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Assessing the Relevance of African-based Institutions in Becoming WHO Collaborating Centres in Digital Health

Master Thesis

Faculty of Life Sciences

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Preface

During my internship and work as a project assistant at the German Agency for International Cooperation (GIZ) in the Department of Sector Program Global Health, I worked closely with the Digital Health team under the supervision of Mrs. Barakissa Tien-Wahser. Together, we recognized a significant imbalance in the distribution of WHO Collaborating Centres (CCs) across the six WHO regional member countries. This imbalance was especially pronounced in the field of Digital Health, where the WHO AFRO region lacked an officially designated WHO CC. Since GIZ has good networking cooperation with the World Health Organization (WHO), African-based institutions, and various international development partners, I embarked on an extensive research endeavor focused on WHO CCs.

Through constructive dialogues and consultations with critical stakeholders, I learned that African-based institutions have great potential to establish WHO CCs for Digital health. Mrs. Barakissa Tien-Wahser graciously permitted me to undertake my thesis project. The research question I pursued is centered on "Assessing the Relevance of African-Based Institutions in Becoming WHO Collaborating Centres in Digital Health." This preface serves as an introduction to my academic journey, motivated by my desire to elaborate on the significance of the discourse surrounding African institutions' fair representation and participation in global health initiatives.

Acknowledgment

I would like to take a moment to say a big thank you to all the fantastic people who have supported and motivated me during my Master of Health Sciences journey and while I was working on my thesis. First, I sincerely thank my respected advisors, Prof. Dr. Walter Leal and Dr. Adekunle Moses Adedeji, for their advice and support during my study and for being my advisors for the thesis writing.

Further sincere appreciation goes to Mrs. Barakissa Tien-Wahser and Dr. Lisa-Marie Ouedraogo-Wasi for allowing me to work part-time at the GIZ, which enabled me to work on my thesis while gaining valuable experience. I want to thank my Master of Health Sciences Coordinator, Dr. Claudia Terschüren, for being supportive throughout my Master of Health Sciences course journey.

All respondents who agreed to be interviewed as part of the qualitative phase of my thesis deserve my sincere appreciation. I am also profoundly thankful for my daughter, Lucy Alemie, who gave me her love and support while writing this thesis. Finally, I greatly appreciate my family and friends; your support and inspiration were helpful even during the Tigray War‘s difficult time.

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List of Abbreviations

ADHI	African Digital Health Initiative
Africa CDC	Africa Centres for Disease Control and Prevention
Apps	Applications
AU DTSA	Africa Union-The Digital Transformation Strategy for Africa
COVID-19	Corona Virus Disease 2019
DH	Digital Health
DHIS	District Health Information Systems
DHIS2	District Health Information Software 2
DHLR	Digital Health Landscaping report
DIIG	Digital Implementation Investment Guide
DOI	Diffusion of Innovation Theory
DRP	Digital Regulation Platform
ECDPM	European Centre for Development Policy Management
ECGs	Electrocardiographs
eHealth	Electronic Health
EHR	Electronic Health Records
EMRs	Electronic Medical Records
EU	The European Union
GOARN	Global Outbreak Alert and Response Network
GIZ	German Agency for International Cooperation
HIS	Health Information Systems
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information Systems
HT&I	Health Technologies and Innovations
IPESSA	International-Partnerships Europe-Sub-Saharan-Africa
IPIMCA	Institutional partnerships improve medical care in Africa.
IT	Information Technology
ICT	Information and Communication Technology
ITU	International Telecommunication Union
LMICs	Low and Middle-Income Countries
MEPI	Medical Education Partnership Initiative
mHealth	Mobile Health
MeSH	Medical Subject Headings
NIH	National Institutes of Health
NIHR	National Institute for Health Research

PAHO	The Pan American Health Organization
PEPFAR	President's Emergency Plan for AIDS Relief
RDT	rapid diagnostic testing
RKI	Robert Koch Institute
SDGs	Sustainable Development Goals
SMS	Short Message Service
TB	Tuberculosis
UHC	Universal health coverage
UN	United Nations
WHO	World Health Organization
WHO AFRO	WHO Regional Office for Africa
WHO AMRO	WHO Regional Office for the Americas
WHO CCs	WHO Collaborating Centres
WHO EMRO	WHO Regional Office for the Eastern Mediterranean
WHO EURO	WHO Regional Office for Europe
WHO GSDH	WHO Global strategy on digital health
WHO SEARO	WHO Regional Office for South-East Asia
WHO WPRO	WHO Regional Office for the Western Pacific

Abstract

Background: The World Health Organisation Collaborating Centres (WHO CCs) are essential in advancing global health initiatives, encouraging cooperation, and supporting new techniques. However, examining their geographical distribution reveals a significant disparity in favor of high-income nations, raising concerns about equal global representation. This thesis focuses on the relevance of African-based institutions becoming WHO CCs in Digital Health (DH).

Objectives: This master's thesis assesses the relevance of African institutions in terms of their potential to become WHO CCs in DH. The primary goals are to analyze the current geographical distribution of CCs, identify the potential significance of African institutions, explore the benefits of becoming a WHO CC for DH, and provide policymakers and other stakeholders with recommendations on engaging more African-based institutions.

Methods: This thesis used a mixed-methods approach, including reviewing current scientific literature, analyzing quantitative data from the WHO CCs global database, and conducting qualitative interviews. The qualitative data is transcribed and analyzed for content, while the quantitative data informs the geographical distribution of WHO CCs.

Results: The thesis reveals an imbalanced geographical distribution of WHO CCs, with African representation lagging. Factors influencing the suitability of African-based institutions include local contextual knowledge, proximity to communities and networks, and skilled expertise. Recommendations for policymakers and other stakeholders encompass funding allocation, policy frameworks, capacity building, and international collaboration.

Conclusion: This thesis underscores the importance of involving African-based institutions in becoming WHO CCs in DH. Their participation can address unique African health challenges, foster innovation, and promote contextually relevant solutions to the health system in Africa. By rectifying the geographical imbalance and enhancing African-based institutions' engagement, global health initiatives can better address African populations' diverse and evolving health needs.

Keywords: WHO Collaborating Centres, Digital Health, Global Health, African-based Institutions, Geographic Distribution.

Zusammenfassung

Hintergrund: Die WHO Collaborating Centres (WHO CCs) sind von entscheidender Bedeutung für die Förderung globaler Gesundheitsinitiativen, der Zusammenarbeit und die Unterstützung neuer Techniken. Bei genauerer Untersuchung ihrer geografischen Verteilung zeigt sich eine erhebliche Ungleichheit zugunsten wohlhabender Länder, was die globale Vertretung in Frage stellt. Diese Arbeit untersucht die Relevanz afrikanischer Institutionen als WHO CCs im Bereich Digital Health (DH)**.**

Ziele: Diese Masterarbeit bewertet das Potenzial afrikanischer Institutionen als WHO CCs im DH-Bereich. Die Hauptziele sind die Analyse der aktuellen geografischen Verteilung der CCs, die Identifizierung des Potenzials afrikanischer Institutionen, die Erkundung der Vorteile einer WHO-CC-Mitgliedschaft für DH und die Bereitstellung von Empfehlungen für politische Entscheidungsträger und anderen Interessenvertretern.

Methoden: Diese Arbeit verwendet einen Mixed-Methods-Ansatz, der die Überprüfung aktueller wissenschaftlicher Literatur, die Analyse quantitativer Daten aus der globalen Datenbank der WHO CCs sowie qualitative Interviews umfasst. Die qualitativen Daten werden transkribiert und inhaltlich analysiert, während die quantitativen Daten die geografische Verteilung der WHO CCs aufzeigen.

Ergebnisse: Die Arbeit zeigt eine unausgewogene geografische Verteilung der WHO CCs, wobei Afrika unterrepräsentiert ist. Einflussfaktoren für die Eignung afrikanischer Institutionen sind lokales Kontextwissen, die Nähe zu Gemeinschaften und Netzwerken sowie sachkundiges Fachwissen. Empfehlungen für politische Entscheidungsträger und andere Interessenvertreter umfassen die Zuweisung von Mitteln, politische Rahmenbedingungen, Kapazitätsaufbau und internationale Zusammenarbeit.

Fazit: Diese Arbeit betont die Bedeutung der Einbindung afrikanischer Institutionen als WHO CCs im DH-Bereich. Ihre Beteiligung kann einzigartige Gesundheitsprobleme in Afrika angehen, Innovation fördern und kontextbezogene Lösungen entwickeln. Durch Ausgleich der geografischen Ungleichheit können globale Gesundheitsinitiativen besser auf afrikanische Bedürfnisse eingehen.

Schlüsselwörter: WHO Collaborating Centres, Digitale Gesundheit, Globale Gesundheit, Afrikanische Institutionen, geografische Verteilung.

Chapter 1: Introduction

Digital health (DH) has recently become a powerful force in the healthcare industry, transforming how healthcare is provided and accessible globally and opening up new chances to increase healthcare services' availability, effectiveness, and efficiency (Verily et al., 2022). The rapid development of DH technologies has created new opportunities for changing healthcare delivery systems around the globe (Van Olmen et al., 2020). Electronic health records, telemedicine, mobile health, and health information systems are only a few of the technologies and treatments included in DH (WHO CC in UOC, n.d; Istepanian & AlAnzi, 2020). DePasse et al. (2014) described that these innovations may increase healthcare access, improve patient outcomes, and strengthen healthcare systems.

Through its World Health Organisation (WHO) Collaborating Centres (CCs) network, the WHO is critical to coordinating worldwide efforts and fostering cooperation in global health (WHO CCs, n.d.). These CCs act as essential knowledge canters, facilitating information exchange, capacity building, and policy formulation in DH. However, the participation and contributions of African-based institutions in this global context must be evaluated (WHO CCs, n.d.). This chapter provides an overview of the Background, the problem statement, the thesis's Significance, the thesis's Scope and limitations, the Methodology approach of the thesis, and the form of the thesis structures.

1.1 Background

DH has arisen as an extraordinary power in Health care, upsetting how Health care is conveyed and received overall and offering new chances to develop further access, quality, and productivity of healthcare services (Verily et al., 2022). Unique opportunities to transform healthcare systems worldwide have emerged due to the rapid development of DH technologies (Van Olmen et al., 2020). Technological advancements have paved the way for various digitally supported treatment scenarios (Smith & Magnani, 2019). For instance, patients can now engage in remote consultations with general practitioners through online platforms (Almathami et al., 2020). Mobile health (mHealth) solutions have become increasingly prevalent, offering body-worn sensory equipment and measurement units that enable convenient monitoring of health parameters (Müller, 2021). Similarly, remote therapeutic examinations and treatments have become possible through technology integration (Seuren et al., 2020). Furthermore, patient data can be measured independently of location and effortlessly transferred to medical facilities for analysis (Vesnic-Alujevic et al., 2018). Online scheduling of appointments (Habibi et al., 2019), digital prescription services (Mueller et al.,

2020), and readily available online information about diseases and symptoms have enhanced the convenience and accessibility of healthcare (Müller, 2021). Moreover, telemonitoring of at-risk patients has become feasible, allowing healthcare providers to remotely track the health status and vital signs of individuals in need (Aamodt et al., 2019).

These technological advancements have transformed the healthcare landscape, providing numerous opportunities for efficient and effective healthcare delivery (Müller, 2021). DH includes electronic health records, telemedicine, mHealth, and health information systems WHO CC in UOC, n.d; Istepanian & AlAnzi, 2020). These developments can potentially improve access to the mind, focus on silent outcomes, and support Health frameworks (De-Passe et al., 2014). The WHO is crucial to advancing DH initiatives worldwide and encouraging nations and institutions to collaborate and share knowledge. The WHO recognizes the significance of knowledge sharing and Collaborating in DH through its WHO CCs. The designated organizations, WHO CCs, support WHO's efforts in various fields, including DH (WHO CC in UOC, n.d). These teaming-up focuses act as Centres of ability and add to WHO's Digital Health drives, exploration, and strategy advancement (WHO CCs, n.d.). However, African-based institutions need to be more represented in this global network.

Digital health technologies have gained attention in the last decade for their potential to address global health concerns and enhance healthcare outcomes while mitigating unintended consequences (Sucala et al., 2021). The COVID-19 pandemic has underlined the need for DH tools in frontline care, surveillance, and strategy execution (Peek et al., 2020). Africa faces several health difficulties due to limited healthcare infrastructure, including chronic diseases and the current epidemic. All countries on the globe should develop and implement DH solutions to improve the national population's health and achieve universal health coverage (Bakibinga-Gaswaga et al., 2020). Many African countries, however, require additional institutional support to build and consolidate national eHealth and DH initiatives and implement their action plans (WHO AFRO HT&I, n.d.). The significance of African-based institutions in driving digital health innovation and addressing African-specific health issues has become increasingly recognized in recent years (Till et al., 2023).

In its normative function, WHO supports and gives orientation to Member States through external institutions to develop or enhance their digital health strategies. Since 1949, the Organization has laid down a policy that requires it to use existing institutions to strengthen country resources, in terms of information, services, research, and training, to support the development of national health systems (WHO CCs, n.d.). With a formal designation by the

Director-General of WHO, an existing collaborating institution can become a WHO Collaborating Center (WHO CCs, n.d.). WHO has over 800 collaborating Centres in over 80 countries; in DH, there are WHO CCs in Singapore and Barcelona. There are only 27 CCs in Africa. These African-based WHO CCs are mainly based in South Africa and work on several health topics such as nursing, occupational health, communicable diseases, nutrition, mental health, and chronic diseases (WHO CCs, n.d.). On Digital health topics, there has yet to be an official WHO CC in Africa. This thesis aims to assess the relevance of African-based institutions in becoming WHO CCs for DH. By examining the current conditions of WHO CCs in DH and evaluating the potential of African institutions to contribute to this network, this research seeks to inform policymakers and stakeholders about the role African institutions can play in shaping the DH agenda in Africa.

1.2 Problem Statement

Despite the fast growth of DH technologies and growing acknowledgment of their potential, African-based institutions still need assistance in actively engaging in and contributing to global DH partnerships. The master's thesis concerns a lack of African-based WHO CCs in DH, which inhibits the region's capacity to create and execute DH solutions. The issue is twofold: (1) Africa needs more institutional support to establish and consolidate national DH plans, and (2) the limited availability of African-based WHO CCs hinders the region's ability to develop and implement DH solutions. (WHO CCs, n.d.). The thesis aims to analyze the work and geographical distribution of the WHO CCs across all six WHO regional country members and assess their relevance to the African continent and the WHO Member States. Based on the results, the readiness of African-based institutions to become WHO CCs for Policymakers and other stakeholders will be discussed. It will then present the thesis's research questions and objectives to highlight the relevance of African-based WHO CCs in DH. This thesis assesses the relevance of African-based institutions to becoming WHO CCs in DH. By examining the barriers and opportunities faced by African institutions in this context, this thesis aims to identify the factors influencing their participation and explore their potential for increasing their engagement. The main objective of this thesis is to promote equitable representation and leverage the expertise of African institutions in shaping global DH agendas.

1.2.1 Thesis Objectives

This Thesis assesses African-based institutions' significance and potential benefits in becoming WHO CCs in DH. To achieve this aim, the following objectives will be addressed:

- To review the existing scientific literature on digital health, WHO CCs, and the significance of African-based institutions.
- To identify and analyze the work and geographical distribution of WHO CCs using quantitative data from the WHO database.
- To conduct qualitative interviews with key stakeholders in African-based institutions, the WHO, and development partners to assess the significance of African-based institutions becoming WHO CCs in DH.
- To provide recommendations to policymakers on the importance of African-based institutions in becoming WHO CCs in DH, including strategies for capacity building, collaboration, and knowledge sharing.

1.2.2 Research Questions

To address the stated objectives, the following research questions will guide the thesis:

- What does the existing scientific literature show about digital health, WHO CCs, and the significance of African-based institutions in this context?
- How these WHO CCs are geographically distributed among the six WHO regional member states, and how do African-based institutions contribute to these efforts?
- What are the potential benefits and challenges associated with African-based institutions becoming WHO CCs in DH?
- What recommendations can be provided to improve the participation and contributions of African-based institutions in shaping global digital health policies and initiatives?

Addressing these research questions will provide a comprehensive understanding of the role of African-based institutions in global DH collaborations, generate valuable insights, and offer recommendations for fostering their engagement and impact.

1.3 Significance of the Thesis

This thesis holds significant importance in several ways. **Firstly,** it will contribute to the knowledge of DH in Africa, providing a comprehensive understanding of the current state, challenges, and opportunities. The thesis will synthesize the relevant literature, offering insights into the adoption, implementation, and impact of DH technologies in Africa. **Secondly,** by analyzing the work and geographical distribution of WHO CCs, the Thesis will shed light on African institutions' representation and assistance to global health Collaborations. This analysis will help identify African institutions' gaps and barriers and explore strategies to enhance their participation and contribution to shaping the DH Agenda.

Thirdly, assessing the significance of African-based institutions becoming WHO CC in DH will highlight the potential contributions and unique perspectives they can bring to global

digital health initiatives. This analysis will consider the continent's specific health challenges and the opportunities for leveraging DH to address these challenges effectively. **Lastly,** the recommendations generated through this research will provide actionable insights for African-based institutions, African governments, international development partners, and the WHO. These recommendations will enhance Collaboration, capacity-building, and policy development in DH, ultimately improving healthcare outcomes and equity in Africa.

1.4 Scope and Limitation of the Thesis

This section focuses on the thesis's scope and limitations, explicitly understanding the Thesis's boundaries and potential restrictions.

1.4.1 Scope of the Thesis

The thesis aims to assess the relevance of African-based institutions in becoming WHO CCs in DH. It focuses on African institutions' capabilities, expertise, and contributions to the DH field and examines the potential impact of their involvement in global DH Collaborations. The scope of the thesis encompasses the following:

Geographic Scope: The thesis focuses on African-based institutions, including academic institutions, research organizations, healthcare facilities, and government health agencies involved in DH initiatives. It considers that institutions across the African continent recognize the diversity of healthcare systems, resources, and challenges in these nations.

Thematic Scope: The thesis explores various aspects of DH initiatives, including but not limited to telemedicine, mHealth, health information systems, and digital health strategy. It assesses the contributions and capabilities of African-based institutions in these thematic areas, recognizing and acknowledging the multidimensional nature of DH intervention and its challenges.

Collaborative Scope: The thesis explicitly investigates the potential for African-based institutions to become WHO CCs in DH. It explores the existing collaborations, partnerships, and initiatives between African institutions and WHO or other international organizations. It assesses the benefits and challenges of enhancing African institutions' role in global DH Collaborations.

1.4.2 Limitations of the Thesis

While this thesis tries to give significant insights into the role of African-based institutions in becoming WHO CCs in DH, the following limitations must be acknowledged:

Data Availability and Accessibility: Data about African institutions' DH initiatives may be available and accessible in different nations and organizations. Some institutions may need more documentation or data on their DH initiatives, impairing the thesis's conclusions' comprehensiveness.

Generalizability: The results of this thesis might only be instantly generalizable to some African institutions due to the variability of conditions, resources, and capabilities throughout the continent. The thesis may provide a representative sample and investigate common themes, although findings may differ among institutions and nations.

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Time Constraints: Due to the thesis completion time frame, the scope and depth of the data collection and analysis might be limited. Recognizing that the DH environment is constantly evolving and that new initiatives and partnerships may emerge after the Thesis is concluded is crucial.

Language and Cultural Limitations: Language and cultural obstacles might pose significant challenges in accessing information from African organizations and comprehending its significance. Language barriers and variations in research methodologies and terminologies might provide data collection and analysis challenges.

Despite these constraints, the thesis might give significant insights into African-based institutions' possible contributions and relevance in becoming WHO CCs in DH. The findings might aid in developing strategies, policies, and activities to strengthen African institutions' participation in global DH partnerships.

1.5 Methodology and Approach of the Thesis

The thesis will adopt a mixed-methods research approach. A mixed-methods approach was adopted to address the thesis objectives and answer the research questions.

- First, systematic literature will be reviewed to assess the current scientific literature on DH, WHO CC, and the significance of African-based institutions.
- Secondly, a quantitative analysis of the work and geographical distribution of the WHO CCs will be examined using data obtained from the WHO CCs global database.

- Thirdly, qualitative interviews will be conducted with experts of critical stakeholders in African-based institutions, the WHO, and development partners to assess the significance of African-based institutions becoming WHO CC in DH.

1.6 Structure of the Thesis

This thesis is divided into several chapters. Each focuses on various aspects of the thesis topic. The following will give an overview of the structure and content of each chapter of the thesis:

Chapter 1: Introduction: The introductory chapter provides a comprehensive context for the thesis. The Thesis's background emphasizes the significance of assessing African-based institutions' relevance in pursuing WHO CC status in DH. The thesis's problem statement, objectives, and research questions are enumerated to understand and guide the investigation's focus. Moreover, the thesis offers a detailed description of its significance, scope, limitations, and methodology. The last chapter closes with a review of the thesis structure to provide a better image of the thesis.

Chapter 2: Literature Review: The literature review chapter examines existing scientific literature on DH, WHO CCs, and the significance of African-based institutions in DH. It delves into the fundamental concepts, theories, and models relevant to the thesis topic. The chapter synthesizes previous studies and identifies gaps in the literature.

