you and you can protect your message well, they would buy into it. Once the message is bought into, then whatever you want them to do, they will do it. … if you don't handle the information well for which you have collected information; the next time when you want it, the person might feel very reluctant." (Respondent, DR002)

"*… the issue of trust is very high in my community and it will help telemedicine to thrive." (*Respondent, HI002)

5.4.2 Challenges of the telemedicine Ecosystem of Ghana

Despite the increase in digital penetration in the country, there are still a number of challenges in the telemedicine ecosystem that may hinder the smooth and sustainable delivery of healthcare through telemedicine. Poor road and telecommunications network, infrastructure deficit, low capacity of healthcare professional, ICT illiteracy of community members, and financial constraints. Below are some responses to the question (***What are the (potential) challenges involved in the establishment a telemedicine ecosystem?):***

"In my community, the main challenge is network connectivity and the high illiteracy rate if the people in the community get the education about telemedicine and a good network, they will be no issues with it being initiated … the availability of the hardware, not just availability, but its maintenance to be consistent." (Respondent, CT033)

"*Telecommunication network is number one and the inability of the nurses to operate telemedicine is another."* (Respondent, CT047)

"The Internet connectivity is one, the availability of the logistics for efficient telemedicine, the financial implication. Sometimes, for staff who needed to make certain calls, the question is who pays for the calls. … The infrastructure as well, ideally, once it's a system set up, I should be given a phone or tablet for that work. In the same way." (Respondent, DR001)

"One of the challenges will be our knowledge and experience level of using resources within to develop." (Respondent, DR003)

"The equipment, the infrastructure, the capacity of the personnel involved, Internet accessibility and the engagement aspect are all potential threats that if not handled very well will affect the smooth implementation of the telemedicine ecosystem." (Respondent, DR004)

5.5 Prevalent Disease in Ghana

Similar to other SSA countries, Ghana faces some chronic and tropical diseases, which includes malaria, tuberculosis, high blood pressure diabetes, HIV, kidney-related diseases, malnutrition and teenage pregnancy. On the topic of teenage pregnancy, participants from the various communities were unanimous that it is a major problem that need to be addressed. Over the years, GHS has taken key initiatives through education, awareness creation and other clinical measures to reduce these diseases. Participants in the FGDs mentioned some diseases that are prevalent in their respective communities within the districts and the measures adopted to reduce or eliminate them.

According to one participant, the leading health challenges in the community, especially among the school children are malaria, eyesight diseases, and malnutrition. She went on to say that malnutrition has gained ground in the society in recent times and though malaria treatment is at the heart of the district health directorate, the problem still persists. This notwithstanding, the district health directorate have implemented measures to address these challenges. The participant further narrated that a meeting was held to address the malnutrition problem. Participants of the meeting were headmasters of schools, representatives of the district health directorate and school feeding program. During the meeting, a call was made on headmasters of schools to hold parent-teacher association meetings to advise parents on foods children should eat. Also, the district nutritionist admonished that health education on the proper diet for children should be planned and executed. For eyesight disease, young people in the community are constantly given medicated eyeglasses to address some eye disorders. Insecticide treated nets are given to community member especially pregnant women to help address the malaria issues.

Another participant also noted that diabetes, high blood pressure and eyesight diseases are the leading health problems she has witnessed. She said health equipment to facilitate health delivery is also limited in most of the health centers in the area. She added that teenage pregnancy is rampant in the community. According to her, talks have been organized in schools within the districts to create awareness and educate the youth on the consequences of teenage pregnancy and HIV-AIDS. Again, the queen-mother calls for community durbar (A traditional woman leader sit in state and meet community members) to engage the people on personal and community hygiene. They are also educated to practice abstinence and protective sex.

On the issue of tuberculosis, a participant said that health personnel engage the families of the patients and advises them to accept the treatment for the tuberculosis and HIV. Patients are also advised and motivated to ignore any stigmatization and seek treatment.