Chapter 3: Research Methodology: The methodology chapter outlines this thesis's research design and approach of the mixed Thesis. It describes the data collection methods, including document analysis, the WHO CC global database and the Expert interviews, and the sample strategy selection of the qualitative Thesis. In addition, the chapter describes the data analysis techniques used to analyze the collected qualitative data, including the transcription procedure, its content analysis, and the coding process of the interview. The ethical considerations are also addressed, ensuring the Thesis's rigor and integrity.

Chapter 4: Results: The results chapter presents the thesis's findings. The Thesis examines the current scientific literature on digital health initiatives and innovations in Africa, the WHO CCs, and the significance of African-based institutions in DH. It identifies and analyzes the WHO Collaborating Centres Database in Quantitative Analysis, focusing on the geographic distribution of CCs and fostering collaboration and Knowledge Exchange. It also assesses the significance of African-based institutions becoming WHO CCs. Qualitative

Analysis: Insights from Expert Interviews highlight their potential contributions and benefits, Challenges, and recommendations.

Chapter 5: Discussion: The discussion chapter comprehensively analyzes and interprets the Thesis's findings. It discusses the essential results and implications of the research, addressing how they align with the objectives and research questions. It explores the Thesis's implications for policy and practice, emphasizing the potential impact on healthcare systems and population health. It also presents the thesis's limitations and highlights the Future Directions for Research and Practice.

Chapter 6: Recommendations: This chapter presents recommendations for the WHO, outlining strategies to enhance the engagement of African-based institutions in DH. It provides recommendations for African governments to support the establishment and growth of WHO CC. It also recommends African-based institutions focusing on capacity-building, collaboration, and advocacy. Finally, it presents recommendations for international development partners to foster partnerships and support the DH initiatives of African-based institutions.

Chapter 7: Conclusion: The thesis concludes with an overarching conclusion that summarizes the thesis, emphasizing the main findings. It also highlights the thesis's contributions, stressing how the results might help harness the full potential of DH and improve healthcare outcomes for the African population.

In conclusion, this thesis aims to assess the relevance of African-based institutions in becoming WHO CCs in DH. This thesis provides insights into the potential contributions, challenges, and opportunities by examining the current scientific literature, analyzing the work of WHO CC, and assessing the significance for African-based institutions. The subsequent chapters of the thesis go through each aspect in detail, contributing to existing knowledge and informing policy and practice.

Chapter 2: Literature Review

This chapter reviews scholarly works assessing the relevance of African-based institutions becoming WHO CCs in DH. This literature review is presented in four parts: an overview of Digital Health, WHO Collaborating Centres, African-based Institutions and their potential for becoming WHO CCs in DH, and the Challenges and limitations of becoming WHO CCs in DH.

2.1 Overview of Digital Health

DH has emerged as a swiftly transforming discipline that utilizes digital technologies to enhance healthcare delivery, improve patient outcomes, and transform health systems. This section summarizes DH, including its definition and historical development. (Awad et al., 2021; Lennon et al., 2017**).**

2.1.1 Definition of Digital Health

In medicine and other health professions, "digital health" is utilizing ICT (Information and Communication Technology) to treat illnesses, minimize health risks, and promote well-being (Ronquillo et al., 2023). EHRs (Electronic Health Records), telemedicine, mHealth (Mobile Health), and HIS (Health Information Systems) use digital technology to provide healthcare, manage health information, and assist processes (WHO DH&I, n.d.). As technology evolved and novel healthcare solutions were sought, DH changed (Awad et al., 2021). EHRs enable the digitizing, storing, and sharing of patient health data information, improving access to care and treatment continuity. Telemedicine enables remote consultations and care delivery, particularly in economically impoverished nations like most African countries, bridging the gap between patients and medical experts. mHealth uses portable electronics like smartphones and wearables to provide healthcare, raise awareness of health concerns, and monitor them (Fatehi et al., 2020). Data and technology are used in HIS to improve healthcare administration, decision-making, and public health initiatives (Awad et al., 2021).

2.1.2 Evolution of Digital Health

The need for better healthcare and health delivery access and efficiency, technological developments, the accessibility and affordability of smart mobile devices, the fast connection of internet availability, and rising awareness of digital solutions to solve healthcare imbalances have propelled the emergence of the DH transformation (Verily et al., 2022). As DH progresses, it has the potential to alter healthcare delivery and improve health outcomes.

Despite promising results from small-scale applications, new technologies are still broadly accepted, assimilated, and routinized (Broomhead et al., 2021; Da Fonseca et al., 2021; Lennon et al., 2017).

2.1.3 Examples of Digital Health Applications

DH encompasses various applications that leverage technology to improve healthcare delivery and outcomes. Figure 1 illustrates that eHealth is composed of three main components. The first component is Health informatics, which involves managing patient information through systems such as EMRs (Electronic Medical Records) and HMIS (Health Management Information Systems) /DHIS2 (District Health Information Software 2). The second component is mHealth, which utilizes mobile technologies like videos, Artificial Intelligence, and diagnostics, as well as teleconsultations, APPs, and Drones. The third and final component is eLearning, which allows for remote learning through videography (Victor et al., 2023). This section provides examples of digital health applications, including mHealth, telemedicine, EHRs, and HISs (Awad et al., 2021).

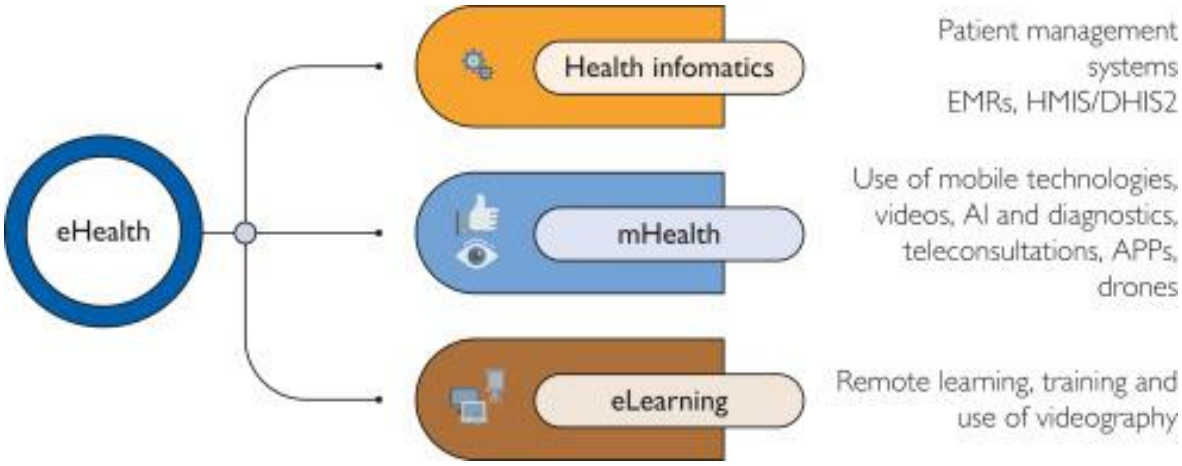


Figure 1: The eHealth framework consists of several components. (Source: Victor et al., 2023).

2.1.3.1 Mobile Health (mHealth)

Using mobile electronic devices like smartphones and tablets for healthcare management and delivery is called "mHealth." MHealth apps provide a wide range of services, such as help with medication adherence, appointment reminders, remote patient monitoring, and health education (Kreitmair, 2023). For instance, the Kenyan mHealth initiative uses SMS to send out health-related information, remind women to schedule prenatal care appointments, and enhance mother and child health. This improves accessibility and healthcare outcomes for vulnerable people (Jayawardena et al., 2018).

2.1.3.2 Telemedicine

Telemedicine uses telecommunications to provide healthcare remotely. It lets doctors consult, diagnose, and treat patients remotely. Telemedicine is highly effective in locations with limited healthcare facilities and expertise. Rural South African healthcare providers may access metropolitan specialists using the Vula Mobile App. The software lets healthcare workers seek assistance, securely exchange patient data, and get actionable suggestions. This enhances patient care in neglected areas and healthcare personnel's abilities (Hasselberg et al., 2017).

2.1.3.3 Electronic Health Records (EHRs)

EHRs are electronic copies of patient medical records that include complete health data. EHRs can store, share, and retrieve patient data securely, promoting effective and well-coordinated treatment. EHRs enable medical workers to access patient data in real time, minimizing mistakes, enhancing care coordination, and using evidence in decision-making (Fraser et al., 2022). The Rwanda Health Information Exchange, a nationwide electronic health information system, has improved patient record accessibility and continuity. It has enhanced treatment, enabled data-driven choices, and supported disease monitoring and public health activities. Despite site infrastructure limits, most users thought the EHR was well-accepted and efficient for low-resource settings. EHR implementation upgrades may improve critical job performance and perceived value. Small healthcare facilities may improve clinical documentation, treatment, reporting, and disease monitoring in low- and middle-income countries by using EHRs. (Fraser et al., 2022).

2.1.3.4 Health Information Systems (HISs)

The integrated HISs collect, store, maintain, and transmit health data. These systems offer healthcare, monitor health trends, and guide policy and planning. HISs comprise reporting systems, analytics platforms, data repositories, and data collection technologies. (Dehnavieh et al., 2019). Insurance and patient care quality are among the benefits of health information systems. District Health Information Systems (DHIS) organize data from all national public health institutions. The main goal of DHIS is to gather and schedule regular health facility data. This data aggregation helps health officials assess a district's or region's health. DHIS also standardizes data collection and ensures uniformity among health institutions to improve accuracy and dependability. DHIS improves patient care beyond financial benefits. This allows focused treatments and evidence-based techniques to improve healthcare delivery and patient outcomes. For instance, numerous African countries use the DHIS2 web-based information system. DHIS2 analyzes health data from multiple sources to facilitate

data-driven decision-making, resource allocation, and health indicator monitoring at several healthcare system levels (Dehnavieh et al., 2019).

2.1.3.5 mHealth Initiatives Across Africa to Respond to COVID-19

Across Africa, several digital and mobile initiatives related to COVID-19 have been identified (as shown in Figure 2). One such initiative is District Health Information Software 2, an open-source, web-based health management information system used by 67 low- and middle-income countries. This platform has a COVID-19-specific application package that several African countries use for field data collection (DHIS2, 2020). In Rwanda and Uganda, the WelTel virtual care system is a real-time remote monitoring platform for COVID-19 cases and contacts in home isolation. These individuals receive semi-automated daily text message check-ins via SMS for two weeks using an open language format, allowing them to self-report new symptoms or issues. Responses are viewed by health officials on a dashboard, resulting in faster triage for patients and saving critical human resource capacity. Novel natural language processing computing tools are also being used to reveal insights into the issues that patients face during home quarantine (Nachega et al., 2020). In Ghana, residents can respond electronically to questions about their symptoms, who they have been in contact with, and their travel history by dialing a short USSD code (*920*222#) on their mobile phones. The Opine Health Assistant compiles the results into maps and graphs to make it easier to understand, monitor, and share (ICT Ghana, 2020). SMS services are being used in Senegal to broadcast good hygiene practices to rural communities to disrupt the spread of COVID-19 (United Purpose, 2020). In South Africa, community screening, referral for testing, and communication of results are being rapidly expanded to over 28,000 trained community health workers using a mHealth platform. These initiatives are helping people undertake home isolation/quarantine more effectively and disrupting the spread of COVID-19 in rural communities (Nachega et al., 2020).

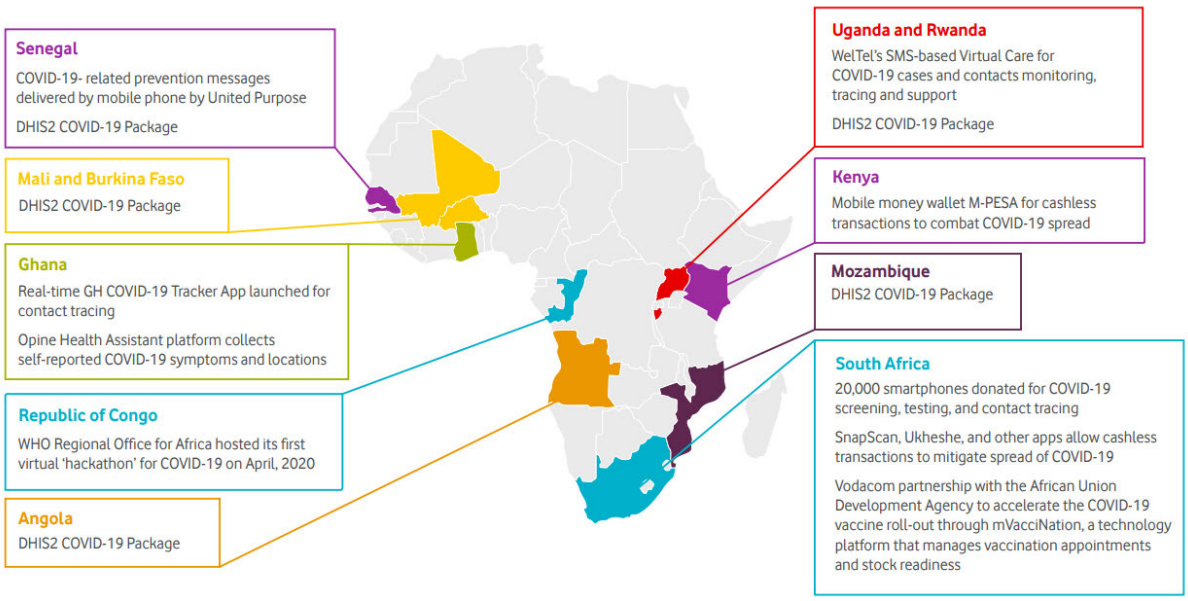


Figure 2: Some examples of how mobile phones are used in mHealth initiatives across Africa to respond to COVID-19. (Source: Nachega et al., 2020).

2.1.4 Benefits and Challenges of DH Implementations

Implementing DH has several advantages for enhancing results and healthcare delivery (Al-Shorbaji, 2022). However, they also address specific difficulties that must be resolved for practical application and adoption. This section examines the benefits and problems of DH implementations.

2.1.4.1 Benefits of DH Implementations

Enhanced Access to Healthcare Services: DH projects can break down geographical boundaries and expand access to healthcare services, especially in impoverished regions (Awad et al., 2021). Telemedicine and mHealth apps provide remote consultations, decreasing the need for patients to travel considerable distances to obtain medical treatment. This is especially useful in areas with insufficient healthcare infrastructure or a demand for additional healthcare experts (Al-Shorbaji, 2022). DH technologies have transformed patient data management, improving efficiency and care coordination. EHRs and HISs are essential to this change. EHRs provide accurate, real-time medical records, allowing healthcare workers to make educated choices and coordinate treatment across providers and locations (Iyawa et al., 2019). This simplified method improves efficiency, avoids unnecessary tests and treatments, and streamlines care (Aapro et al., 2020). Information technology solutions that integrate and coordinate care and promote provider cooperation are needed to reduce the costs and harm of poor communication and fragmented care (NIHR, 2022). Healthcare professionals may offer systematic, high-quality treatment by integrating clinical information,

decision support, and knowledge management systems into standardized processes (Iyawa et al., 2017).

Empowering Patients through Enhanced Engagement: Access to critical health information, educational materials, and self-management tools via DH apps has changed how individuals interact with their healthcare (ECDPM, n.d.). Patients may actively engage in treatment choices through these digital platforms, monitor their health, and get individualized health advice (Al-Shorbaji, 2022). This promotes patient participation, treatment adherence, and health management empowerment (Koehle et al., 2022). Tools that enable patient involvement and self-management are needed to minimize transaction costs and alter the patient-caregiver interaction, allowing more meaningful participation in treatment and more self-service (Iyawa et al., 2019). Digital technologies boost patient happiness and health outcomes. This movement in patient empowerment turns healthcare into a Collaboration between patients and caregivers to achieve maximum health and well-being (Awad et al., 2021).

Optimizing Costs and Resources through Digital Health: DH solutions may save healthcare costs and optimize resource use. Telemedicine and remote monitoring cut hospital visits, reduce travel costs, and relieve healthcare facilities. Electronic documentation reduces paperwork and administrative expenditures (Iyawa et al., 2017). Data analytics from health information systems inform resource allocation and health planning, improving resource efficiency. (Al-Shorbaji, 2022). Healthcare may improve resource management using other industries' methods (NIHR, 2022). Healthcare businesses may better meet patient care needs using resource management tools, including staff roster planning, patient flow optimization, and capacity matching (Yang et al., 2022). Smoother operations and resource optimization are also possible with improved scheduling systems. Digital solutions and resource optimization provide a more sustainable and effective healthcare system (Awad et al., 2021).

2.1.4.2 Challenges of DH Implementations

Establishing Robust Infrastructure and Connectivity: Significant challenges include integrating DH technologies into hospital systems and guaranteeing stable infrastructure and connections (Butcher & Hussain, 2022). In isolated and rural regions, internet connectivity and electricity may hinder digital health systems (Iyawa et al., 2019). These infrastructural deficiencies must be addressed for fair access and successful adoption of DH solutions (Awad et al., 2021). However, the financial and infrastructural implications for countrywide

community- and facility-based data collection and universal support system access are unknown (Aapro et al., 2020).

Ensuring Data Privacy and Security: DH systems raise severe privacy and security concerns about collecting, retaining, and exchanging patient data (Budd et al., 2020). Maintaining patient confidence and meeting legal standards requires protecting sensitive health information. To secure patient data, encryption, authentication, and privacy rules are needed (Awad et al., 2021). In addition to data privacy and security, data use standards and rights must be established. This involves choosing server storage sites, organizing data aggregation, and sharing between local communities and regional and national health information systems. These indicators aid DH ecosystem decision-making and data integrity (Butcher & Hussain, 2022).

Promoting Health Equity and Accessibility: DH initiatives may improve healthcare access and increase health inequalities. Internet access, digital literacy, and device availability may prevent underprivileged communities from using digital health solutions equitably (Budd et al., 2020). Inclusivity and digital divide reduction are essential to preventing health inequities. (El-Jardali et al., 2023). A fair digital healthcare approach requires bridging the gap for those without the resources to buy devices. Innovative technology typically assists these patients the most. Healthcare organizations may enable everyone, regardless of socioeconomic position, to use digital health solutions by providing resources and support for devices and connections (Awad et al., 2021). To improve operations and patient experiences, high-performing digital hospitals connect their systems organization-wide. Interoperability across healthcare institutions should be prioritized to enhance patient and citizen experiences and results (Devlin et al., 2016). This aim requires buying and using national data and interoperability solutions (Butcher & Hussain, 2022).

Workflow Integration and User Acceptance: DH systems must be integrated into healthcare processes to overcome challenges. Healthcare professionals may resist change and need training and help to use new technology (Iyawa et al., 2019). DH adoption and engagement depend on user acceptability, usability, and workflow integration (Adler-Milstein & Jha, 2017). Digital-first strategies only succeed if a large percentage of the population lacks digital literacy, access to devices and data, or experiences poverty (Butcher & Hussain, 2022). Designing and implementing DH systems must address accessibility and inclusivity for everyone. These systems must meet patient and healthcare professional demands (Awad et al., 2021). This requires a thorough awareness of work processes and customers. Integrating healthcare systems with off-the-shelf package solutions designed for

the company is a delicate balance. Combining a core package solution with a few specific clinical systems is the standard for top digital hospitals (Awad et al., 2021).

Building dependable infrastructure and connectivity for DH initiatives may solve these challenges (Liem et al., 2021). This requires improving internet connectivity in unserved areas, investing in telecommunications infrastructure, and maintaining a continuous electrical supply for DH systems (Kipruto et al., 2022). Filling these infrastructure deficiencies and building an environment fit for DH solutions requires Collaborating across the public, commercial, and technological sectors (Iyawa et al., 2019). Giving infrastructure and link development priority does this. This promotes equitable healthcare access and smoothly incorporates DH technologies into healthcare systems (Awad et al., 2021). However, implementing open-source software is crucial for addressing the challenges mentioned above and is pivotal in improving healthcare accessibility and equity (Paton et al., 2022).

2.2 WHO Collaborating Centres

The history and purposes, functions and roles, and benefits and challenges of WHO CCs are briefly discussed in this section.

2.2.1 The six regional offices of the WHO

AFRO/ WHO Regional Office for Africa: The WHO Regional Committee for Africa makes health policy decisions in Africa. Regional Health Ministers represent 47 Member States. The Regional Committee's primary duties include policymaking and office management under Article 50 of the WHO Constitution. The Committee recommends the Regional Director for Africa to the WHO Executive Board every five years. Annually, the Regional Committee meets with the Regional Director as secretary in August. The WHO Constitution and Regional Committee Rules of Procedure govern it (WHO AFRO, n.d.).

AMRO/ WHO Regional Office for the Americas (cf. PAHO): The PAHO regional membership includes 35 countries and four associates. They encourage PAHO to develop regional health goals and coordinate global health issues threatening healthcare systems. PAHO represents the WHO in the Americas and is the Inter-American System's public health agency. From its headquarters in Washington, D.C., 27 country offices, and three specialized facilities nearby, PAHO promotes evidence-based decision-making to enhance health as part of sustainable development (WHO AMRO/PAHO, n.d.).

EMRO/ WHO Regional Office for the Eastern Mediterranean: The Eastern Mediterranean Regional Office is one of six WHO regional offices globally. It serves the WHO Eastern Mediterranean Region, which has 745 million people in 21 member nations and occupied Palestinian territories (including East Jerusalem). The Executive Board assists the highest-ranking WHO decision-making body, the World Health Assembly. Regional committees handle local WHO activities. The Regional Committee for the Eastern Mediterranean has yearly meetings around the start of October, and all countries participate. These meetings authorize regional spending and project proposals by member states (WHO EMRO, n.d.)**.**

EURO/ WHO Regional Office for Europe: The WHO/Europe is one of six regional offices worldwide. It comprises 53 states from the Atlantic to the Pacific Oceans in the WHO European Region. Public health, scientific, and technological professionals work at EURO headquarters in Copenhagen, Denmark, seven technical Centres, and 32 Member State offices. EURO houses the European Observatory on Health Systems and Policies within the EU and its institutions (WHO EURO, n.d.)**.**

SEARO/ WHO Regional Office for South-East Asia: SEARO is one of six WHO regions. It is working with its eleven Member States to address epidemiological and demographic issues to enhance the health of the region's over two billion people. The Southeast Asia Region is vulnerable to natural disasters, disease outbreaks, and climate change-related health hazards; hence, SEARO prioritizes emergency risk management for sustainable development. The aims include universal health coverage (UHC), robust health systems, and excellent health. Eight regional flagship activities align with the UN SDGs and the WHO's Triple Billion Targets (WHO SEARO, n.d.).

WPRO/ WHO Regional Office for the Western Pacific: WPRO fights noncommunicable illnesses, including diabetes, heart disease, dengue, and malaria, in 37 Member States and territories. Immunization programs like First Embrace help parents and children flourish. WPRO prepares for disasters and reacts quickly, knowing they are life-threatening. WPRO promotes the health and well-being of the Western Pacific Region's 1.9 billion people because the stakes are high. Health for everybody requires robust health systems and extensive coverage. WPRO anticipates and reacts rapidly to crises and disasters, remembering that life and death are at stake (WHO WPRO, n.d.).

2.2.2 History and Purpose of WHO CCs

Since the beginning of the World Health Organization in 1948, WHO has had CCs, with the first being named. WHO recognizes relevant institutions assisting it in implementing its mandated work through a cooperation mechanism called CCs (Guide WHO CCs, 2018). This assistance supports the achievement of WHO's planned strategic objectives at the regional and global levels, enhances the scientific validity of its global health work, and develops and strengthens institutional capacity in countries and regions (WHO EURO, 2021). The WHO Director-General designates research institutes, university departments, and academies as WHO CCs to assist the organization's operations actively. Over 80 Member States have over 800 cooperating Centres (WHO CC, n.d.). These Centres work with WHO in nursing, occupational health, infectious diseases, nutrition, mental health, chronic diseases, and health technology. Their initiatives improve world health and address major health issues. The WHO CCs promote global health initiatives and enhance cooperation between the WHO and other organizations. This section describes WHO CCs' history and purpose (WHO CC, n.d.). WHO CCs have been designated worldwide in several sectors. These Centres, which might be national entities like governmental authorities or research institutes, help WHO carry out its programs and duties using their knowledge and staff (Fujita

et al., 2021). They advise WHO on preventative measures and worldwide public health efforts using scientific expertise. Germany has multiple WHO CCs on various health topics (RKI-WHO CCs, n.d.).

The following WHO Collaborating Centres have been recognized as being associated with the Robert Koch Institute:

- WHO CCs for Emerging Infections and Biological Threats.
- WHO CCs for the Global Outbreak Alert and Response Network (GOARN).
- WHO CCs for HIV and viral hepatitis.
- WHO CCs for Antimicrobial Resistance, Consumption, and Health Care-Associated Infections (RKI-WHO CCs, n.d.).

2.2.2.1 History of WHO CCs

The League of Nations introduced the idea of using national institutions for international goals. National labs became biological product standardization reference Centres at this time. The World Health Organization (WHO) followed this approach and designated more reference Centres. The World Influenza Centre in London became a worldwide epidemiological monitoring reference point in 1947 (WHO CCs, n.d.). A strategy established at the Second World Health Assembly in 1949 has governed WHO's approach. This policy states that WHO does not build its international research institutes but supports, coordinates, and leverages existing institutions to improve health research. This policy designates WHO cooperating Centres regardless of specialty (Fujita et al., 2021). This method increases country involvement in WHO's operations and promotes cooperation using existing institutions' knowledge and resources. The number of collaborative Centres has grown to include many health professions (Guide WHO CCs, 2018). Strategically supporting WHO's mission and initiatives and building institutional capacity, these Collaborating Centres are vital partners (PAHO/WHO CCs, n.d.).

2.2.2.2 Purpose of WHO CCs

WHO CCs' primary goals are Collaboration, research, and capacity development. Based on their expertise and track record in crucial health sectors, WHO designates these Centres to work closely with the organization on different projects and initiatives (*WHO CC*, n.d.). The fundamental purposes of WHO CCs are as follows:

Knowledge Generation and Exchange: CCs generate expertise and knowledge in various fields. Research, technical assistance, and best practices are shared with WHO and

other institutions around the globe (Guide WHO CCs, 2018). Research and partnerships contribute to evidence-based policymaking and global health recommendations and initiatives (Fujita et al., 2021).

Capacity Building: Training, seminars, and technical help from CCs increase capacity. They help member nations' human resource development, especially in sectors with limited experience and resources (Guide WHO CCs, 2018). Health systems are strengthened through capacity-building initiatives that improve healthcare practitioners, researchers, and policymakers (Fujita et al., 2021).

Collaborating and Networking: Global, regional, and national institutions collaborate and network via WHO CCs (Guide WHO CCs, 2018). They build stakeholder Collaboration by sharing information, knowledge, and resources to solve health issues. CCs help WHO and member nations collaborate and share best practices and lessons (Fujita et al., 2021).

Technical Support and Quality Assurance: To help WHO and member countries in research, surveillance, laboratory services, and policy development, CCs deploy technical advisors to the Global Outbreak Alert and Response Network (Fujita et al., 2021). They evaluate and improve health systems and services, ensuring international standards and best practices are followed.

In conclusion, WHO CCs have a long history and are vital to global health. Their expertise, research, capacity building, and cooperation promote global knowledge sharing, capacity development, and global health outcomes, supporting WHO's goals (RKI-WHO CCs, n.d.).

2.2.3 Functions and Roles of WHO CCs

WHO CCs advance global health programs and promote WHO-institutional cooperation. This section describes WHO CCs' duties.

Knowledge Generation and Research: WHO CCs develop knowledge via research (RKI-WHO CCs, n.d.). These centers study, collect, and evaluate data to build health evidence. Research informs WHO's global health policies, recommendations, and initiatives. Research helps CCs improve science, identify new health challenges, and provide creative solutions (Fujita et al., 2021)**.**

Technical Expertise and Support: CCs provide WHO and member nations with technical knowledge. Their expertise in various health areas makes them hubs. Technical support, advising services, and capacity-building initiatives address complicated health issues at

these facilities (Guide WHO CCs, 2018). Their specialties include disease surveillance, outbreak response, laboratory services, health system enhancement, and policy creation. Using their expertise, CCs may improve health treatments' quality, efficacy, and efficiency (Fujita et al., 2021)**.**

Capacity Building and Training: Building capacity is essential for WHO CCs. These CCs help member nations' healthcare professionals, researchers, and policymakers. Their training programs, seminars, and instructional materials improve health skills, knowledge, and competencies (Guide WHO CCs, 2018). The tools and resources of CCs enable people and organizations to solve health issues. These CCs boost health systems and promote sustainable development via capacity-building (Fujita et al., 2021)**.**

Collaborating and Networking: WHO CCs rely on Collaborating and networking. These CCs encourage WHO and non-WHO partnerships. They share knowledge, research, and collaborate on health issues (WHO CCs, n.d.). A worldwide community of practice is promoted through the CCs' knowledge, expertise, and exchange of resources. These CCs boost their effects and help solve global health issues through Collaboration (Fujita et al., 2021)**.**

Policy Development and Advocacy: WHO CCs develop and advocate global and national policies. Expert advice, evidence-based suggestions, and technological assistance affect health policies and practices (DRP, n.d.). Policy discourse, recommendations, and evidence-based decision-making are promoted through CCs. Their policy contributions guarantee that programs and initiatives follow the latest scientific findings and global health goals (Guide WHO CCs, 2018).

Emergency Response and Preparedness: CCs are essential for disaster response and preparation. CCs support WHO epidemic investigations, fast response teams, and technical assistance for health emergencies. CC's skills and resources improve global health security and reduce disease outbreaks (Guide WHO CCs, 2018).

Standardization and Harmonization: CCs produce and harmonize field standards, guidelines, and practices. CCs collaborate with WHO on methods, tactics, and quality assurance (Guide WHO CCs, 2018). Standardizing health treatments, data gathering, and reporting ensures consistency and interoperability.

WHO CCs provide critical work to improve global health. CCs develop knowledge, give technical assistance, build capacity, promote cooperation and networking, and advocate for policy. CCs may address global health issues and promote health equality through these functions (WHO CCs, n.d.).

2.2.4 Benefits and Challenges of Becoming a WHO CC

Global health institutes may benefit from becoming WHO CCs. It also has some challenges. This section discusses WHO CC's benefits and challenges.

2.2.4.1 Benefits of Becoming a WHO CC

The WHO uses its global network of cooperating institutions to gain support and assure scientific integrity in global health operations. These partnering Centres acquire prominence and national recognition by accessing renowned institutions worldwide. Public awareness of their health problems increases with exposure (WHO CCs, n.d.). These Centres have improved information interchange, technical interaction with other institutions globally, and the capacity to acquire funds from funding partners.

Global Recognition and Prestige: Become a WHO CC for prestige and recognition. The worldwide health community values WHO CCs. It represents competence, quality, and a dedication to global health objectives (Guide WHO CCs, 2018).

Enhanced Networking and Collaborating Opportunities: WHO CCs provide institutions with better networking and cooperation options. A global network of institutions allows CCs to cooperate with experts, researchers, and policymakers worldwide (Guide WHO CCs, 2018). This network promotes cooperation and innovation by sharing knowledge, cooperative research, and best practices (Ford et al., 2021; Gallagher et al., 2019).

Access to Resources and Technical Support: WHO provides CCs with several resources and technical assistance. Health-specific data, recommendations, toolkits, and technical knowledge may be included (DRP, n.d.). These tools may help CCs improve research, policy, and capacity-building. WHO technical assistance helps boost institutional capacity and health service quality (Guide WHO CCs, 2018).

Influence on Global Health Agenda: Being a WHO CC allows institutions to influence the global health agenda. CCs shape worldwide health policies, initiatives, and recommendations (Guide WHO CCs, 2018). These institutions may help solve global health issues and shape healthcare by engaging in global health talks and efforts (Ford et al., 2021).

2.2.4.2 Challenges of Becoming a WHO CC

Stringent Criteria and Evaluation Process: A WHO CC must fulfill strict standards and undergo an extensive examination. Institutions seeking CC status must show competence, capability, and a track record of contributions. The assessment procedure is time-consuming and rigorous (Guide WHO CCs, 2018).

Resource and Capacity Requirements: Maintaining WHO CC accreditation demands resources and institutional capabilities. Institutions require dedicated personnel, infrastructure, and financial support to support designation activities and responsibilities. This may be challenging for resource- or funding-constrained institutions (Guide WHO CCs, 2018).

Sustaining Relevance and Impact: As WHO CCs, institutions must show their relevance and effect on global health objectives. They must adjust their efforts to address global health issues. Continuous dedication, innovation, and response to emerging health challenges are needed to maintain relevance and impact (Guide WHO CCs, 2018).

Collaborating and Coordination Efforts: Collaboration and coordination with other WHO CCs, WHO offices, and stakeholders is crucial (WHO CCs, n.d.). l. Institutions must prioritize partnerships, communication, and alignment with the WHO network's goals. Institutional cultures, time zones, and resource availability make Collaboration difficult.

In conclusion, joining a WHO CC provides worldwide recognition, networking opportunities, resources, and the power to affect the global health agenda (Guide WHO CCs, 2018). However, institutions seeking to become CCs should understand the barriers of strict criteria, resource needs, relevance, and teamwork. By identifying and tackling these challenges, African institutions may contribute to global health initiatives and use digital health to enhance regional healthcare results (Fujita et al., 2021).

2.3 African-based Institutions in DH

Africa needs urgent technological, industrial, intellectual, and research-focused health solutions to meet the public's expectations. To transform Africa's health system, assume new health technologies. Country-specific information is needed to identify regional possibilities and restrictions for future initiatives. The WHO adopted a proactive approach (Manyazewal et al., 2021).

The WHO developed a 2020–2025 global DH agenda 2020 (WHO GSDH 2020-2025, n.d.). The strategy intended to advance and implement person-centered DH solutions that were appropriate, affordable, accessible, scalable, and sustainable to prevent, detect, and respond to epidemics and pandemics (Labrique et al., 2020). It also created the infrastructure and applications nations needed to utilize data to improve health and comply with health-related UN Sustainable Development Goals (Manyazewal et al., 2021). The WHO Regional Office for Africa (WHO-AFRO) created the health technologies and innovations program to improve access, quality, and rational use of medicines, medical products, and technologies. The program guides national health technology strategy evaluation, development, ethics, usage, and monitoring. In 2019, the WHO produced a guideline with DHT recommendations for health systems (WHO AFRO HT&I, n.d.). This section discusses African health systems and institutions' strengths, challenges, and potential to become DH WHO CCs.

2.3.1 Overview of African Health Systems and Institutions

Africa's health systems and institutions are vital to tackling healthcare issues and advancing digital health (Azevedo, 2017). African health systems involve government departments, regulatory authorities, academic institutions, research groups, NGOs, and the private sector. Stakeholders create and implement national health policies, programs, and initiatives (GIZ, 2019; Dizon et al., 2016). Technological advances, growing internet use, and mobile device accessibility rapidly transform Africa's digital health environment (Oleribe et al., 2019). African nations have primarily implemented EHRs, telemedicine, mHealth, and HISs, which have shown promise in improving healthcare access, quality, and efficiency (Waweru et al., 2019). Africa is developing DH initiatives, funding, regulations, and techniques to encourage technology use. To promote digital health growth, donors and partners help African countries improve their skills, resources, and capabilities (ADHI, n.d.). Due to IT infrastructure upgrades and digital readiness, mobile phone subscriptions are predicted to reach 46% in 2021, increasing DH affordability and uptake (McKinsey Digital Tools, n.d.).

The overall level of connectivity among individuals aged 18 and over was measured using mobile device connections, Internet usage, and social media usage. All countries had access to these technologies, and some even exceeded 100% mobile phone connectivity due to individuals owning more than one mobile device each (Porter et al., 2020). Because people might have several registered phone numbers, mobile connectivity, which measures the ratio of mobile connections to the population, can be higher than 100%. The average mobile phone connectivity across all countries was 101%, with a range of 169% in South Africa to 43% in Malaw (see Figure 3) (DHLR, 2020). eHealth and mHealth activities, including linking and providing healthcare services, rapidly expand across Africa and are primarily based on the country's gross national income. West Africa, Ghana, and Nigeria have reported active mHealth approaches, including many interventions, the emergence of iHubs for information, mLabs for diagnosis, and larger-scale private sector initiatives (DHLR, 2020; Porter et al., 2020).

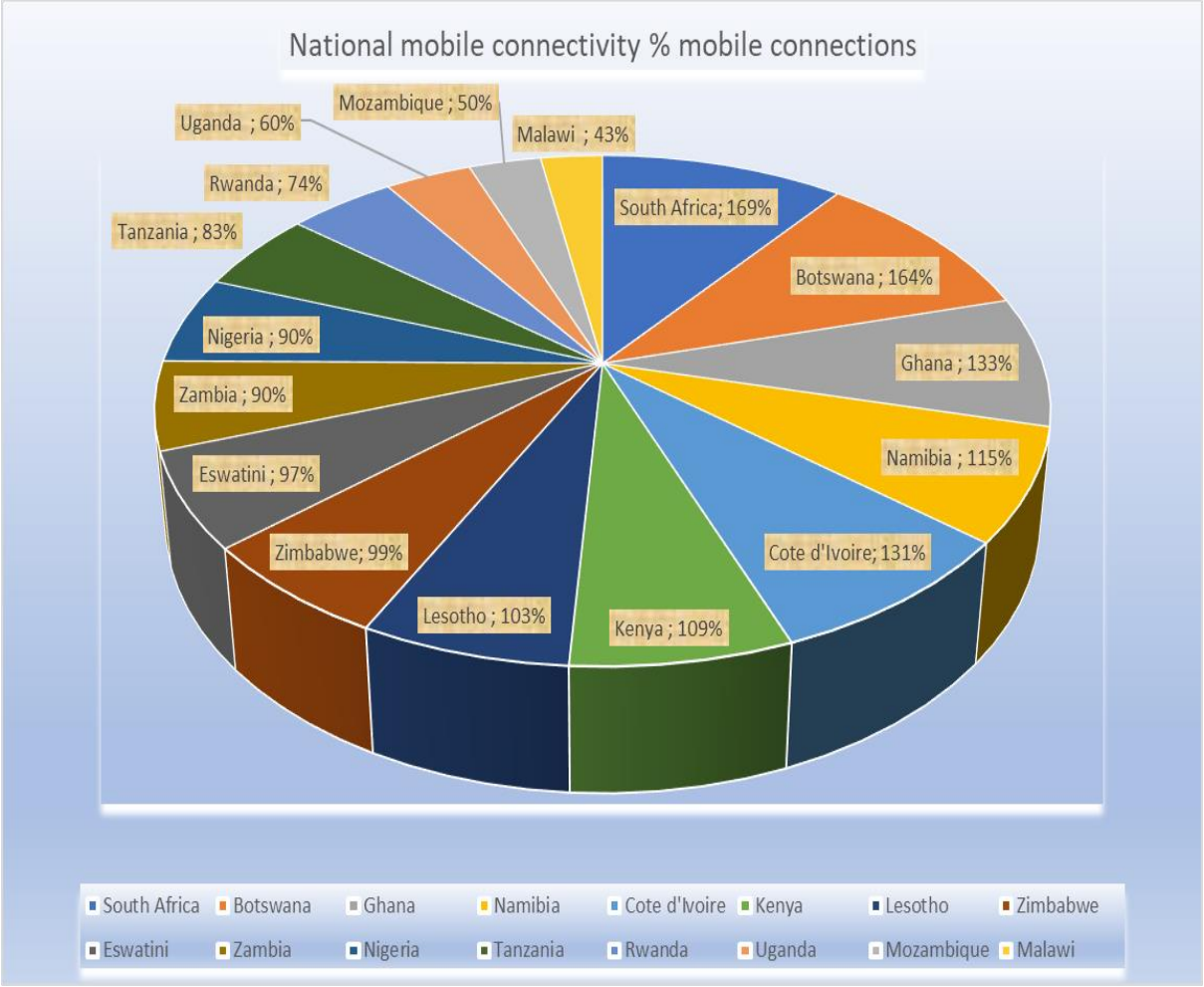


Figure 3: The mobile connectivity status of 16 African Countries. (Self-designed diagram based on sources: DHLR, 2020; Porter et al., 2020).

2.3.2 African-Based Institutions' Contributions to DH

To advance digital health in Africa, more potential obstacles, ecosystem evaluations, strong governance, leadership, and financial and implementation strategies are needed (Liu et al., 2019). All African Alliances for DH Networks, Digital REACH projects, and other partnerships with African-based Institutions should support these efforts. These relationships and African institutions' experience may help the region improve healthcare, evaluate outcomes, and develop sustainably. African foundations improve DH through research, capacity development, policymaking, and project execution (ADHI, n.d.). Their advances in DH suggest they might become WHO CC. Their skills and engagement are essential to developing Africa's DH environment, promoting good change, and attaining sustainable healthcare development (Olu et al., 2019).

Research in Digital Health: African-based institutions have significantly contributed to DH research by studying how digital technologies impact healthcare outcomes and delivery (Owoyemi et al., 2022). This research has shown that telemedicine, EHRs, HISs, and mHealth interventions improve patient access, disease monitoring, and health systems. These studies have influenced public policy and increased evidence of DH therapies' efficacy in Africa (Victor et al., 2023).

Capacity Building and Training: Digital clinics in Africa employ medical technology for remote diagnostics, meeting the demand for more skilled healthcare staff (Olu et al., 2019). Zambia, South Africa, and The Gambia have successfully used computer-aided chest X-ray TB diagnosis. Tanzania uses mHealth and telemedicine for digital ultrasound. Kenya, Tanzania, and Ghana deploy cloud-based mHealth Smart Reader systems with rapid diagnostic testing (RDT). Malawi and Uganda employ smartphone-powered, cloud-connected electrocardiographs (ECGs) to assess heart health (Victor et al., 2023).

Policy Development and Implementation: African institutions have taken on the role of DH policy development and implementation. They developed national DH plans, policies, and recommendations with governments, health ministries, and international organizations (Labrique et al., 2020). These joint projects meet African needs and align the DH agenda with international standards and best practices. African groups have also developed and implemented DH programs, shown viable models, and promoted their adoption in their native countries (Victor et al., 2023). They also stressed creating an enabling environment with legislation, standards, acceptable technical and service delivery alternatives, and sufficient human and financial resources (Olu et al., 2019).