5.6 Focal areas for upscaling telemedicine

As stated above, some diseases are prevalent in Ghana which cause health challenges for most people. GHS in collaboration with the regional and district health directorate over the years have put measures in place (i.e., creating awareness and educating the public) to reduce some of these conditions. Some respondents outlined certain diseases and health conditions that a telemedicine intervention in their communities could focus on. About 80 percent of the respondents stated that a telemedicine intervention should focus on emergency services. Additionally, respondents suggested that a telemedicine intervention should consider antenatal and child health services, OPD consultations, tuberculosis, malaria and teenage pregnancy. Some respondents were also of the view that a telemedicine system should be able to provide feedback.

“Telemedicine can be used for emergencies and things that are beyond the level of whoever the client is seeing … if somebody collapses, if a pregnant woman is bleeding, if a pregnant woman is convulsing you can use it. You are attending to

someone; you realize the condition has changed and you need to make a call for information, you can use telemedicine." (Respondent, DR005)

"I think the child health care, maternity, children under five years because such issues are more reported in my community. Also, malaria and TB should be added." (Respondent, CT033)

"In my community, teenage pregnancy is high. … I think telemedicine should focus on teenage pregnancy." (Respondent, DR002)

*"Maternal and child health, management of cases like snake bites, scorpions' bites. We have a lot of those cases here. All other conditions are inclusive I think health is holistic so, every aspect." (*Respondent, DR009)

"… the referral system: the referral system should have a feedback system all through the application." (Respondent, DR004)

5.7 Sources of financing telemedicine

The source of financing a telemedicine intervention is key because it has an impact on the implementation, the smooth running and the sustainability of the system. Some respondents believed that the workforce or human resource of a country is a function of the health status of the citizens. Therefore, it is the responsibility of government to ensure that citizens have access to quality healthcare. They were of the view that the government should finance the telemedicine to ensure that all citizens have access.

"It has to start with the government, government will have to play a major role." (Respondent, CM001)

"I would have wished the government steps in because if they don't step in along the line, we may have issues with sustainability." (Respondent, DR004)

"The government has to come in; if NGOs are ready to take up the space and provided everything, that will be ok." (Respondent, DR009)

"I believe that we need to talk about sustainability. Which means we should fund it ourselves. If somebody funds it for you how long can that person fund you?" (Respondent, DR001)

Even though some respondents support the government's role to finance telemedicine to ensure sustainability, others are of the view that government has a lot of priorities which are yet to be completed. So, adding another priority may mean that it will not materialize, and even if it manages to implement it, sustainability will be a challenge.

"…Government is not ready because there are no funds and there are other things they are doing that are not fully completed yet. So, with this one, the health facility itself through the CHPS compound, within the community should take it up. They can generate a way through soliciting so that they can do it but for the government, am sorry." (Respondent, HN001)

"This should be the responsibility of the government, but now so many things are happening; so, if we solely depend on the government for it, sustainability will be a big issue. If there is a partnership among NGOs, health partners, and donors that one can help." (Respondent, DR003)

Also, some respondents were of the view that NGOs, philanthropists, and/or a collaboration among stakeholders should be the source of financing a telemedicine intervention.

"Though I expect the government to pay, I think everyone should be ready to pay except the vulnerable group who cannot pay. I expect partners who can support should come in. Sincerely about 60% of our people cannot pay for telemedicine." (Respondent, DR007)

"*I think it is the major role of the government, district Assemblies vis-a-vis philanthropist."* (Respondent, CT003)

"*The government, the NGOs, and donor partners.*" (Respondent, HI003)

There is the general question of who bears the financial charges on the calls that are made on a telemedicine platform. Some respondents suggested that if a telemedicine system is setup, then whatever equipment that is required for the system to operate must be made available. Also, there should be toll-free calls implemented so that healthcare professionals would not have to use their personal devices and resources to provide services to clients on a telemedicine platform. Below are what some respondents had to say:

"… now am using my phone but if we are doing telemedicine, I don't need to use my phone. Ideally, once it's a system set up, I should be given a phone or tablet for that work." (Respondent, DR001)

"In the implementation of telemedicine, please consider the cost of making the call. It will help if the calls are toll-free." (Respondent, CT022)

"… also be a challenge if there can be a toll-free system it will help." (Respondent, CT030)

6. Discussions

6.1 The Telemedicine and Telecommunication Ecosystem of Ghana

In the study by Babalola et al., (2021) telemedicine in SSA was observed to be in its early stage; while results from the study indicate that telemedicine is not well grounded in Ghana. Although some patients and healthcare professionals use various technological means to access information with regards to health issues, most of them do not understand the concept of telemedicine, nor of its existence. Respondents in this study informed us that the telemedicine ecosystem in Ghana is not well developed

as there is no clear outline or structure in place for the delivery of healthcare service through telemedicine. This could be as a result of the lack of a national policy framework on telemedicine, as observed by Isabalija et al. (2011) in Uganda that in addition to other factors, the adoption of telemedicine is hindered by the lack of telemedicine policy. Similarly, Sani (2020) and Wamala and Augustin (2013) noted in Nigeria and Burkina Faso that the lack of political will has prevented telemedicine from receiving the necessary recognition and support. The case could not be too different in Ghana as the healthcare system in Ghana is similar to other countries in SSA. Again, telemedicine in Ghana is not well grounded and has not received the necessary attention due to inadequate sensitization of the public. We also observed that there is a lack of awareness of telemedicine in the communities that benefited from the telemedicine pilots in the past.

This corroborates with the findings of Bradford et al. (2015) who found that despite use of telehealth services, participants were still not aware of the concept and its existence.

The effective utilization of telemedicine relies on the backbone of a good telecommunication system. Although all district capitals in Ghana have network connectivity, most communities especially in rural areas have connectivity challenges. This hinders the delivery of quality healthcare services through a telemedicine platform (Shiferaw & Zoloft, 2012; Wamala & Augustine, 2013; Bali, 2018). The study results indicate that the telecommunications companies are not able to provide quality of service and also extend services to rural communities due to the huge cost of investment and the government's regulatory framework (Perkins, 2018).

6.2 Factors and Challenges of Implementing Telemedicine

To aid the upscaling of telemedicine in Ghana and facilitate the sustainable adoption of telemedicine in SSA, the study sought to understand the success factors and the challenges that hinder the adoption of telemedicine. Results indicated that digital penetration, the structure of the country, trust and the convenience associated with the use of telemedicine are the linchpin on which telemedicine can rely on to be successful in Ghana. As observered by Benis et al. (2021), some people patronized telemedicine services during COVID-19 because of their comfort level in the use of common web-based tool, the reduction in queuing time and the convenience in terms of time-saving. Similarly, Haleem et al. (2021) argued that telemedicine helps to eliminate distance limitation to accessing quality healthcare and ensure every citizen has equal access to healthcare. Despite the increase in the use of electronic devices in Ghana, most people especially those in rural communities are handicapped in the use of these technological devices (Ajuwon & Rhine 2008; Shiferaw & Zoloft, 2012). This hinders the utilization of telemedicine platform for healthcare delivery (Triana, 2020). Also, the structure of the country is such that resources are situated at the urban centers, and this deprives the rural communities access to quality healthcare services hence exacerbate the need for telemedicine.

The telemedicine ecosystem in Ghana is challenged by some factors. The study found infrastructure deficit, ICT illiteracy of community members, financial constraints, inadequate technical know-how on the part of the healthcare professionals coupled with poor road and telecommunication network as the challenges of the Ghana's

telemedicine ecosystem. These challenges create a gap in the healthcare delivery system. As noted by some scholars, inadequate ICT infrastructure, the high cost of initial ICT infrastructure set up and low Internet connectivity impedes the deployment of telemedicine in Africa (Wamala & Augustine, 2013; Bali, 2018; Sani, 2020). Additionally, some healthcare professionals at the lower level lack the required technical knowledge to utilize the telemedicine system in healthcare delivery (Ajuwon & Rhine, 2008; Isabalija et al., 2011; Sagaro & Amenta, 2020). To successfully implement telemedicine, there is the need to improve on the network connectivity, invest in roads (Bali, 2018) and train healthcare professionals on the use of digital infrastructure. This will ensure that the telemedicine system delivers quality health service.