Innovation and Collaboration: African institutions have innovated DH solutions. Mobile technology, inexpensive equipment, and locally relevant applications have addressed healthcare problems. Examples include telemedicine platforms for remote consultations, health information systems for data gathering and analysis, and disorder-regulating smartphone apps (Labrique et al., 2020). African institutions collaborate with international partners, academic institutions, and the private sector to utilize resources, exchange knowledge, and foster reciprocal learning (Olu et al., 2019). These collaborations have improved the efficacy and sustainability of digital health projects. The WHO and ITU created a national eHealth toolkit to standardize and guide governments in adopting eHealth policies (WHO & ITU Africa, 2017).

Potential for Becoming WHO CCs: African institutions will likely become WHO CCs in DH. Their talents and passion for DH research, capacity development, policy formation, and innovation are evident. These organizations may become WHO CCs to improve their skills, resources, and networks. This recognition would enhance their technical assistance, best practice sharing, and worldwide DH understanding. As WHO CCs, these institutions may support African DH goals and provide regional policies and recommendations (Olu et al., 2019).

In conclusion, Africa-based institutions have significantly contributed to DH on the continent. The DH agenda has focused on research, capacity development, policymaking, and innovation to improve healthcare outcomes. These organizations may assist in building WHO CCs for DH by maximizing their strengths and potential. This recognition might help them influence, collaborate, and develop DH in Africa.

2.3.3 Relevance of African-Based Institutions

African institutions have a good potential for becoming WHO CCs in DH due to their unique strengths, contextual understanding, and ability to address Africa's healthcare concerns. These organizations may improve DH in Africa and beyond by becoming WHO CCs, exchanging knowledge, and developing capacity. These characteristics demonstrate the relevance of African-based institutions in this capacity (WHO & ITU Africa, 2017).

Contextual Understanding: African institutions understand the local healthcare context, prevalent diseases, varying health systems, and socioeconomic variables well. This local knowledge allows them to create and implement customized DH solutions for African communities. These universities' expertise can help build novel and contextually suitable DH treatments that address the continent's unique healthcare concerns (WHO & ITU Africa,

2017). To maximize the promise of DH in Africa, context-specific treatments must be implemented within solid health systems, resilient communities, and socioeconomic determinants of health. This comprehensive strategy keeps DH efforts aligned with local needs, maximizing their impact and benefits (Olu et al., 2019).

Local Capacity Building: African institutions can help boost DH capabilities. Healthcare workers, policymakers, and other stakeholders may benefit from training and empowerment to utilize digital technology to enhance healthcare delivery (Tran Ngoc et al., 2018). As WHO CCs, these institutions may collaborate with international partners, share best practices, and standardize training programs to increase capacity. Communication, coordination, and knowledge gaps between public health and ICT stakeholders must be addressed (WHO & ITU Africa, 2017). Doing so will teach thousands how to administer and maintain DH infrastructure. This unified strategy helps African DH programs grow and endure (Olu et al., 2019).

Collaborating and Networking: African institutions may interact with global DH institutions and stakeholders by becoming WHO CCs. This cooperation promotes innovation and effective DH practices by sharing knowledge, experience, and resources. African Institutions may acquire money, collaborate on research, and advocate for regional and international policy through building solid networks (WHO & ITU Africa, 2017). This partnership also promotes regional and national DH technology integration, flexibility, and interoperability by setting standards and protocols. This helps African DH projects collaborate and share data, improving healthcare delivery and results (Olu et al., 2019).

Representation and Influence: African institutions are vital to global DH discussions and decision-making processes as WHO CCs. This representation ensures that African concerns and healthcare issues are addressed. It also lets African institutions shape global DH policies, standards, and recommendations to fit the African situation (Tomlinson et al., 2013). In addition to long-term financing, DH programs must be evaluated for efficacy, impact, and cost (Olu et al., 2019). These studies help decision-makers decide how to deploy DH treatments and their feasibility in each country.

Promoting Innovation and Research: African institutions may lead DH research and innovation. Partnerships with other WHO CCs and international partners may help them create novel technology, initiatives, and evidence-based practices. This cooperative method encourages Africa to foster a culture of innovation and research, which advances DH and improves African health (Tran Ngoc et al., 2018). DH initiatives must engage, mobilize, and

educate communities and other stakeholders who will adopt DH solutions. Their involvement is essential to shaping and improving these initiatives. African institutions must become WHO CCs in DH. They contribute to the global DH agenda via contextual knowledge, capacity-building, collaboration, representation, and innovation promotion (Olu et al., 2019). Maximizing their potential and addressing challenges may help these organizations spread DH solutions that enhance healthcare delivery and outcomes in Africa and globally.

2.3.4 Advantages of African-Based Institutions Becoming WHO CCs in DH

Digital healthcare technologies might improve access, especially for distant and underprivileged patients. Improving knowledge dissemination and access to health information for healthcare workers and communities improves healthcare delivery safety and quality by increasing workforce productivity and health service (Roess, 2017). By improving efficiency, digital technology may cut healthcare delivery costs (Shuvo et al., 2015). They speed up the transmission of real-time public health data, improving program effectiveness and health system functioning. Additionally, digital technology may help detect and solve sociological, physical, and economic barriers to healthcare, boosting equality. Health insurance programs may be more efficient through digitization (Roess, 2017).

To succeed, DH initiatives must match societal needs, development objectives, and national health agendas. To increase the value of these initiatives while keeping them affordable and context-specific, they must be scaled up (Konduri et al., 2018). The foundation for Universal Health Coverage (UHC) may be laid by DH, which can provide excellent and affordable healthcare to even the most remote areas (Olu et al., 2019; Shuvo et al., 2015). Major foreign funders are becoming more aware of the advantages of African-led initiatives in DH (Kasprowicz et al., 2020; Izugbara et al., 2017). The National Institutes of Health (NIH), the Wellcome Trust, and the African Academy of Sciences are supporting the Human Heredity and Health in Africa (H3Africa) initiative from 2011 to 2021, as is the President's Emergency Plan for AIDS Relief (PEPFAR) of the United States and the Medical Education Partnership Initiative (MEPI) from 2010 to 2015 (Kasprowicz et al., 2020).

African-led projects have unique benefits for DH programs. Establishing national and international collaborations centered on research objectives may be guided by African institutions, well-positioned to identify and contextualize critical local challenges (Kasprowicz et al., 2020; Noormahomed et al., 2013). African institutions that take the initiative:

Enhanced Collaborating and Networking: African institutions will have more opportunities to cooperate with other top organizations and leading authorities on DH worldwide if they become WHO CCs (AU DTSA 2020-2030, n.d.). Through this cooperation, information, skills, and best practices may be shared, encouraging innovation and the creation of successful DH solutions (Ibeneme et al., 2020). African-based institutions may access global resources, research partnerships, and financing possibilities via cooperative initiatives, enhancing their ability and influence (WHO GSDH 2020-2025, n.d.).

Recognition and Credibility: African institutions benefit from worldwide recognition and legitimacy thanks to their designation as WHO CCs (AU DTSA 2020-2030, n.d.). This honor confirms their expertise and contributions to digital health nationally and internationally. Due to their enhanced reputation and standing as dependable partners, CCs will be better able to cooperate and communicate with governmental entities, non-governmental organizations, and other stakeholders (WHO CCs AFRO, 2019). The prestige of becoming an official WHO CC may lead to more options for financing, collaborative research, and policy impact (WHO CCs, n.d.).

Access to Resources and Technical Support: African institutions may access WHO and other CC resources, tools, and technical assistance as WHO CCs (AU DTSA 2020-2030, n.d.). Guidelines, training materials, data repositories, and technical knowledge are examples. African institutions may use these resources to create and execute DH solutions that meet their populations' health needs (WHO CC, n.d.)

Capacity Building and Training: WHO CCs are essential for training and capacity development. By establishing collaborative hubs, African institutions may teach more healthcare practitioners, policymakers, and researchers about DH (WHO CCs AFRO, 2019. This develops a competent workforce that can execute and maintain DH solutions. African institutions' capacity-building efforts improve healthcare systems, delivery, and results (Amde et al., 2014).

Policy Influence and Advocacy: WHO CCs may impact DH policy development and advocacy. CCs may reflect the African context and advocate for policies and initiatives addressing the continent's concerns (AU DTSA 2020-2030, n.d.). Regional and national DH policies, standards, and recommendations may be contextually relevant and tailored to African communities (IPESSA 2021-2007, n.d.).

Knowledge Transfer and Localization: WHO CCs can help African institutions transfer and localize DH technologies (AU DTSA 2020-2030, n.d.). They may adapt DH tools to the local language, culture, infrastructure, and resources (Mairs et al., 2013). This localization method ensures the long-term effect and relevance of DH treatments in Africa (Rinke De Wit et al., 2022).

In conclusion, African institutions may greatly benefit from becoming WHO CCs in DH. These institutions can advance DH in Africa through improved cooperation, recognition, resource access, capacity development, policy impact, and knowledge transfer (WHO CCs AFRO, 2019). By exploiting these advantages, African institutions may innovate, enhance healthcare delivery, and improve African health outcomes.

2.4 Challenges and Limitations of African-based Institutions

While there are several benefits to being a WHO CC for DH, African-based institutions face several obstacles and restrictions. These difficulties may make it more difficult for them to build and maintain partnerships with the WHO and fully take advantage of the advantages of having CC accreditation. The following are significant challenges and limitations:

Limits on resources: African-focused institutions usually require more funding, infrastructure, and personnel. Technology, equipment, and people investments are crucial to becoming a WHO CC (WHO CCs AFRO, 2019). Institutions might quickly meet the WHO's requirements and objectives with enough money. Lack of funds may require enhancing their research capacity, developing novel solutions, and implementing long-term DH initiatives (ECDPM, n.d.).

Gaps in Capacity and Expertise: African-based institutions may need help having the capacity and knowledge to become WHO CCs. High levels of technological expertise, research prowess, and familiarity with DH procedures are required for the process (Silenou et al., 2021). Many African institutions, though, need to improve in these areas, such as restricted access to chances for professional development and training (ECDPM, n.d.). Developing the requisite expertise and capacity within institutions could take some time and outside assistance (Kasprowicz et al., 2020).

Regulatory and Policy Frameworks: In some cases, operating institutions based in Africa within the regulatory and policy frameworks that regulate them may be challenging (ECDPM, n.d.). These frameworks may need to adequately address each individual's needs

and objectives for becoming a WHO CC. Institutional policies, governance, and legal frameworks may need to be modified or created from inception to comply with WHO standards and recommendations (WHO GSDH 2020-2025, n.d.; Labrique et al., 2018). Collaborating with key stakeholders and government institutions is crucial to resolving these regulatory and policy issues (DRP, n.d.).

Limited Collaborating Culture: Collaborative cultures and effective partnerships are crucial for the success of WHO CCs. However, African-based institutions may face challenges establishing and maintaining collaborations with local and international stakeholders. Competition for limited resources, institutional hierarchies, and cultural barriers can hinder effective Collaboration. Building a collaborative culture requires fostering trust, promoting knowledge sharing, and creating platforms for dialogue and cooperation (Morrison-Smith & Ruiz, 2020).

Data and information management: WHO CCs are expected to increase global knowledge through data interchange, research publication, and information management. Due to the lack of health information systems and the diversity of data sources, African institutions may face data collection, management, and sharing challenges (Poppe et al., 2021). Investments in reliable health information systems, data privacy, security safeguards, and interoperability standards are required to address data patient management concerns (Koumamba et al., 2021).

Sustainability and Long-Term Dedication: Becoming a WHO CC is a continuous process that necessitates continued dedication and sustainability. Achieving optimal improvement of health financing functions and universal health coverage is impossible without sufficient health financing, infrastructure, and human capacity to sustain Digital Health solutions (Schuetze et al., 2023). Over time, African-based institutions may experience challenges sustaining their activities and maintaining the requisite degree of involvement with the WHO. This problem is especially acute in resource-limited environments, where competing agendas and inadequate finance might jeopardize the long-term viability of CC activities (Nölting et al., 2020). African governments, international organizations, academics, and the development partner sector must collaborate to address these challenges and limitations (Cohen et al., 2022). Strategies should focus on building institutional capacity, improving Collaborating frameworks, pushing for supporting legislation, and mobilizing resources to help create and sustain WHO CCs in Africa (WHO CCs AFRO, 2019).

Chapter 3: Research Methodology

This research method in Chapter 3 describes the study's design, collection, and data analysis. The research issue was fully understood using a combined study design with quantitative and qualitative methods.

3.1 Study Design and Approach: Mixed Study

The study's mixed-methods approach integrates quantitative and qualitative data to complete the concept's investigation by collecting and analyzing numerical data and recording in-depth ideas and opinions. Combining these approaches would help it comprehend the importance of African institutions becoming WHO CCs for DH.

3.1.1 Current Scientific Literature

A careful review of the existing scientific literature was prepared for the thesis. This required carefully reviewing WHO CC, DH, and African-based institution research articles, reports, and publications. The literature review identified knowledge gaps and guided thesis questions and objectives.

Systematic Literature Review: According to Okoli (2015), research that aims to make a meaningful contribution should use a methodical approach when reviewing existing literature. This study examined the scholarly literature on digital health (DH), World Health Organization Collaborating Centres (WHO CCs), and African-based institutions. A systematic literature review was conducted by analyzing relevant databases, academic journals, and grey literature sources to ensure thoroughness. The thesis utilized keywords and MeSH terms related to DH, WHO CCs, and African institutions to search databases like PubMed, Scopus, and Google Scholar. The review included papers from various African locations and institutions with a solid African perspective to ensure diverse viewpoints were considered. By carefully reviewing the reference lists of the included papers, relevant research was found, expanding the review's scope. Predefined inclusion and exclusion criteria helped curate a high-quality, relevant content body. Systematic data extraction and synthesis revealed critical themes, gaps, and literature findings. Notably, the databases used for this purpose contain many scholarly articles and research papers from several fields, encompassing all aspects of digital health.

3.1.2 Quantitative Study: Identification of WHO CC Database

The quantitative analysis identified and examined the WHO CCs database. This extensive database gave helpful insights into the efforts and contributions of these Centres, including their particular areas of concentration, teamwork, geographical location, and noteworthy accomplishments (WHO CC Database, n.d.). Through systematic data collection and analysis, quantitative results were achieved to evaluate the absence of contributions of African institutions within this domain of WHO CCs for DH (WHO CCs AFRO, 2019).

3.1.3 Qualitative Study: Expert Interviews

Preparation and Participant Selection: Expert interviews constitute a specialized form of qualitative individual surveys and represent a comprehensive approach to engaging experts in discussions about specific subject areas or topics (Döringer, 2021). In qualitative research, expert interviews are considered an intervention wherein an interview guide is aligned with established techniques or questioning methods (Kaiser, 2021). These interviews harness experts' unique factual and experiential knowledge, enabling insightful access to areas of expertise (Flick, 2018). Expert interviews are a widely employed qualitative research method within the social sciences, primarily aimed at eliciting specialized insights and knowledge from individuals possessing expertise in distinct fields (Kaiser, 2021. These interviews serve as conduits for information collection and tap into the wellspring of expert knowledge, offering invaluable perspectives on the research subject (Glaser & Laudel, 2019). Unlike other types of interviews, expert interviews do not seek to establish an objective truth. Instead, they operate on the premise that the data and insights provided by experts are inherently valid (Bogner et al., 2014). Consequently, the emphasis lies on collecting expert perspectives rather than constructing meaning.

Expert interviews were conducted as a foundational aspect of the qualitative study to glean profound insights and perspectives from essential stakeholders within digital health. A meticulous and rigorous preparatory phase preceded these interviews, encompassing the creation of a purposeful interview guide and identifying relevant subject matter specialists. The interview guide was meticulously crafted to contain various topics, including the significance of institutions focused on Africa, the challenges these institutions face, and potential strategies for collaborative engagement with WHO. The selection of interview participants carried immense significance, aiming to ensure a comprehensive representation of viewpoints. Critical criteria guiding participant selection included expertise in digital health, prior engagement with WHO, and regional model. Adopting a purposeful sampling strategy was instrumental in ensuring a judicious blend of perspectives and experiences among the interviewees.

3.1.4 Sample Strategy Selection of the Qualitative Study

Inclusion & Exclusion: The sampling approach for this thesis involves choosing organizations based in Africa and specialists in the field of DH who have worked with WHO before. Institutions must actively engage in DH projects and be interested in joining the WHO CC network. Institutions that failed to meet the eligibility requirements or needed more means or capacity to participate in joint efforts were subject to exclusion criteria (Adams et al., 2017).

Sample Size Determination: The systematic literature review sample size was based on the number of relevant articles found throughout the search. It included enough studies to summarize the field's latest research. The sample size for the qualitative interviews was chosen based on data saturation. Data saturation occurred when there was no longer any more data to be gleaned from additional interviews. To ensure that the viewpoints and experiences of essential stakeholders were appropriately represented, the sample size was modified iteratively until data saturation was attained (Hennink & Kaiser, 2022).

Sampling Bias and Limitations: Despite extensive sampling efforts, limitations and sampling biases may exist. This systematic literature review may have publication bias because it only includes published studies and excludes grey literature. Key stakeholders' availability and willingness to participate may limit the quality of interviews. Data gathering, analysis, and interpretation reduced these biases and limitations (Andrade, 2021).

3.2 Data Collection

This section presents the data collection methods employed in the thesis to gather information and insights on the relevance of African-based institutions becoming WHO CCs in DH. The data collection process incorporated document analysis, database research, and interviews, enabling a comprehensive exploration of the topic (Mazhar et al., 2021)**.** Using proper approaches, the obtained data will be managed and analyzed. Thematically organized and synthesized data from the literature review will be used to identify significant themes, research needs, and patterns in the literature. To detect trends and practices in the activity of WHO CCs, quantitative data acquired from the WHO will be analyzed using statistical methods (ibid.). Thematic analysis will uncover reoccurring themes and codes in the interview's qualitative data.

3.2.1 Data from Scientific Literature of Document Analysis

Document analysis involved the systematic review and analysis of scientific literature related to WHO CCs, DHs, and African-based institutions. A comprehensive search was conducted using scholarly databases, research repositories, and relevant journals. In the DH domain, the selected keywords ("digital health," "WHO Collaborating Centres," "African-based institutions," "health informatics," "telemedicine," "mHealth," "eHealth," or "health technology") were used as search terms at PubMed and Scopus, and they were combined with the word "AND" by refining initial search results and conducting backward and forward searches. Each article was carefully examined for its components, entities, explanations, and value propositions. Specific criteria were used to select publications for this thesis to ensure accuracy and relevance. Only publications written in English and German were considered, and studies that referred to Digital Health, WHO CCs and African-based institutions were included. Any studies outside this domain were excluded; studies on Digital Health, WHO CCs, and African-based institution ecosystems were included. The next step, collecting data (see Figure 4), was done similarly on paper and with Zotero, a software used to manage literature references (Zotero, n.d.). The PRISMA Flow Chart in Figure 7 shows the entire selection process (Page et al., 2021).

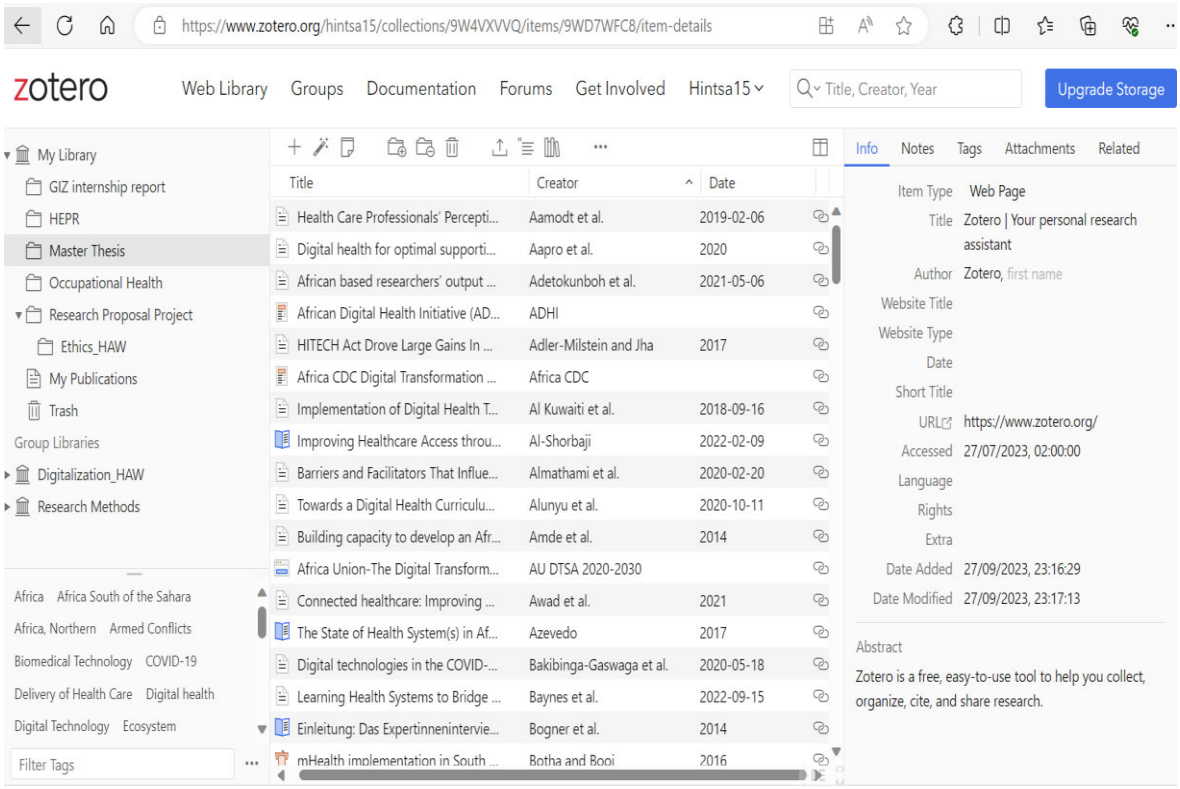


Figure 4: A screenshot of Zotero's software manager application collecting literature references and data from different databases. (Source: Zetero, n.d.).

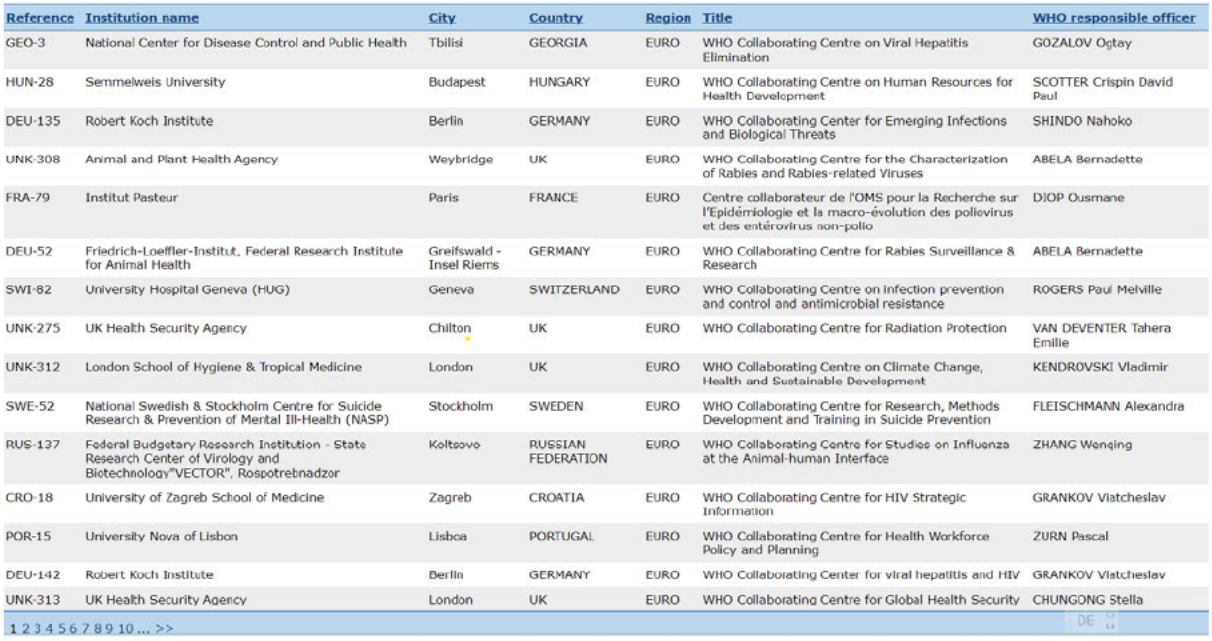
3.2.2 Data from Database (Quantitative Study)

The quantitative study relied on data from the WHO CC database related to all medical fields and health issues. The database provided valuable information about these CCs' activities, Collaborations, and impact. A systematic approach was implemented to extract relevant data from this database of the WHO CCs, including the geographic distribution of collaborating Centres, their focus areas on health topics, and their engagement in health system initiatives. The quantitative analysis of this data aimed to provide a comprehensive overview of the involvement of African-based institutions in this context.

In the quantitative Thesis, an analysis was performed using data from the WHO CC database. This database contained information on the locations of the 811 presently recognized CCs throughout all six WHO regions (WHO CC Database, n.d.). The study showed a noticeable imbalance in the geographic distribution of CCs, with a distinct preference for high-income nations and specific areas. Data on the Collaborating Centres in all six WHO regions are collected from the WHO Collaborating Centres Global database in Excel format (ibid.). To illustrate the regions with the highest and lowest number of CCs, data is presented through screenshots, such as Figure 5 for the WHO AFRO region and Figure 6 for the WHO EURO region.

Reference	Institution name	City	Country	Region	Title	WHO responsible officer
SOA-48	University of Pretoria	Pretoria,	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Prevention of Deafness and Hearing Loss	CHADHA Shelly
MAD-6	Institut Pasteur de Madagascar	Antananarivo	MADAGASCAR	AFRO	WHO collaborating center on plague control and research	BERTHERAT Eric Gerard Georges
SOA-49	University of the Free State	Bloemfontein	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Vaccine Preventable Diseases Surveillance and Pathogens Genomics	MATHIU Jason Mwenda
SOA-27	National Institute for Occupational Health (NIOH)	Johannesburg	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Occupational Health	PEGA Frank
GAB-2	Centre International de Recherches Médicales de Franceville	FRANCEVILLE	GABON	AFRO	WHO Collaborating Centre for Arboviruses and Viral Haemorrhagic Fevers	FORMENTY Pierre B.H.
MAL-3	University of Malawi	Lilongwe	MALAWI	AFRO	WHO Collaborating Centre for Interprofessional Education and Collaborative Practice	ASAMANI James Avoka
NIE-23	University of Ibadan	Ibadan	NIGERIA	AFRO	WHO Collaborating Centre for Research & Training in Mental Health, Neurosciences & Drug & Alcohol Abuse	HANNA Fahmy
TAN-8	Public Health Laboratory Ivo de Carneri (PHL-IdC)	Pemba, Zanzibar	UNITED REP. TANZANIA	AFRO	WHO Collaborating Centre for neglected tropical diseases	MUPFASONI Denise
SOA-38	University of KwaZulu-Natal	Durban	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Pharmaceutical Policy and Evidence Based Practice	IYENGAR Swathi Bhargav
SOA-34	University of Cape Town	Cape town	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Mental Health and Psychiatry	GRAY Brandon
SOA-43	National Institute for Communicable Diseases	Johannesburg	SOUTH AFRICA	AFRO	WHO Collaborating Centre for Antimicrobial Resistance	COULIBALY Sheick Oumar
ETH-5	Addis Ababa University	Addis Ababa	ETHIOPIA	AFRO	WHO Collaborating Centre for Mental Health research and capacity-building	CHOWDHARY Neerja
BFA-4	Laboratoire National de Santé Publique	Ouagadougou	BURKINA FASO	AFRO	WHO Collaborating Center on Tobacco Product Testing and Research	FAYOKUN Ranti
BOT-3	University of Botswana	Gaborone	BOTSWANA	AFRO	WHO Collaborating Centre for Nursing and Midwifery Development	ASAMANI James Avoka
COD-1	Institut National de Recherche Biomédicale	Kinshasa - Gombe	DEM. REP. OF CONGO	AFRO	WHO collaborating centre for reference and training on diagnosis of human African trypanosomiasis	FRANCO MINGUELL Jose Ramon

Figure 5: A screenshot of the Collaborating Cntres' data in the WHO AFRO region. (Source: WHO CC Database, n.d.).



Reference	Institution name	City	Country	Region	Title	WHO responsible officer
GEO-3	National Center for Disease Control and Public Health	Tbilisi	GEORGIA	EURO	WHO Collaborating Centre on Viral Hepatitis Elimination	GOZALOV Ogtay
HUN-28	Semmelweis University	Budapest	HUNGARY	EURO	WHO Collaborating Centre on Human Resources for Health Development	SCOTTER Crispin David Paul
DEU-135	Robert Koch Institute	Berlin	GERMANY	EURO	WHO Collaborating Center for Emerging Infections and Biological Threats	SHINDO Nahoko
UNK-308	Animal and Plant Health Agency	Weybridge	UK	EURO	WHO Collaborating Centre for the Characterization of Rabies and Rabies-related Viruses	ABELA Bernadette
FRA-79	Institut Pasteur	Paris	FRANCE	EURO	Centre collaborateur de l'OMS pour la Recherche sur l'Epidémiologie et la macro-évolution des poliovirus et des entérovirus non-polio	DIOP Ousmane
DEU-52	Friedrich-Loeffler-Institut, Federal Research Institute for Animal Health	Greifswald - Insel Riems	GERMANY	EURO	WHO Collaborating Centre for Rabies Surveillance & Research	ABELA Bernadette
SWI-82	University Hospital Geneva (HUG)	Geneva	SWITZERLAND	EURO	WHO Collaborating Centre on infection prevention and control and antimicrobial resistance	ROGERS Paul Melville
UNK-275	UK Health Security Agency	Chilton	UK	EURO	WHO Collaborating Centre for Radiation Protection	VAN DEVENTER Tahera Emilie
UNK-312	London School of Hygiene & Tropical Medicine	London	UK	EURO	WHO Collaborating Centre on Climate Change, Health and Sustainable Development	KENDROVSKI Vladimir
SWE-52	National Swedish & Stockholm Centre for Suicide Research & Prevention of Mental Ill-Health (NASP)	Stockholm	SWEDEN	EURO	WHO Collaborating Centre for Research, Methods Development and Training in Suicide Prevention	FLEISCHMANN Alexandra
RUS-137	Federal Budgetary Research Institution - State Research Center of Virology and Biotechnology"VECTOR", Rospotrebnadzor	Koltsovo	RUSSIAN FEDERATION	EURO	WHO Collaborating Centre for Studies on Influenza at the Animal-human Interface	ZHANG Wenqing
CRO-18	University of Zagreb School of Medicine	Zagreb	CROATIA	EURO	WHO Collaborating Centre for HIV Strategic Information	GRANKOV Viatcheslav
POR-15	University Nova of Lisbon	Lisboa	PORTUGAL	EURO	WHO Collaborating Centre for Health Workforce Policy and Planning	ZURN Pascal
DEU-142	Robert Koch Institute	Berlin	GERMANY	EURO	WHO Collaborating Center for viral hepatitis and HIV	GRANKOV Viatcheslav
UNK-313	UK Health Security Agency	London	UK	EURO	WHO Collaborating Centre for Global Health Security	CHUNGONG Stella

1 2 3 4 5 6 7 8 9 10 ... >>

Figure 6: A screenshot of the Collaborating Centres' data in the WHO EURO. (Source: WHO CC Database, n.d.).

Data was gathered from the global database of WHO CCs and compiled in an Excel sheet. The number and distribution of WHO CCs in six regions are presented in Table 1. The table indicates that only 25 CCs are in the WHO AFRO region, accounting for 3% of worldwide CCs. Conversely, the WHO EURO region has the highest number of CCs, with 267, representing 33% of all CCs across the six regions of WHO.

Table 1: The Quantity and allocation of WHO Collaborating Centres across all six regions. (Self-designed table based on the Source: WHO CC Database, n.d.).

WHO Collaborating Centres		
WHO Regional	**Number of WHO CC in the region**	**Location of WHO CCs in Percentage**
AFRO	25	3%
EMRO	56	7%
SEARO	94	11%
AMRO	177	22%
WPRO	192	24%
EURO	267	33%

3.2.3 Data from the Expert Interviews (Qualitative Study)

Participant Selection and Approach: The author of this thesis surveyed while concurrently engaged in part-time work at GIZ. Through this affiliation, the author established connections that facilitated the execution of expert interviews, leveraging associations with WHO, African-based institutions, and international development partners. In this case, the author initiated a step to establish direct communication by sending personal emails to all chosen interviewees. The content of the emails adhered to a consistent template. The cover letter, drafted in English for four interviewees, encompassed various aspects. These included outlining the anticipated interview duration, suggesting potential interview dates, requesting permission to record the interview, and highlighting the assurance of data anonymization. These elements were strategically incorporated into the cover letter to enhance the appeal and willingness of potential participants to partake in the survey.

The qualitative study involved engaging critical stakeholders for interviews, including representatives from WHO, international development partners, and institutions prioritizing an African focus. These individuals are acknowledged experts in the domain of digital health. The interviews were facilitated using a flexible guide to explore the pertinent subject matter. The discussions during the interviews were meticulously audio-recorded and subsequently transcribed to facilitate comprehensive analysis. Two of the four interviewees expounded on Health Informatics within African-based institutions. One interviewee was affiliated with WHO, while another represented the international development partner segment.

The interviews, on average, spanned approximately 15 to 20 minutes. Once all the requisite interview documents, encompassing the consent form, interview guidelines, and interview questions, were methodically prepared, meticulous planning and coordination with subject matter experts well-versed in the operations of WHO CCs and the sphere of Digital Health was imperative. Moreover, a considerable window of time was afforded to these stakeholders to facilitate communication. Caution was exercised to avoid contacting participants during public holidays or vacation periods, considering the possibility of extended response times or potential non-compliance with interview requests. The prepared questions for the interview, including open-ended questions, were sent to the selected experts. The respondents were given an introduction to the thesis and informed consent (see Appendices A, B, and C). The experts were requested to read the informed consent carefully and sign it if they agreed.

Conducting expert interviews Procedure: The experts for the four interviews were selected according to the following criteria. The chosen actors are active in practice and have experience working with the target group. In addition, various areas of activity should be covered. To obtain practical experience and results, four guideline-based expert interviews were conducted with various actors from WHO, African-based Institutions, and international development partners between June 2023 and July 2023. The four expert interviews were conducted as individual Video calls on MS Teams. The content of the discussions was summarized, and the interviews resulted in various responses and categorizations. For example, the initial results in the excerpts indicate that Awareness and Familiarity with WHO Collaborating Centres and an individual approach play a significant role in cooperation with African-based institutions. Furthermore, assessing the relevance, factors influencing the relevance, support, and promotion, the benefits of African-based institutions, challenges, and recommendations were identified as codes and focal points.

The survey of experts aims to obtain expert knowledge from lived practice. This knowledge is also called process knowledge and includes events, interactions, or even an insight into action sequences in practice. This type of knowledge is experiential and strongly tied to locations or people (Bogner et al., 2014). Creating a checklist in Excel in advance to prepare for the interview was essential. The list helped the interview process prepare well for the interview to be carried out. It has served as a reminder. At the beginning of the interview, the interviewer should briefly introduce themselves and the project. The interviewer should also explain why the conversation is being recorded. The question might arise as to why a conversation guide is used. The interview guide ensures the comparability of the interviews during the evaluation. The interview will be recorded using the online recording feature on MS Teams. The interview recording primarily serves as a backup of the data and the later transcription (Kaiser, 2021). The audio recording will be deleted after the transcribed interview.

The following rules were observed for the transcription of the expert interviews:

- **Comprehensive Transcription:** The entire dialogue was transcribed.
- **Anonymization**: Personal data underwent meticulous anonymization procedures.
- **Structural Clarity**: The sequential numbering of all dialogue lines was undertaken, enhancing the overall clarity of the transcribed content.
- **Structural Markers:** Different capital letters were employed to demarcate distinct locations within the interview (Döringer, 2021).

The Interview Situations and Procedures: The interviewees were informed of the anticipated planning time before the appointments. This lets interviewees make an informed

choice about participating in the expert interview. If the Internet connection permitted it or the interviewees gave their consent, MS Teams would conduct the interviews using video cameras. It is preferable to interview in person to obtain the most realistic picture of the participants' lives. Due to the distances and occasionally challenging scheduling, this could not be accomplished (the interviewees had to postpone two interviews on short notice). The Video camera on MS Teams was a supporting component, and the interviewers could see one another. Through MS Teams, three interviews were conducted entirely on video Cameras. One interviewer switched off the video Camera due to a poor internet connection.

The interviewer briefly outlined the procedure and explained the method used to start the interviews. He informed the respondent that the questions were open-ended, not "right" or "wrong." The interviewer provided the interviewee another opportunity to ask questions once all the questions prepared per the question criteria had been addressed. The interviewer asked the interviewee to affirm that the audio-video recording may begin after assuring no further questions concerning the procedure. After the recording was complete, there may have been an interview evaluation that looked more closely at the interview assessment the interviewees provided. Except for two interviewees who actively addressed a reflection on the interview, this needed to be included. Additionally, the agreed-upon interview time was wholly or nearly overrun when the final question was addressed.

Ensuring the anonymity of Interview Participants: Interviewees were protected under strict confidentiality and anonymity procedures. The interviewees' identities were changed in the transcripts to protect their privacy and prevent accidental publication. Thus, interview transcripts were organized and consistent. A common term was used instead of participant names. This designated those who participated in "Interviewee 1," "Interviewee 2," "Interviewee 3," and "Interviewee 4." This approach preserved participant anonymity and ensured documentation clarity and consistency. This approach hid interviewees' identities from transcription, analysis, and publication. This precaution showed the Thesis's dedication to ethical research and respecting the privacy and anonymity of its contributors.

Overall, the data collection methods implemented in this thesis included a scientific literature review, database examination for the quantitative research, and expert interviews for the qualitative analysis. These methodologies in the thesis provided a comprehensive range of data sources, enabling a holistic exploration of the research topic. The subsequent section of the chapter will analyze the collected data, providing valuable insights into the relevance of African-based institutions becoming WHO CCs in DH.

3.3 Data Analysis of the Qualitative Study

This section presents the data analysis methods employed in the Thesis to analyze and interpret the data collected mainly from expert interviews in qualitative studies. The data analysis process involved qualitative data transcription and content analysis to derive meaningful insights.

3.3.1 Transcription Procedure

Transcription was done on the interviews that were conducted as part of the qualitative research project so the analysis could go more smoothly. The transcription process was done carefully to capture verbal and nonverbal communication during the interviews accurately. This was necessary for the research process to ensure accuracy and provide a written report of the interview material (Fuß & Karbach, 2019). The interviews were listened to several times to provide an accurate transcription that retains details, pauses, and intonations. Afterward, based on their transcribed data, each interview participant's information was meticulously divided into several categories. A careful setup was made at the second analysis step to improve Data accessibility, and effective administration was prioritized during the investigation. To protect the identity of each interviewee, they were each assigned a number, such as Interview 1, -2, -3, and -4. They had these numbers in the final report. English was used for the interviews. Following the thesis's conclusion, all audio and video recordings of the interviews were deleted, and the transcripts will not be used for any other purpose.

3.3.2 Content Analysis of the Qualitative Data

Content analysis was used to generate conclusions from expert interview qualitative data. The data were grouped into codes, categories, and subjects for easy management. Content analysis was based on a system of coding focused on the thesis's objectives and data patterns (Kaiser, 2021). Based on the content and relevance to the research objectives of the various parts of the transcription, pertinent codes were assigned after a comprehensive evaluation of the transcribed data. The coded data was then arranged into categories and themes to capture the interviews' significant concepts, viewpoints, and discoveries. Content analysis was used to investigate the qualitative data from the Expert interviews, highlighting the responses' similarities, contrasts, and linkages. It helped highlight the complexities of the participants' viewpoints, identify recurring patterns and insights, and provide relevant information regarding the thesis's objectives. A combination of transcription and content analysis was utilized to examine and interpret the qualitative data collected for the thesis (Maguire & Delahunt, 2017)**.** The content analysis followed the next steps:

Data Familiarization: The transcribed interviews were thoroughly read and evaluated to comprehend the data and become acquainted with the content (Maguire & Delahunt, 2017).
Initial Coding: The initial step of the codes was given to relevant data units, such as phrases, sentences, or paragraphs, representing essential ideas, concepts, or topics. This approach was carried out repeatedly with numerous rounds of coding to ensure that all crucial information was included (Ritchie et al., 2022).
Codebook Development: A codebook that acted as a roadmap for the Thesis was created as the coding process advanced. The codebook provided definitions, examples, and guidelines for consistently coding each code (ibid.).
Coding and Categorization: The data were coded using the identified codes and categories from the codebook. Similar codes were grouped into categories, enabling systematic data organization (ibid.).
Theme Identification: Themes emerged as patterns and connections across the categories were identified. Themes represented broader concepts or ideas in the data (ibid.).
Data Interpretation: The themes were interpreted and analyzed concerning the research objectives and questions. The interpretation involved examining the relationships between themes, exploring variations within the data, and explaining the findings (Maguire & Delahunt, 2017).

The content analysis process ensured a rigorous and systematic analysis of the qualitative data, allowing for the identification of key findings and insights related to the relevance of African-based institutions in becoming WHO CCs in DH.

3.3.3 The Coding Process of the Interviews

Organizing the data, reading through the database in advance, classifying and arranging themes, representing the data, and finally developing an interpretation were all processes in the qualitative Thesis's data analysis. The transcription of the video-audio-recorded data came first. Finally, it involves presenting data in a conversation using a table, charts, and figures. The following step involved describing, categorizing, and analyzing the data (Creswell, 2014). This research utilized a purely inductive data analysis process, where codes and themes were identified directly from the data rather than based on a pre-existing theory. The following categories emerged from the data analysis: Table 3 below summarizes the main categories of the Themes, the codes, and the corresponding descriptions.

Table 2: The expert interview summary: Themes, Codes, and Descriptions.

Themes	Codes	Descriptions
Role and Familiarity	Institute and Role	Indicating the interviewee's workplace and position. Mention the interviewee's current position and workplace.
	Familiarity with WHO CCs	The interviewee's familiarity, indication, awareness, experience, and engagement with various WHO Collaborating Centres.
Relevance of African-based Institutions	Relevance of African-based institutions	The interviewee's viewpoint, exploration, and recognition of the importance of African-based institutions in the context of becoming WHO CCs in digital health.
	Factors Influencing Relevance	Identifying the key factors that influence the relevance of African-based institutions becoming WHO CCs in digital health.
Support and Benefits	Support from WHO and Stakeholders	Discussing the role of WHO and other stakeholders in supporting and promoting African-based institutions in becoming WHO CCs.
	Benefits of African-based Institutions	Highlighting the advantages and contributions that African-based institutions can bring as WHO CCs in digital health.
Challenges and Recommendations	Challenges Faced	Identifying the obstacles and Challenges that African-based institutions encounter in becoming WHO CCs.
	Recommendations for Policymakers	Providing suggestions and Recommendations to policymakers regarding the role of African-based institutions in becoming WHO CCs.