6.3 Diffusion of telemedicine and COVID-19 pandemic

Although telemedicine is not well grounded in Ghana, both healthcare professionals and their patients resorted to telemedicine during the COVID-19 pandemic. This was as a result of the movement restrictions that were imposed to curb the spread of the virus. The study results show that some participants used various digital platforms to access healthcare in the periods of the COVID-19 pandemic. This result corroborated the finding of some scholars who noted that telemedicine was the first line of call for healthcare delivery amidst the COVID-19 pandemic to slow the spread of the virus (Vidal-Alaball et al., 2020; Monaghesh & Hajizadeh, 2020; Kichloo et al., 2020). The result further indicates that telemedicine should be integrated into the healthcare system of Ghana to ensure that the rural dwellers have access to quality healthcare.

The study also sought to find the mode of diffusion of telemedicine services to the vulnerable group. Results indicate that making voice calls was the most used means of extending telemedicine services to the vulnerable communities. This could be due to the inadequate knowledge on the use of advanced electronic devices and the poor Internet connectivity in most vulnerable communities to support video services. As found by Bali (2018), low ICT literacy among the population of developing countries serves as a barrier and hiders the utilization of telemedicine in these countries.

6.4 Financing Telemedicine

One major factor that help the implementation of telemedicine is the source of funds. Without financial support telemedicine cannot thrive. For instance, the infrastructure, the equipment and other aspects that need to be put in place for the success of telemedicine require financial investment. One question of major concern is who should finance telemedicine. Findings from the study pointed out government, NGOs, philanthropist as the sources from which funds can be accessed for a telemedicine intervention. This however contradicts the findings of Tchao et al. (2019) who concluded that some telemedicine interventions in Ghana were not successful due to lack of fund and little government support. The results further indicated that stakeholders should collaborate to finance telemedicine to ensure the sustainability of

the system. Contrary to this finding, scholars found that most telemedicine projects are financed by NGOs and international development organizations (Tchao et al., 2019; Willcox et al, 2019; Dodoo, 2021; Afarikumah, 2014).

7. Conclusion and Recommendations

The general findings of the study suggest that the telemedicine ecosystem is faced with challenges that hinders the deployment of telemedicine. These challenges are poor telecommunication and road networks, infrastructure deficit, low ICT capacity of healthcare professionals, ICT illiteracy of community members, and financial constraints. The most prominent among these challenges is the poor communication network connectivity. However, with digital penetration in the country and if these highlighted challenges are addressed, it will help in the successful implementation of a telemedicine policy. In conclusion, telemedicine is an efficient tool for the delivery of healthcare especially to the marginal community and should be integrated in the healthcare system of Ghana to supplement the quality service delivery.

Based on the research findings the study proffers the following recommendations for policy action:

- Healthcare policymakers should constantly collaborate with academia to undertake evidence-based studies to support healthcare policy making in Ghana.

- A national telemedicine policy should be developed in consultation with stakeholders to aid in the implementation of a telemedicine.

- Healthcare professionals and community members should be sensitized on the need to mainstream telemedicine into the healthcare delivery system.

- Government should work with the telecommunication companies to address outstanding inefficiencies such as poor communication networks.

- GHS is entreated to consult, design and implement appropriate training modules on telemedicine to build the capacity of healthcare professionals.

- Government should work with the telecommunication companies to implement a toll-free system for telemedicine related services.

- Ghana Investment Funds for Electronic Communication (GIFEC) should expedite action to ensure that telecommunication services are extended to rural communities to support the adoption of telemedicine.