3.4 Ethical Considerations

Research projects must address ethics to protect expert interviewees, maintain confidentiality, and uphold research integrity. This section outlines the thesis's ethical concerns and how the research investigation was conducted ethically (Sanjari et al., 2014).

Respecting Ethical Principles: The thesis supported autonomy, beneficence, nonmaleficence, and justice as ethical norms (Sanjari et al., 2014). All expert interviewees gave informed consent after being briefed about the thesis study's objectives, their rights as subjects, and their willingness to participate. All opinions were kept anonymous, and participants might leave the research at any moment without consequence (ibid.).

Confidentiality and Anonymity: All personal identifiers of names were removed or anonymized during data analysis and reporting to ensure participant data confidentiality. Participants were assigned codes to protect their identities (Sanjari et al., 2014). Only the author of this thesis had access to the raw data of the expert interviewees, and strict data privacy policy measures were implemented to prevent unauthorized access.

Minimizing Harm and Potential Risks: The thesis took the utmost care to minimize potential harm or risks to the participants. The thesis's objectives and any possible dangers associated with participants' involvement were explained to those participating in the expert interviews (Sanjari et al., 2014). The Participants were assured that their participation would not have any negative consequences and that their discussions would be used solely for the thesis.

Informed Consent: A crucial component of the thesis was getting informed consent. A Consent form explaining the thesis's objectives, methods, possible dangers, and advantages was given to participants. The respondents had sufficient time to read and review the agreement consent form, ask any questions they might have had, and decide whether to participate. Before each subject participated in the Thesis, their written agreement was collected.

Data Protection and Storage: Implementing data protection measures is crucial for safeguarding the security and integrity of the obtained data (Sanjari et al., 2014). The author of this thesis securely stored the data gathered in password-protected electronic files or encrypted hard drives.

Ethical Reporting and Dissemination: The author of this thesis took essential precautions to ensure accuracy, objectivity, and respect for the participants' rights when reporting and disseminating the Thesis's results. The thesis's findings were presented anonymously and aggregated to maintain confidentiality. The participants' contributions were duly acknowledged without disclosing their identities.

Overall, the thesis adhered to ethical guidelines and principles to protect the rights of the participants. This thesis's author maintained the data's confidentiality, delivering informed consent, minimizing harm, and ensuring secure storage and responsible data reporting. By addressing these ethical considerations, the thesis upheld the highest standards of research integrity and contributed to the ethical conduct of research in DH. The following chapters will present the findings, insightful ideas, and practical suggestions and recommendations.

Chapter 4: Results

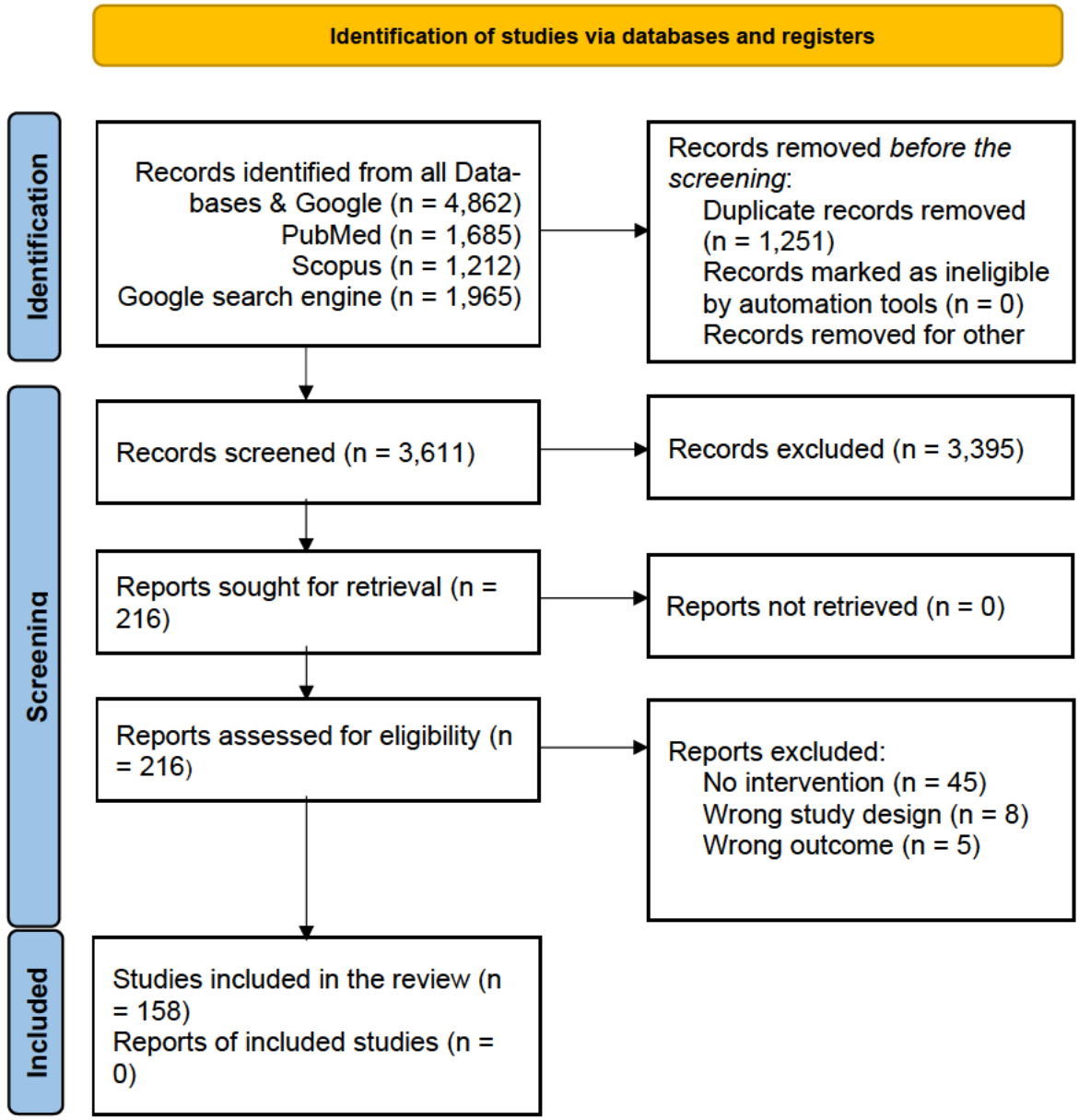
This chapter presents the thesis's findings, examining the current scientific literature on DH, WHO CC, and the significance of African-based institutions in becoming WHO CC in DH, and provides insights into various aspects, including quantitative analysis of the WHO CC database and qualitative expert interviews.

4.1 Current Scientific Literature Analysis

This section examines the scientific literature about DH, WHO CCs, and the significance of African-based institutions. The literature review aims to identify the existing body of knowledge, research gaps, and significant findings. It also highlights substantial insights into the landscape of WHO CCs in DH and the role of African-based institutions in this context. The literature review reveals a growing consensus on international Collaborations' importance in advancing DH initiatives. It is observed that CCs play a pivotal role in facilitating knowledge exchange and capacity-building in global health (WHO EURO, 2021). Despite this, there is an apparent geographic disparity in the distribution of these WHO CCs, with a concentration in high-income regions, particularly in Europe. Only some of the CCs were in Africa. (WHO CCs AFRO, 2019). The following insights emerge from a review of the pertinent literature:

Study selection: During the search process on PubMed, Scopus, and Google, 4,862 studies were found. After removing 1,251 duplicates, 3,611 citations were screened, and 3,395 studies were excluded. The remaining 216 reports were assessed for eligibility using abstract and full-text screening. Some studies were excluded because they did not meet the criteria, such as having no intervention (N = 45), incorrect study design (N = 8), or poor outcome (N = 5). Eventually, 158 full-text publications were included in this thesis. Please refer to Figure 7 for a flowchart overview of the selection procedure to better understand the search process (Page et al., 2021).

Figure 7: PRISMA flow diagram chart for selection of the study. (Source: Page et al., 2021).



4.1.1 Digital Health in Africa

The scientific literature review shows that DH is an emerging topic with great potential to enhance healthcare delivery and outcomes in developing regions like Africa (AU DTSA 2020-2030, n.d.). It emphasizes that DH can change healthcare delivery and improve patient outcomes. Many technological advancements, such as telemedicine, health information systems, and mHealth applications, look into DH. The benefits of DH treatments for managing illness, gaining access to healthcare, and promoting health have been shown in studies. Infrastructure, resources, insufficient regulations and standards, technological competence, data privacy, and security, to name several issues, must all be addressed for DH to reach its full potential (Awad et al., 2021).

DH Initiatives and Innovations in Africa: Africa witnesses a multitude of DH initiatives and innovations that have the potential to transform healthcare delivery and improve health outcomes. The following are good examples:

MHealth Applications for Health Information Distribution: Kenyan mHealth applications have successfully used text messages to disseminate health information, remind women to schedule prenatal care appointments, and enhance mother and child health. Community health workers can use these Kenyan applications to report disease outbreaks and inform health authorities (Jayawardena et al., 2018). According to West (2015, p. 6), the "Clinical Patient Administration Kit" is a mobile electronic medical record system in four Nigerian states. This system uses mobile technologies to track patients' medical information before and after pregnancy. Botha and Booi (2016) reviewed various mHealth implementations in South Africa, utilizing different approaches to provide healthcare services through mobile technology. In South Africa, young people use mobile phones for health-related purposes, such as contacting relevant individuals when ill or seeking medical information (Hampshire et al., 2015). Additionally, South Africa implemented "Momconnect," a mobile application for pregnant women that provides personalized SMS messages to registered individuals (Lippman et al., 2016). However, a study on m-health in Mali revealed that text and voice messaging alone cannot effectively deploy indoor residual spray against malaria. Instead, combining text messaging, voice messaging, and human-based intervention is necessary to promote indoor residual spray in Mali (Mangam et al., 2016).

Telehealth for Remote Consultations: Telehealth has proven instrumental in delivering specialized medical care to underserved and rural low- and middle-income countries (LMICs), particularly in Africa. Notable telehealth implementations include its adoption in South Africa and Ethiopia (Walama & Augustine, 2013). Holmes et al. (2014) highlighted the potential job creation in rural communities by implementing Mashavu, a telehealth system utilized in Kenya and Namibia, which boasts a telehealth center that facilitates medical education. Telehealth significantly enhances patient outcomes and the overall efficiency of healthcare systems by extending healthcare services to remote locations. In South Africa, the Vula Mobile App serves as a bridge, connecting rural healthcare providers with urban specialists. This technology enables healthcare practitioners to seek expert opinions, securely exchange patient data, and obtain recommendations, ultimately advancing healthcare accessibility for marginalized populations and empowering healthcare professionals (Hasselberg et al., 2017).

Electronic Health Record (EHR) Systems: The adoption of EHR systems in African nations enhances healthcare services by securely storing, exchanging, and retrieving patient information, fostering efficient and well-coordinated care. In Rwanda, the DHIS2 has played a pivotal role in enhancing data collection, management, and analysis, facilitating informed decision-making within the healthcare system. EHR systems are crucial in elevating data precision, expediting patient care, and strengthening program monitoring and evaluation (Fraser et al., 2022). South Africa has also embraced EHRs by implementing electronic trauma health records, replacing traditional paper-based records (Spence et al., 2016). DH innovations across Africa can potentially enhance healthcare delivery and patient outcomes. This includes mobile applications for disease surveillance, telehealth for remote consultations, digital tools for maternal and child healthcare, and electronic health record systems collectively contributing to improving regional healthcare services. The integration of DH technologies in Africa can enhance healthcare accessibility, strengthen healthcare systems, and ultimately promote the population's overall health (Dehnavieh et al., 2019.)

4.1.2 WHO Collaborating Centres

According to the literature, WHO CCs are vital to the WHO's work in various fields. WHO CCs promote institutional Collaboration, knowledge sharing, and capacity building. WHO CCs address global health issues and promote best practices. The research supported CCs as Centres of expertise that generate partnerships and innovations (WHO AMRO/PAHO, n.d.). Most of the CCs are significantly concentrated in the European Region. The African Region, on the other hand, was underrepresented. This confirms that equitable global health cooperation must address regional differences (Fujita et al., 2021).

4.1.3 Significance of African-based Institutions in Digital Health

The literature review recognizes the importance of African-based institutions in tackling African health issues. African institutions can contribute to DH initiatives, according to the literature. These institutions can support local innovation and meet African health needs. Funding, facilities, and employee capacity limit African institutions. The literature review highlights African institutions' expanding role in DH. These institutions supported telemedicine, mHealth, and health informatics (WHO GSDH 2020-2025, n.d.). African WHO CCs are underrepresented in most health topics, and there are no African WHO CCs for DH despite their engagement and commitment. This discrepancy raises concerns regarding African institutions' partnership potential (Manyazewal et al., 2023).

4.2 Quantitative Analysis: WHO Collaborating Centres Database

This section presents the findings of the quantitative analysis of the work of the WHO CCs. The thesis shows that WHO CCs perform various activities, including research, training, capacity building, and policy development. The thesis also shows that WHO CCs contribute significantly to the DH field, particularly telemedicine, mHealth, health information systems, and e-learning. Limited Funding, low human capability, and a lack of cooperation across multiple stakeholders are all highlighted as obstacles to the success of WHO CCs. The geographic distribution of CCs is examined to gather knowledge of the global CC landscape and its implications for African institutions (WHO CC Database, n.d.). The thesis aims to reveal insights into the extent of engagement and contribution of African-based institutions within the global network of CCs.

4.2.1 Geographic Distribution of WHO CCs

This subsection presents the geographic distribution of WHO CCs, emphasizing the representation of African-based institutions. The analysis sheds light on the presence of CCs in Africa compared to other regions. The Quantitative findings echo the previously identified geographic disparity, emphasizing the dominance of European and high-income regions in hosting CCs. Notably, the African Region exhibits a significantly lower representation in the WHO CC network. This quantitative assessment further underscores the importance of addressing the underrepresentation of African institutions to ensure a more balanced global distribution of CCs and their benefits. The analysis reveals a significant geographic imbalance in the distribution of WHO CCs. One-third of all CCs are based in the Europe region of WHO (EURO), while only 3% are in the Africa region of WHO (AFRO) (WHO CC Database, n.d.). This imbalance and lack of representation indicate that African-based institutions need more models within the network of CCs. This imbalance in representation potentially hinders and obstructs the African region's access to global health initiatives, cooperation, and Collaboration.

The quantitative study conducted an analysis using data from the WHO CC database, which included information on the location of the 811 currently designated CCs across all six WHO regions (WHO CC Database, n.d.). The thesis's findings revealed a noticeable imbalance in the geographic distribution of CCs, with a clear preference towards high-income countries and specific areas.

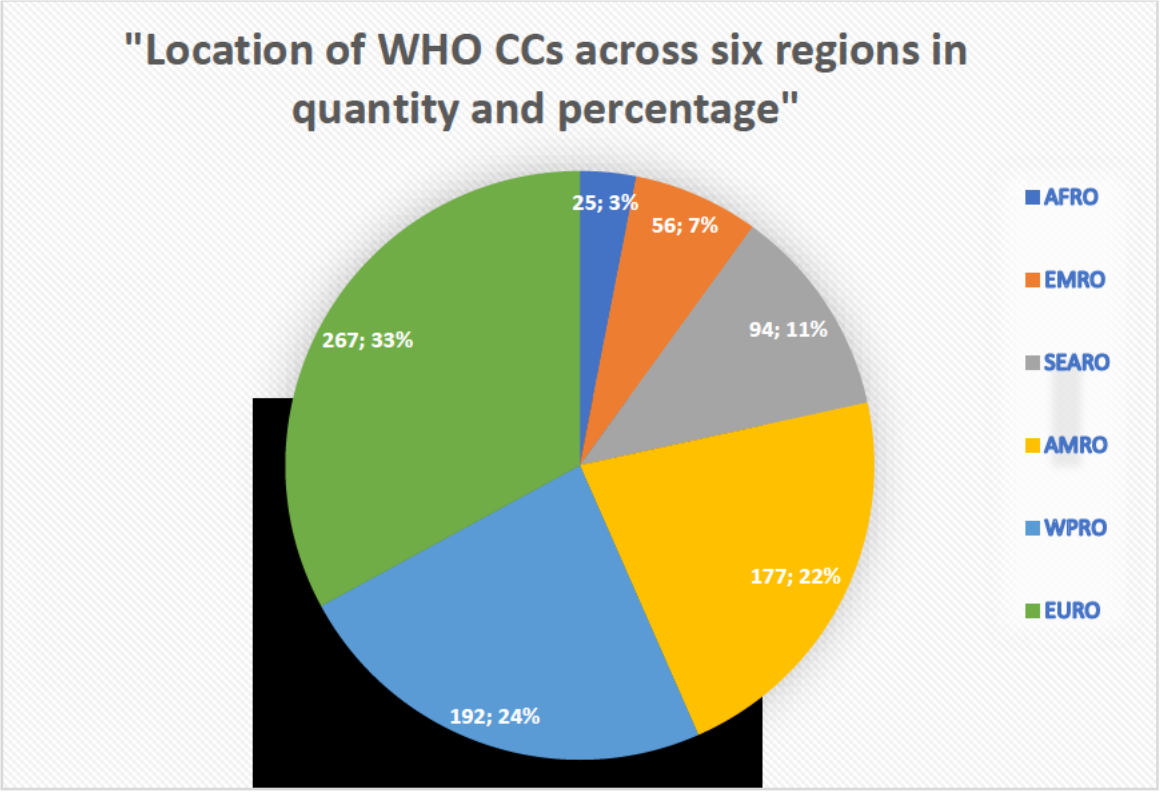


Figure 8: The quantity and percentage allocation of WHO Collaborating Centres across all six regions. (Self-designed diagram based on the source: WHO CC Database, n.d.).

The findings demonstrated that 33% of all CCs, or 267 CCs, are concentrated in the European Region (EURO). 24% (192 CCs) are based in the Western Pacific Region (WPRO), 22% (177 CCs) in the Region of the Americas (AMRO), and 11% (94 CCs) in South-East Asia (SEARO). In comparison, just 7% (56 CCs) of CCs are headquartered in the Eastern Mediterranean Region (EMRO). With only 3% (25 CCs) of all CCs located there, the African Region (AFRO) had the lowest representation (see Figure 7). Furthermore, the thesis observed that most CCs, almost 80%, are concentrated in just 22 countries, with 13 categorized as high-income countries (WHO CC Database, n.d.). This concentration further contributes to the uneven global presence and reach of CCs, potentially limiting their overall effectiveness worldwide. The ramifications of this geographic mismatch create questions regarding how institutions in areas with fewer CCs, particularly those in Africa, might have equitable access to resources, knowledge, and Collaborating possibilities. It is imperative to address this mismatch to guarantee that global health partnerships are more inclusive and realistic and to maximize the potential of CCs in reaching global health goals.

Implications for African-based Institutions in DH Collaborations: The geographic concentration of CCs favoring high-income nations and particular regions raises concerns regarding the applicability and inclusiveness of DH cooperation for institutions with an African

base. Due to the small number of CCs in the African Region, these institutions may have few opportunities to actively contribute to the worldwide development of DH solutions.

Addressing the Imbalance: The findings of the analysis underscore the importance of addressing the geographic imbalance of CCs to enhance the relevance of African-based institutions in DH Collaborating. Policymakers and stakeholders should prioritize efforts to promote the establishment of more CCs in the African Region. Funding and technical support for African-based institutions can significantly build the capacity and infrastructure necessary to become CCs.

4.2.2 Fostering Collaboration and Knowledge Exchange

The quantitative analysis thoroughly examines the thematic areas of engagement of African-based institutions within the WHO CC network. There is a need to foster partnerships and knowledge exchange between existing CCs and African institutions to enhance the relevance of African-based institutions in DH Collaborating. Networking with well-established CCs in other regions can provide valuable insights, technical expertise, and mentorship to support African institutions' journey toward boosting CCs. The analysis of the geographic distribution of WHO CCs highlights the disparities in the global representation of CCs, particularly for African-based institutions (WHO CC Database, n.d.). Addressing the geographic imbalance and fostering supportive policies and partnerships are imperative to ensuring African institutions' relevance and active participation in DH Collaborating. By doing so, African-based institutions can be more significant in advancing DH solutions, contributing to improved health outcomes in the region and beyond. The thesis explores strategies and recommendations to empower African institutions to become WHO CCs and strengthen their position in the global DH landscape.

4.3 Qualitative Analysis: Insights from Expert Interviews

The qualitative findings from expert interviews with key stakeholders from African-based institutions, the WHO, and development partners are presented here. The thesis examines the relevance, challenges, and ways African institutions can become WHO CCs in DH. The evaluation shows that African institutions are appropriate for WHO CCs in DH designation because of their unique strengths. Regional and cultural understanding is one of their strengths, enabling them to solve local challenges. Their ability to provide inventive solutions for local situations also boosts their skills. Their vast network of partners and stakeholders also helps them achieve their goals. The thesis also found that African institutions face challenges in becoming WHO CCs, including a lack of financial resources, experienced staff, and local and international support.