- The GHS through district health directorates should work with the National Communications Authority (NCA) to organize ICT clinics to enhance ICT literacy in rural communities.

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9. Appendices

Interview Guide

Interview Checklist for Stakeholders (NGOs, technology companies, health directors, health professional, district chief executives etc.)

The qualitative instrument elicits more in-depth responses on the telemedicine ecosystem in Ghana and Sub-Saharan Africa (SSA)

Note: Telemedicine broadly refers to the remote diagnosis and treatment of patients by means of telecommunications technology.

The state of telemedicine ecosystem in Ghana and SSA

1. How would you describe the telemedicine ecosystem in Ghana and SSA? (Probe for pilots etc).
2. In your opinion, how important is a telemedicine ecosystem to the vulnerable? (Probe for potential positive and negative consequences)
3. In your opinion, what do you consider to be the main critical success factors for the establishment of a telemedicine ecosystem for the vulnerable in society?

    - Clear strategic direction
    - Health delivery culture transformation
    - Development of technological capability and/or know-how
    - Appropriate infrastructure
    - Etc.

Diffusion of telemedicine to vulnerable groups

4. What is/are the mode(s) of diffusion of telemedicine to vulnerable groups in society?
5. What is/are the mode(s) of diffusion of your telemedicine products and/or services to vulnerable groups in Ghana?
6. What are the (potential) challenges involved in a telemedicine enabled healthcare delivery system?

Improving resilience with telemedicine

7. How can telemedicine be used to improve resilience in healthcare delivery during pandemics and epidemics?
8. How should the implementation of a telemedicine ecosystem be approached during pandemics and epidemics?
9. How time critical is the implementation of a telemedicine ecosystem before, during and after pandemics and epidemics?

Challenges and successes involved in expanding telemedicine

10. How accessible is telemedicine in vulnerable communities?

11. What do you consider to be the main critical success factors for the delivery of a telemedicine ecosystem to the vulnerable in society?
    - Trust
    - Convenience
    - Access to affordable healthcare delivery services
    - Transport cost is eliminated
    - Data Privacy
    - Loyalty benefits to the NGOs
12. What are the (potential) challenges involved in the establishment of a telemedicine ecosystem?
13. Who do you think will lead the development of the telemedicine ecosystem in vulnerable communities?
    - Big tech companies
    - Digital healthcare start-ups
    - Pharma
    - Telemedicine providers
    - Private insurers
    - Meditech
    - Government
    - Online Pharmacies

14. In your opinion, how should the telemedicine ecosystem be designed to be effective and what services should be the focus of the for telemedicine ecosystem for your community?
15. what would be your preferred sourcing model for a telemedicine ecosystem?

Interview Checklist for technological aspect of telemedicine

The qualitative instrument elicits more in-depth responses on the telemedicine ecosystem in Ghana and Sub-Saharan Africa (SSA)
Note: Telemedicine broadly refers to the remote diagnosis and treatment of patients by means of telecommunications technology.

1. What is the current status of the technological aspects (e.g., broadband infrastructure, connectivity, interaction design, functioning of audio and video services) of telemedicine?
2. What are the challenges with building the telemedicine ecosystem in Ghana from the technological perspectives?
3. What are the key factors for implementing telemedicine in Ghana?
4. How have the human dimensions of the technology use been considered when designing telemedicine solutions?
5. Do you have some good technological solutions to address users' privacy and security concerns with telemedicine?

Interview Checklist for community actors

Knowledge of the telemedicine ecosystem in Ghana and SSA

1. Is there a telemedicine system in place in your community and district? (Probe for history of telemedicine for vulnerable groups including persons with disabilities, refugees, pregnant women, people with mental disorders etc.
2. Have you ever called or interacted with a health practitioner on the phone or using any telecommunication tool regarding your any health issues including the COVID-19 pandemic? (Probe for whether it is instituted by the government or the private sector)

Improving resilience with telemedicine

3. In your opinion, do you think a telemedicine system would be useful for your community? (Probe for how useful)
4. In your opinion, do you think a telemedicine system in the district could have helped to reduce infections from the recent pandemic, and have potential to improve resilience in healthcare delivery during pandemics and epidemics?
5. In your opinion, how should the telemedicine ecosystem be designed to be effective and what services should be the focus of for telemedicine ecosystem for your community?

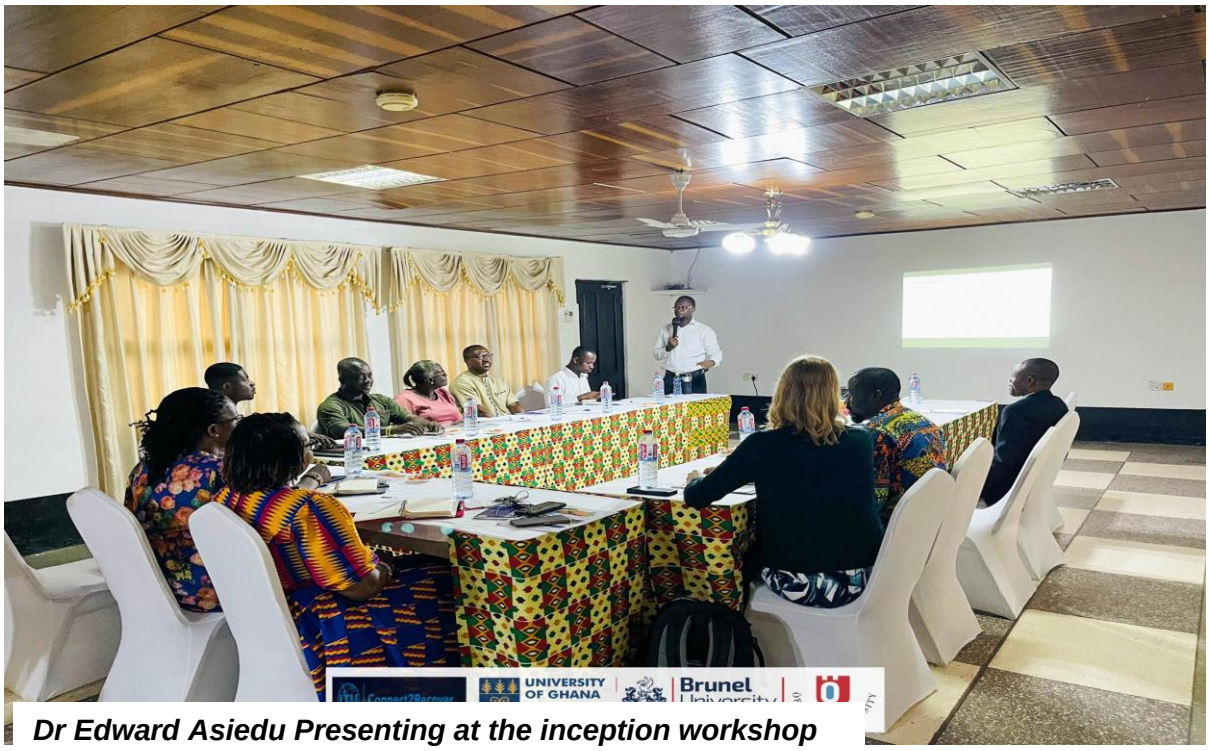
Challenges

6. In your opinion, what do you consider to be the main critical challenges for the community if telemedicine ecosystem is scaled – up to your community? (Probe for cost, trust, network connectivity)

7. In your opinion, who should institute the telemedicine ecosystem (Probe the role of government, NGOs, telecommunication companies, private sector, clinics etc).

8. Overall, how important is a telemedicine ecosystem to you and your family? (Probe for perceived benefits)

Pictures from Workshops and Focus Group Discussions



Dr Edward Asiedu Presenting at the inception workshop

Focus Group Discussion Participants