4.3.1 Assessing the Relevance Factors of African-based Institutions.

The experts assess the significance of African-based institutions on how to become WHO CCs in DH and present several key findings in the qualitative Thesis. First, African-based institutions have valuable expertise and insights into the local context; second, becoming WHO CCs would offer African-based institutions opportunities for capacity building, knowledge transfer, and networking, facilitating the development of DH expertise in Africa. Third, as WHO CCs, African-based institutions would have more visibility and influence in setting the global DH agenda, addressing the digital divide, and promoting resource allocation for African DH initiatives.

The respondents in the expert interview shared their perspectives on the significance of African-based institutions in becoming WHO CCs in digital health:

> *"I think there is much work going on in the African region, and African-based institutions must work directly with the WHO because we have many instances where we have foreign partners." (Interview 2, lines 17-19).*

The other respondent in Interview 4 also expresses it in a similar way:

> *"These local Collaborating Centres understand Africa's local situation, its culture, and its health problems. By becoming cooperating Centres, they can use their knowledge to help create and use digital health solutions that are tailored to the specific needs of African countries. This makes sure that treatments are long-lasting and effective and that they meet the specific health problems of African regions." (Interview 4, lines 18-22).*

The respondent in Interview 3 identifies the critical factors that affect the relevance of African institutions becoming WHO Collaborating Centres in digital health.

> *" To kick start the initiative, we need to establish a well-collaborating system in Africa and focus on the infrastructure, organizational, human resource, and technical domains. These are the four key driving factors necessary for success." (Interview 3, lines 35-37).*

The respondent in Interview 4 also emphasizes the crucial importance of a solid connection to local communities, as highlighted by the respondent:

> *"I would say that their connection to the local communities could help them understand the healthcare environment and cultural concerns and present the health systems of the area better." (Interview 4, lines 27-29).*

4.3.2 The Potential, Support, and Benefits

The qualitative analysis emphasizes the consensus among experts regarding the significance of African-based institutions' involvement as WHO CCs in DH. Experts highlight the potential of these institutions to drive localized innovations, address region-specific health challenges, and contribute to global health goals. Establishing CCs is perceived as an avenue to enhance collaboration, leverage expertise, and drive meaningful impact.

The respondents discuss supporting and promoting African-based institutions to become WHO CCs, including the role of WHO and other stakeholders.

> *"Yeah. I think first, to be suitable for other entities and stakeholders, inform them that they should support them in becoming CCs." (Interview 1, lines. 57-58).*

The respondent in Interviewee 3 emphasizes the significance of support from stakeholders and the WHO:

> *"Responsible support from WHO and other stakeholders is essential for forming this digital health Collaborating center in the respective countries. So, the Ministry of Health and its partners, particularly those working on the projects and initiatives, should come together and form a viable state called stakeholders (…)." (Interview 3, lines. 42-45).*

The respondent in Interview 4 identifies the support needed from WHO and other stakeholders, including technical help, funds, and capacity building:

> *"I think that WHO and other interested parties could support African institutions to become WHO CCs in DH by giving them technical help, funds, and programs to build their knowledge and capacities. This support could come in tangible programs that teach these groups about DH projects, data management, and health informatics." (Interview 4, lines. 39-42).*

The respondents highlight the advantages and contributions that African-based institutions can bring as WHO Collaborating Centres in digital health.

> *"(…) that African-based institutions can maybe create linkage with other collaborating Centres and entities to provide more impact since there will be awareness of other collaborating Centres and start to engage with this community of collaborating Centres." (Interview 1, lines 82-84).*

The respondent in Interview 3 states that having a WHO Collaborating Centre would provide a platform for learning that would benefit the entire continent:

“(…) make Africa an ideal platform for WHO to launch these Collaborating Centres. This would ultimately become a learning platform, and it would have a great benefit to the continent. That is based on the updated evidence coming out from Africa to inform the global health friends, track the challenge, and respond to the rising. Bottle next to any healthcare system in the context of global health.” (Interview 3, lines 54-59).

The other respondent Interview unequivocally stresses that addressing health issues necessitates active participation and inclusion:

"(…) WHO CCs for DH contribute to the global health landscape in various ways. Their participation and inclusion would enable a more complete and inclusive approach to solving health concerns, as they can contribute insights into the particular needs and realities of African communities." (Interview 4, lines 50-53).

4.3.3 Challenges and Barriers

Expert interviews illuminate a spectrum of challenges and barriers faced by African-based institutions. These challenges encompass financial constraints, regulatory complexities, and aligning local priorities with global mandates. The assessment also identifies challenges and limitations African-based institutions face in DH implementation. These include limited resources, infrastructure constraints, capacity gaps, regulatory and policy barriers, and the need for sustainable funding models. Addressing these challenges is crucial to harnessing the full potential of African-based institutions as WHO CCs in DH.

The respondents in the interview identify the obstacles and Challenges that African-based institutions encounter in the process of becoming WHO CCs:

"The first challenge would be. It is maintaining the technical working groups that are established from the first outset and sustaining this expertise." (Interview 3, lines 63-64).

The other respondent in Interview 4 identifies the main barriers as a lack of funding and resources:

"(…) African institutions confront several obstacles and challenges in becoming WHO Collaborating Centres for Digital Health. A lack of funds and resources might make it difficult for the African-based institution to start and maintain Digital Health programs." (Interview 4, lines 61-64).

4.3.4 Recommendations

Insights from expert interviews also generate valuable strategies and recommendations for enhancing the involvement of African-based institutions, such as WHO CCs. Experts advocate for targeted capacity-building initiatives, mentorship programs, and simplified application procedures. Collaborative efforts involving international partners, WHO, and local institutions are pivotal for amplifying the impact of CCs and overcoming the barriers identified.

The respondents in the expert interview provide suggestions and recommendations to policymakers and other stakeholders about African-based institutions becoming WHO CCs:

> *"I believe that policymakers should try to push forward like this kind of Collaborating Centres to highlight the needs that are not fulfilled within the regional area and the scope of execution." (Interview 1, lines 114-115).*

The respondent in Interview 2 emphasizes the need for policymakers to allocate funds to the Collaborating Centre.

> *"I think every government or policymaker within the health sector, or even the allied health sectors, needs information that is relevant evidence that is relevant to the country. So, if they are willing to work with their senses, policymakers should support not just work but also provide some funding sources that can help the Collaborating Centres run." (Interview 2, lines 94-98).*

Member states must take the necessary steps to establish WHO CCs in coordination with various stakeholders, as suggested by the respondent in interview 3. This will ensure effective and efficient communication and Collaboration amongst all parties establishing WHO CCs at African-based institutions.

> *"African member states should gather their academia, research universities, and international partners to establish a Collaborating Centre. This will bring together key stakeholders and enable Collaboration between members, creating a strong and well-equipped hotspot. This way will lead to a Stable and sustainable collaborating centre." (Interview 3, lines 73-77).*

The respondent in Interview 4 strongly recommends taking swift action on the goal that policymakers recognize the importance of African-based institutions in establishing WHO CCs. This can be achieved by providing uninterrupted internet access, developing sustainable connection networks, and implementing coordinated health information systems:

> *"(…) Policymakers or the government should acknowledge the crucial role of African-based institutions in joining the WHO Collaborating Centres in Digital Health*

and take concrete steps to facilitate their participation. Policies that prioritize investment in Digital Health infrastructure, such as internet access, communications networks, and health information systems, can help establish a Collaborating Centre in Africa." (Interview 4, lines 73-77).

The mixed approach, encompassing literature analysis, quantitative assessment, and qualitative insights, highlights the complex interplay between global collaboration, geographic disparities, and institutional aspirations. The results also show that WHO CCs are critical to advancing DH by providing technical expertise, facilitating research, and promoting collaboration between countries. The findings indicated that African-based institutions have unique strengths and capabilities that make them well-suited to become WHO CCs in DH. African institutions can also potentially become valuable participants in the global endeavor to strengthen DH capacity. To realize this potential, however, addressing the identified obstacles and providing more substantial support to these institutions is necessary. The synthesis of findings lays the groundwork for subsequent chapters to venture into discussions, formulate recommendations, and draw overarching conclusions based on the research findings.

Chapter 5: Discussion

This chapter presents a comprehensive discussion of the essential findings and their implications from the Thesis, which aims to assess the relevance of African-based institutions in becoming WHO C in DH. The discussion is structured around the following section:

5.1 Key Findings

5.1.1 Related to the Potential of African-based Institutions.

The thesis's findings highlight the substantial potential for African institutions to become WHO CCs in DH. These African-based institutions have valuable expertise and insights into the local context, allowing them to design and implement DH solutions that are culturally appropriate and responsive to the requirements of African nations (WHO AFRO HT&I, n.d.). African-based institutions can promote innovation and address the continent's unique healthcare challenges by capitalizing on their knowledge and comprehension of the African healthcare landscape (Azevedo, 2017). Furthermore, the thesis reveals that becoming WHO CCs would provide African-based institutions with opportunities for capacity building, knowledge transfer, and networking. This implies that African institutions can benefit from the expertise and experiences of other CCs, enhancing their capabilities in DH (Tran Ngoc et al., 2018). The knowledge gained through collaboration can be disseminated within Africa, fostering the development of a skilled workforce and nurturing a sustainable DH ecosystem (Manyazewal et al., 2021).

5.1.2 Findings Related to the Representation and Advocacy Role

Another critical Thesis finding is African-based institutions' potential representation and advocacy role as WHO CCs. By assuming this role, African institutions can enhance their visibility and influence in shaping the global DH agenda (GIZ IPIMCA, n.d.). This has implications for addressing the digital divide, advocating for resource allocation to support DH initiatives in Africa, and ensuring that the specific needs of the African continent are adequately represented in global discussions and decision-making processes (ADHI, n.d.). The active participation of African-based institutions such as WHO CCs can contribute to more equitable and inclusive DH policies and interventions (Olu et al., 2019).

5.1.3 Findings Related to Challenges.

The thesis also identifies challenges and limitations African-based institutions face in DH implementation. Limited resources, infrastructure constraints, capacity and knowledge gaps, regulatory and policy barriers, and the need for sustainable funding models are

among the main challenges to be identified (Van Olmen et al., 2020). These findings emphasize the significance of addressing such barriers to ultimately realize the potential of African institutions such as WHO CCs. African governments, the WHO, international development partners, and the private sector must work together to overcome these challenges and foster a conducive environment for African institutions to flourish in the DH (Kasprowicz et al., 2020; Taura et al., 2019).

5.2 Implications for Policy and Practice

The findings of this thesis have significant policy and practice implications. Policymakers and stakeholders in the DH sector should recognize the value and potential of African-based institutions and actively support their involvement as WHO CCs. This support should include financial investment, capacity-building programs, and the development of favorable regulatory frameworks (Baynes et al., 2022). By doing so, policymakers can ensure that African DH initiatives are locally driven, contextually appropriate, and aligned with the population's specific needs (Olu et al., 2019). Moreover, the thesis findings call for more Collaboration and knowledge sharing among African-based institutions, WHO CCs, and other global stakeholders. This Collaboration can facilitate the exchange of best practices, lessons learned, and innovative solutions, ultimately strengthening DH efforts in Africa and beyond.

5.2.1 Policy Implications

The implications are discussed below:

Promoting investment in digital health: The thesis highlighted the potential of African-based institutions to drive DH innovation and address healthcare challenges. Policymakers should prioritize investments in DH infrastructure, research, and capacity building to enable these institutions to fulfill their potential as WHO CCs (Olu et al., 2019). This includes allocating training programs, research grants, and infrastructure development funding. (Africa CDC, n.d.).

Strengthening regulatory frameworks: Policymakers should establish robust regulatory frameworks that govern DH interventions' development, implementation, and evaluation (WHO guideline, 2019). These frameworks should address data privacy and security issues, ethical considerations, interoperability, and quality assurance (Victor et al., 2023). By creating a supportive regulatory environment, policymakers can encourage adopting and scaling up DH solutions while ensuring patient safety and data protection (Rinke De Wit et al., 2022).

Enhancing Collaborating and Knowledge Sharing: Policymakers should promote cooperation and knowledge exchange between African-based institutions, WHO CCs, and other stakeholders. This can be facilitated by setting up networks, platforms, and conferences that promote cooperation, facilitate knowledge exchange, and spur innovation in DH (Victor et al., 2023). Moreover, governments should encourage projects that enhance cross-sector Collaboration. Some examples of such initiatives include partnerships with the private sector, academic institutions, and organizations representing civil society (Olu et al., 2019; WHO and ITU in Africa, 2017).

5.2.2 Practice Implications

The practice of the implications are discussed below:

Strengthening capacity and skills: African-based institutions should prioritize capacity-building activities to strengthen the workforce's knowledge, talents, and skills. This includes courses, seminars, and certifications in data analytics, DH project management, and health informatics (Victor et al., 2023). African-based Institutions can develop, implement, and evaluate DH initiatives that enhance healthcare outcomes if their personnel possess the necessary competencies (Amde et al., 2014).

Engaging communities and ensuring inclusivity: African-based institutions should adopt community-centered approaches in DH interventions (Walden et al., 2020). This involves engaging communities, understanding their needs and preferences, and co-designing culturally sensitive and contextually appropriate solutions (Van Stam, 2022). African-based Institutions should also ensure inclusivity by addressing barriers to accessing and using DH technologies, such as language barriers, affordability, and digital literacy (Olu et al., 2019; Tran Ngoc et al., 2018).

Fostering research and evidence generation: African-based institutions should prioritize research and evidence generation in DH. These African-based institutions can generate evidence on DH interventions' effectiveness, cost-effectiveness, and impact by conducting rigorous research studies and evaluations (Victor et al., 2023). This evidence can inform policy decisions, guide program implementation, and contribute to the global knowledge base on DH (Olu et al., 2019; Tomlinson et al., 2013).

Overall, the findings of this thesis have significant implications for policy and practice in the field of DH, particularly about African-based institutions becoming WHO CCs. Policymakers, the government, and development partners should assist the growth of DH in Africa by considering the implications of enhancing healthcare delivery and contributing to achieving

universal health coverage and the Sustainable Development Goals that the United Nations has set for the year 2030.

5.3 Limitations of the Thesis

Even though this thesis provides vital insights into the significance of African institutions becoming WHO CCs in DH, its limitations must be acknowledged. Understanding the scope and generalizability of the thesis is enhanced by recognizing these limitations. The limitations of this thesis include:

Sample size and representation: The thesis relied on a specific sample of African-based institutions and key stakeholders, which may only represent part of Africa's entire landscape of DH. The findings may only apply to some African countries or institutions included in the sample.

Data availability and reliability: The quantitative analysis of the work of WHO CCs in DH relied on data obtained from the WHO database. In terms of completeness and consistency in getting the data from the dataset, there could be incomplete information, and the availability of the data may vary across institutions and regions, which may impact the analysis's comprehensiveness.

Bias and subjectivity: Interpreting the findings and assessing the significance of African-based institutions becoming WHO CCs involved subjective judgment. Despite efforts to minimize bias, the author's perspectives and experiences may have influenced the analysis and conclusions. Additionally, the qualitative interviews with key stakeholders were subject to individual perceptions and biases.

Time constraints: The thesis's time constraints may have constrained the depth and scope of the investigation. The rapidly evolving nature of DH and the dynamic landscape of African-based institutions may mean that this thesis needs to capture some developments and emerging trends.

Author's background: The author's experience and skills in DH and African healthcare systems and the knowledge of the WHO CCs may have impacted the research design, data collection, and interpretation of the findings. Researchers with diverse backgrounds and experiences may have approached the research differently and arrived at different findings.

Despite these limitations, the findings of this thesis provide valuable insights into the relevance of African-based institutions becoming WHO CCs in DH. Future research should consider addressing these limitations to understand the topic better.

5.4 Future Directions for Research and Practice

The thesis's findings also highlighted several areas for further research. These include exploring different African countries' specific DH needs and priorities, evaluating the impact of DH interventions implemented by African-based institutions, and investigating effective strategies for overcoming the identified challenges and limitations. Continued research in these areas can contribute to evidence-based policymaking and developing sustainable DH ecosystems in Africa. The following may be considered for future directions:

Further exploration of the potential of African-based institutions: The thesis highlighted African-based institutions' significant contributions and potential in DH. Future studies should concentrate on finding particular areas where these African-based institutions may play an essential role in tackling the healthcare issues the African continent is now facing. This can include telemedicine, health information systems, mHealth, health policy development, and capacity building (WHO GSDH 2020-2025, n.d.; Ibeneme et al., 2020).

Collaborating and Knowledge Sharing: Collaborating among African-based institutions, international organizations, and other WHO CCs can foster knowledge sharing and the exchange of best practices. Future research should explore mechanisms and platforms that facilitate Collaboration and knowledge sharing to enhance the capabilities and impact of African-based institutions in DH (Rinke De Wit et al., 2022; Mairs et al., 2013).

Capacity building and training programs: Future research and practice should focus on developing comprehensive capacity-building and training programs to strengthen African-based institutions' capacity. These programs can enhance the skills and knowledge of healthcare professionals, policymakers, and other stakeholders in utilizing DH technologies effectively. Such initiatives can promote sustainable DH solutions and strengthen the overall healthcare system in Africa (Amde et al., 2014).

Policy and regulatory frameworks: The thesis reveals the importance of supportive policy and regulatory frameworks in facilitating the growth and sustainability of DH initiatives (WHO guideline, 2019). Future research should explore African countries' specific policy and regulatory challenges and provide recommendations for developing context-specific

frameworks that encourage innovation, data privacy, and interoperability (IPESSA 2021-2027, n.d.).

Evaluation and impact assessment: The implemented DH interventions by institutions with an African base need to undergo a thorough evaluation and impact assessment. Future studies should concentrate on creating reliable frameworks and methodologies for evaluating these interventions' efficacy, efficiency, and sustainability. As a result, there will be evidence to support decision-making processes for accelerating successful initiatives and ending ineffective ones (Rinke De Wit et al., 2022; Mairs et al., 2013).

Funding and investment: Adequate funding and investment are essential to supporting the development and implementing of DH initiatives in African-based institutions to set up WHO CCs. Future research should explore innovative funding models, public-private partnerships, and opportunities for leveraging existing resources to ensure sustainable financial support for African DH projects (AU DTSA 2020-2030, n.d.).

Policy advocacy and stakeholder engagement: Future research and practice should emphasize policy advocacy to raise awareness about the significance of African-based institutions such as WHO CCs in DH. Engaging with policymakers, international organizations, and other stakeholders can help create an enabling environment and gain support for the initiatives taken by institutions based in Africa (IPESSA 2021-2027, n.d.).

In conclusion, examining the key results and their consequences highlights the potential of African institutions to become WHO CCs in DH. The results stress the necessity of identifying and supporting African institutions' specific strengths and limitations. African institutions can advance digital health in Africa, improve healthcare results, and advance the global digital health agenda. These research and practice directions seek to increase the relevance and effect of African-based WHO CCs in DH. Addressing gaps and concentrating on these areas may improve healthcare delivery and results in Africa (Victor et al., 2023). Prioritizing investments in DH infrastructure, technical expertise, and capacity development is crucial for policymakers and stakeholders. They should strive to strengthen partnerships between African institutions and international organizations like the WHO. This thesis lays the groundwork for future research and initiatives to enhance African institutions' roles in digital health. It emphasizes recognizing and supporting African institutions' distinctive contributions and potential in addressing the continent's digital health requirements.

Chapter 6: Recommendations

This chapter presents recommendations for WHO, the African government, African-based Institutions, and international development partners based on the findings and implications of the Thesis, which assessed the relevance of African-based institutions in becoming WHO CCs in DH.

6.1 Recommendations for WHO

As the world's foremost health agency, the WHO promotes health and well-being globally. The following guidelines are presented to help African-based institutions exploit their potential in DH and improve their engagement as WHO CCs.

Enhance support and recognition: WHO should enhance its support and recognition of African-based institutions in DH. This can be achieved through increased technical assistance, capacity-building programs, and funding opportunities targeting African institutions. Recognizing and promoting the work of these institutions will encourage their continued contribution to DH initiatives in Africa (Manyazewal et al., 2021).

Strengthen partnerships and Collaborations: WHO should foster stronger partnerships and Collaboration with African-based institutions. This can be achieved by establishing formal mechanisms for engagement, such as joint projects, knowledge-sharing platforms, and regular dialogue (Kebede et al., 2014). Collaborative efforts can help leverage African institutions' expertise and local knowledge, leading to more context-specific and impactful DH interventions (Victor et al., 2023).

Provide guidance and standards: WHO should develop clear guidelines and standards for DH interventions in African contexts (WHO guideline, 2019). These guidelines should consider African countries' unique challenges and opportunities and provide practical recommendations for designing, implementing, and evaluating DH initiatives (Jandoo, 2020). Clear guidance will ensure interventions' consistency, quality, and effectiveness across different African-based institutions (Koumamba et al., 2021).

Support policy development: WHO can play a pivotal role in supporting African countries in developing comprehensive policy frameworks for DH (Tamrat et al., 2022). This includes assisting in developing national DH strategies, data privacy and protection regulations, and interoperability standards. WHO can provide technical expertise, share best practices, and

facilitate knowledge exchange among African countries to strengthen their policy environment for DH (DRP, n.d.).

Foster capacity building: WHO should prioritize capacity-building initiatives to enhance African-based DH institutions' skills and knowledge (WHO & Union, 2020). This may be accomplished by developing and implementing training programs, workshops, and seminar opportunities (Mairs et al., 2013. Building the capacity of African institutions will empower them to effectively utilize DH technologies, develop innovative solutions, and drive sustainable change (Rinke De Wit et al., 2022).

Promote research and evidence generation: WHO should encourage and promote DH research in Africa. This involves sponsoring research programs, enabling cooperation between African-based institutions and development partners, and promoting the dissemination of research results. WHO can inform decisions about policy, assist advocacy activities, and encourage future innovation in the field by producing solid data on the effectiveness of DH initiatives (Rinke De Wit et al., 2022; Mairs et al., 2013).

Monitor and evaluate progress: WHO should establish mechanisms to monitor and evaluate the progress and impact of African-based institutions, such as WHO CCs in DH. This includes developing key performance indicators, conducting regular assessments, and reporting on these institutions' achievements and challenges (AU DTSA 2020-2030, n.d.). Monitoring and evaluation will provide valuable insights for continuous improvement and enable the identification of successful models and strategies (WHO GSDH 2020-2025, n.d.).

By implementing these recommendations, the WHO can enhance its engagement with African institutions and better use its potential as a WHO CC in DH. This Collaboration will support the DH initiative in Africa, improve healthcare delivery, and ultimately enhance health outcomes for the people of Africa.

6.2 Recommendations for African Governments

African governments play a crucial role in advancing DH initiatives and supporting the establishment of WHO CCs. The following recommendations are proposed for African governments to enhance their engagement in DH:

Develop national digital health strategies: African governments should prioritize developing and implementing comprehensive national DH strategies (AU DTSA 2020-2030, n.d.).

These strategies should outline the vision, goals, and action plans for integrating DH technologies into the healthcare system. They should also consider each country's unique healthcare challenges and priorities, ensuring alignment with the broader national health agenda (Mogessie et al., 2021).

Invest in digital infrastructure: African governments should invest in developing and maintaining robust digital infrastructure to support the implementation of DH solutions. This includes expanding access to reliable internet connectivity, establishing secure data networks, and promoting interoperable health information systems (DIIG, n.d.). Adequate digital infrastructure will enable seamless communication and data exchange, facilitating the effective delivery of DH services (Ibeneme et al., 2022).

Foster public-private partnerships: African governments should actively foster public-private partnerships in the DH sector. Collaborating with private technology companies, start-ups, and innovators can accelerate the development and deployment of DH solutions (Mbunge et al., 2022). Governments can provide incentives, create conducive regulatory environments, and establish mechanisms for Collaboration to encourage private sector engagement in DH initiatives (Ibeneme et al., 2022).

Strengthen health data governance: African governments should prioritize the establishment of robust health data governance frameworks. This includes developing policies and regulations to ensure health data's privacy, security, and ethical use. Governments should also promote data interoperability and data-sharing mechanisms among healthcare providers and stakeholders (Hermes et al., 2020). Strong health data governance will enhance data-driven decision-making, facilitate research, and ensure the responsible use of DH technologies (Ibeneme et al., 2022).

Invest in capacity building: African governments should invest in building the capacity of healthcare professionals and other stakeholders in DH (Alunyu et al., 2020). This includes training programs, workshops, and continuous professional development opportunities to enhance digital literacy and skills (Fokom Domgue et al., 2022). Governments should also support integrating DH education into the curricula of healthcare training institutions and relevant academic programs to ensure that future healthcare professionals are equipped with the necessary knowledge and skills across the continent (Kasprowicz et al., 2020; Amde et al., 2014).

Promote digital health entrepreneurship: African governments should create an enabling environment for the entrepreneurship and innovation of DH. This can be done by setting up innovation hubs and funding sources for digital health sector start-ups (Karamagi et al., 2022). Governments should also simplify regulatory procedures and offer incentives to promote the creation and adoption of locally-driven DH solutions (Ibeneme et al., 2022).

Collaborate with regional and international partners: African governments should collaborate actively with regional and international development partners and the WHO to capitalize on their DH expertise and resources (Nölting et al., 2020). Collaborations and partnerships may speed up the implementation of DH by facilitating the exchange of information, the pooling of resources among the partners, and collaborative projects across the continent (Ibeneme et al., 2022).

By implementing these recommendations, African governments can strengthen their commitment to DH and create an enabling environment for African-based institutions to become WHO CCs. This will contribute to developing robust DH ecosystems, improving healthcare access and quality, and ultimately, enhancing health outcomes for the population.

6.3 Recommendations for African-based Institutions

African-based institutions have a crucial role in advancing DH and becoming WHO CCs. The following recommendations are proposed for African-based institutions to enhance their capacity and engagement in DH:

Strengthen institutional partnerships: African-based institutions should aggressively seek opportunities to collaborate with similar institutions worldwide (Ibeneme et al., 2022). When people work together, sharing information, pooling resources, and launching combined projects to tackle problems and advance digital health, it becomes more accessible (Gallagher et al., 2019). African-based institutions must explore avenues for Collaborating with other entities to facilitate the exchange of resources and experience, enhancing their ability to provide for their people effectively (Adetokunboh et al., 2021).

Enhance digital health research and innovation: African-based institutions should prioritize DH research and innovation to contribute to the knowledge base and drive evidence-based practices (Al Kuwaiti et al., 2018). Institutions should establish dedicated research units or Centres focused on DH, engage in research projects, and seek funding opportunities to support research initiatives. Institutions can generate insights, identify best practices,

and contribute to developing context-specific DH solutions by conducting research (Nölting et al., 2020).

Foster innovation and entrepreneurship: African-based institutions should foster a culture of innovation and entrepreneurship within their organizations. Establishing innovation hubs that support and supply resources to start-ups and innovators in DH can help achieve this (Muinga et al., 2020). Africa-based Institutions should also explore opportunities for technology transfer and commercialization of DH solutions developed within their organizations (Roess, 2017).

Advocate for supportive policies and regulations: African-based institutions should engage in policy advocacy to promote supportive policies and regulations for DH (Mackintosh et al., 2018). Institutions should work with governments, regulatory bodies, and other stakeholders to create an enabling regulatory environment that encourages the adoption and scaling of DH solutions. By advocating for policies prioritizing patient privacy, data security, and interoperability, institutions can contribute to developing robust DH ecosystems (DRP, n.d.).

Promote knowledge sharing and Collaborating: African-based institutions should actively participate in knowledge-sharing platforms, conferences, and workshops related to DH. African-based Institutions should also contribute to developing open-access resources, such as publications, guidelines, and toolkits, to share their experiences and best practices with the broader DH community (WHO & Union, 2020). Collaborating and knowledge sharing can accelerate learning, facilitate the replication of successful models, and foster a supportive ecosystem for DH (Rinke De Wit et al., 2022; Mairs et al., 2013)**.**

Engage with the WHO and other global initiatives: African-based institutions should actively engage with the WHO and other global initiatives in DH. Institutions should explore opportunities to become WHO CCs or participate in WHO-led projects and programs (Ibeneme et al., 2020). Engaging with the WHO can provide access to expertise, resources, and networks, enhancing institutional capacity and visibility in the DH field (WHO GSDH 2020-2025, n.d.)**.**

By implementing these recommendations, African-based institutions can enhance their role in DH and contribute to developing sustainable and impactful DH initiatives. This will strengthen their potential to become WHO CCs and drive positive change in healthcare delivery and outcomes in Africa.

6.4 Recommendation for Development Partners

International development partners are crucial in supporting African-based institutions in their efforts to become WHO CCs in DH. The following recommendations are proposed for development partners to enhance their collaboration and support:

Increase funding for digital health initiatives: International development partners should allocate more resources and funding for DH initiatives in Africa. This includes funding research projects, capacity-building programs, and implementing DH solutions (Ibe et al., 2022). By increasing financial support, development partners can enable African-based institutions to develop and scale innovative DH solutions, conduct impactful research, and strengthen their overall capacity (Waweru et al., 2019).

Support capacity-building and training programs: Development partners should prioritize training and capacity-building initiatives for DH institutions on an African basis. These might include offering technological know-how, venues for information exchange, and chances for training to improve the abilities of medical personnel and researchers (Dizon et al., 2016). Development partners may also assist in building DH training Centres or academies to provide specialist training in health informatics, telemedicine, mHealth, and data analytics (Olu et al., 2019).

Foster collaboration and knowledge exchange: Development partners should facilitate collaboration and knowledge exchange between African-based institutions and global DH stakeholders (Fujita et al., 2021). Organizing conferences, workshops, and networking events can bring together institutions, policymakers, researchers, and practitioners (WHO & Union, 2020). Development partners should also establish virtual platforms and communities of practice to facilitate ongoing Collaboration and training (Olu et al., 2019).

Support policy and regulatory frameworks: International development partners should assist African governments in developing supportive policies and regulatory frameworks for DH. This includes providing technical expertise and guidance on policy formulation, data protection, interoperability standards, and privacy regulations (WHO guideline, 2019; WHO & ITU Africa, 2017). Development partners can also support the establishment of regulatory bodies or committees dedicated to overseeing DH initiatives and ensuring compliance with international standards (IPESSA 2021-2027, n.d.).

Encourage innovation and entrepreneurship: International development partners should support a climate encouraging DH innovation and entrepreneurship in African nations. This can be done by funding and mentorship programs for DH start-ups, supporting innovation hubs, and facilitating access to markets and investors. By encouraging innovation, development partners can stimulate the growth of the digital health sector and support the emergence of sustainable solutions (WHO & ITU Africa, 2017).

Facilitate technology transfer and adaptation: International development partners should facilitate technology transfer and adaptation of DH solutions from other regions to Africa. This can include supporting the localization of technologies, providing technical assistance for implementation, and facilitating partnerships between African-based institutions and technology providers (ADHI, n.d.). Development partners should also encourage sharing best practices and lessons from successful DH implementations in other contexts (Olu et al., 2019).

Promote sustainability and scalability: International development partners should prioritize sustainability and scalability in DH initiatives (Godinho et al., 2022). This includes supporting the development of robust business models, promoting interoperability and data exchange, and fostering collaboration between African-based institutions and healthcare delivery systems (Baynes et al., 2022). Development partners should also encourage integrating DH into national health strategies and plans, ensuring long-term support and sustainability (Fujita et al., 2021)**.**

By implementing these recommendations, development partners can contribute to the growth and impact of African-based institutions in DH. Through Collaboration and support, development partners can help African countries leverage digital technologies to improve healthcare access, quality, and outcomes.

Chapter 7: Conclusion

This thesis, titled "Assessing the Relevance of African-Based Institutions in Becoming WHO Collaborating Centres in Digital Health," seeks to assess the potential of African-based institutions in becoming WHO CCs in DH and their importance in advancing DH initiatives in Africa. The thesis uses a mixed-methods approach, combining a literature review, a quantitative analysis of the work of WHO CCs in DH, and qualitative expert interviews with key stakeholders. The findings provide recommendations for various stakeholders and valuable insights into how African-based institutions fit into the DH landscape. This thesis highlights the potential of African institutions to support the DH agenda and address the health issues that African populations face.

7.1 Summary of Key Findings

Examining the current scientific literature on DH, WHO CCs, and the significance of African-based institutions revealed several key themes. First, DH technologies can transform healthcare delivery in Africa, overcoming poor access to healthcare, resource shortages, and health inequities (Awad et al., 2021; Lennon et al., 2017). Second, WHO CCs are critical to advancing DH globally by promoting Collaboration, knowledge exchange, and capacity building (WHO CCs, n.d.; Fujita et al., 2021). Third, African-based institutions possess unique strengths and capabilities that make them well-positioned to contribute significantly to DH initiatives, including contextual knowledge, cultural understanding, and innovative approaches tailored to the African context (Manyazewal et al., 2021).

The identification and analysis of the work of WHO CCs in DH highlight the diverse range of activities these Centres undertake. WHO CCs have made substantial contributions to the field, from research and development of DH solutions to policy advocacy, capacity building, and implementation support (WHO CCs, n.d.). However, the representation of African-based institutions among the CCs needed to be improved, indicating a potential gap in African participation and influence in global DH agendas.

The assessment of the significance of African-based institutions becoming WHO CCs in DH through qualitative interviews reveals several key findings. African-based institutions are recognized for their unique contributions to DH, including their ability to address local health challenges, provide contextually relevant solutions, leverage local expertise, and foster innovation (Flick, 2018). Establishing African-based WHO CCs in DH would enhance Africa's representation, influence, and voice in global DH governance and policy-making processes.

In Addition, it would facilitate knowledge sharing, collaboration, and capacity building among African institutions and global DH stakeholders, promoting sustainable and impactful DH initiatives in Africa.

In conclusion, this thesis underscores the importance of African-based institutions becoming WHO CCs in DH. By leveraging their strengths, expertise, and innovative approaches, African-based institutions can significantly contribute to advancing DH in Africa. Nevertheless, challenges and limitations must be addressed to tackle the problems, such as limited funding, inadequate infrastructure, poor internet connections, regulatory barriers, and the need for capacity development (Brewer et al., 2020). To overcome these challenges and limitations, the thesis recommends various stakeholders, including WHO, African governments, African-based institutions, and development partners.

7.2 Contributions of the Thesis

This thesis tries to leverage several significant contributions to the field of DH and the role of African-based institutions in driving DH initiatives and advocating for their greater involvement in global DH governance. This thesis's findings illustrate the potential of African-based institutions in advancing DH initiatives and the significance of their participation as WHO CCs. By prioritizing the recommendations outlined in this thesis, stakeholders can work collaboratively to harness the full potential of DH and improve healthcare outcomes for the African population.

Knowledge Generation: The systematic literature review conducted in this thesis provided a comprehensive understanding of the current scientific literature on DH, WHO CCs, and the significance of African-based institutions. The analysis of this literature contributes to the existing knowledge base by synthesizing key themes and highlighting the unique contributions and potential of African-based institutions in DH (Manyazewal et al., 2021).

Quantitative Analysis: The quantitative analysis of the work of WHO CCs in DH, using data obtained from the WHO CCs dataset, highlights insights into the activities and contributions of these CCs. This analysis identifies gaps and disparities in African participation and influence in global DH agendas by examining the representation of African-based institutions among the CCs (WHO CC Database, n.d.). This thesis emphasizes the need for increased participation and collaboration of African-based institutions in global digital health initiatives by quantifying their involvement in research, capacity-building, and policy activities (WHO CCs AFRO, 2019).

Qualitative Insights: The thesis conducts qualitative expert interviews with key stakeholders, including African-based institutions, the WHO, and international development partners. It offers valuable insights into the importance of African-based institutions becoming WHO CCs in DH. These interviews highlight a deeper understanding of African-based institutions' unique strengths, challenges, and opportunities, underscoring the importance of local expertise, context-specific approaches, and sustainable partnerships in driving DH advancements in Africa (Flick, 2018).

As a result of the thesis's findings, several recommendations are suggested to WHO, African policymakers, African-based academics, and development partners. These recommendations provide crucial steps, so African-based institutions would become WHO CCs for DH, improve their involvement in global DH governance, and promote collaboration, capacity development, and knowledge exchange (Godinho et al., 2022). African institutions can significantly impact healthcare in the region by promoting collaboration and prioritizing digital health initiatives. This includes hosting WHO Collaborating Centres for Digital Health on the continent.

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Confidentiality Statement

I declare that this thesis is entirely my own work, that I wrote it myself without the assistance of others, and that I have used only the materials and sources declared as such within it. I further declare that I have fully referenced all ideas and verbatim quotations taken from other works.

Hamburg, den 04.10.2023

SIGNITURE

DATE

Hintsa Kidanemariam Alemie

Student Number: 2315495

Appendices

Appendix A: Informed Consent Form

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences
Faculty of Life Sciences, Department of Master Health Sciences

An **Informed Consent form** for the expert interviewers in the qualitative study of the master thesis: "Assessing the Relevance of African-based Institutions in Becoming WHO Collaborating Centres in Digital Health."

Title of Study: Assessing the Relevance of African-based Institutions in Becoming WHO Collaborating Centres in Digital Health

Principal Investigator: Hintsa Kidanemariam Alemie
Contact Information : hintsa.alemie@haw-hamburg.de, hintsakidanemariam.alemie@giz.de
0049 176303 41641

You are invited to participate in a research study on the above-mentioned topic. The study aims to explore the current conditions of WHO Collaborating Centers in digital health and the relevance of African-based institutions becoming WHO Collaborating Centers in digital health.

Participation in this study involves a one-on-one interview with the researcher, which will be conducted online. The interview will take approximately [15-20] minutes and will be recorded to ensure accuracy during transcription. Participation in this study is voluntary, and you can withdraw without penalty. The information gathered during the interview will be kept confidential, and all data will be anonymized to protect your identity.

By signing this form, you confirm that you understand the nature and purpose of the study and agree to participate voluntarily. You also agree that the recorded data will be kept confidential and used only for this study.

If you have any questions about the study, contact the principal investigator at the abovementioned contact information.

Signature: _____
Printed Name: _____
Date: _____

Appendix B: Survey Questions

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences
Faculty of Life Sciences, Department of Master Health Sciences

Questions for the expert interviews in the qualitative study of the master thesis: "Assessing the Relevance of African-based Institutions in Becoming WHO Collaborating Centres in Digital Health."

1. Would you please state in which institute you work?
    a. WHO
    b. African-based Institution
    c. Development Partner
    d. Other
2. How familiar are you with the work of WHO Collaborating Centers?
3. How do you assess the relevance of African-based institutions becoming WHO Collaborating Centres in digital health?
4. What are the most significant factors influencing the relevance of African-based institutions in becoming WHO Collaborating Centers in digital health?
5. How can WHO and other stakeholders support African-based institutions in their efforts to become WHO Collaborating Centres in digital health?
6. What benefits do you think African-based institutions can bring as WHO Collaborating Centers in digital health?
7. What challenges do African-based institutions face in becoming WHO Collaborating Centers in digital health?
8. What recommendations would you provide to policymakers regarding the role of African-based institutions in becoming WHO Collaborating Centers in digital health?

Appendix C: Interview Transcripts

Interviewee 1

Date of Interview: 09.06.2023

Location of Interview: Online MS Teams Meeting

Interview 1

Would you please state in which institute you work?

I work at the **WHO Headquarters.**

How familiar are you with the work of WHO Collaborating Centers?

I'm familiar with WHO CCs because I like working with several collaborating centers, so I work with the University of Geneva and other collaboration centers in other regions. So, and as well, we bring in some collaboration centers to become calibrating centers. Currently, we are working with a digital health center of excellence in the Kingdom of Saudi Arabia that is like to try to become a collaborative center. Other entities that are interested, like NGOs and others that are interested in becoming Collaborating centers. This is interesting. The notion of this is like being interested in becoming CC. So, I'm used to it. I know the process internally and the work together with the Visitors.

How do you assess the relevance of African-based institutions becoming WHO Collaborating Centres in digital health?

Yeah, so the process takes time to execute because you don't become a calibrating center within two days. You need to show, like, collaboration within, at least two years to show that you've been collaborating with WHO and like, and it's not as well, it's not just collaborating, that's efficient collaboration. And then you'll be able to apply to be a collaboration center; that's how it goes.

That is true, as well, in African regions, like a need to be involved by the after region of WHO. And I'm from HQ, so there needs to be a kind of alignment between the global and African regions into what the collaborative center will be doing. Sometimes, it might be difficult because the involvement in staff revision or the global is nonexistent. So that, like, we don't have the rights momentum with the African region, but they are relevant, to be honest. There is a lot of relevancies for me. They are very relevant because they are on the field and as relevant as others trying to collaborate from other countries we work with. So it makes sense that we bring more calories and centers that are already working in the areas we are working in. So, that makes sense, and there will be able to execute more Portrait, for example, like talking about after Africa region, we have now, or it's kind of associations that's called definitely

become collaborative center to help like engage with the network of digital health and others. Others could be a good target for us to engage with.

What are the most significant factors influencing the relevance of African-based institutions in becoming WHO Collaborating Centers in digital health?

Influencing, I believe, is like awareness. Like an Opportunity to have a collaboration center like this. Sometimes, those entities may focus more on their work area and are not looking into becoming collaborating centers. Since the process is very complex, they might not be willing to do it because it takes two years and then, after Index forever, to become the collaborating center, and then define TRs and batters acting as the infamous factor, as well as the fact that we are changing.

And we, the collaborating center, need to align with what WHO is focused on and the vision. So, there's importance. So, they need to know what aspect they could augment establish to do. Or are they maybe already doing it? I'm sure many of them are already doing it, but they don't know they're doing it. They are actually entitled to become collaborating centers, and then they can coordinate the execution with the WHO. So, I think, yeah, be reasonable. One thing is the awareness of what WHO is doing. And give you an opportunity to all potential collaboration centers so that they know How to become a collaboration century and how they would like to execute with the WHO in the long term.

How can WHO and other stakeholders support African-based institutions in their efforts to become WHO Collaborating Centres in digital health?

Yeah. I think first, to be suitable for other entities and stakeholders, inform them that they should support them in becoming CCs. Sometimes, there is kindness in execution. So it's more the people allowed to collaborate. I think African-based institutions should be informed, and they should get help from stakeholders, too. It's like they are entitled to become a state like a collaborative center in digital health. This is not something that is like not attainable.

It should be considered, and the state may advertise the collaboration center process more and advertise in its working area where others could plug in. So, in a way that it's difficult to decide, I will become a collaboration center without knowing what the?

The road that the WHO takes in the long term. So, it could be like an option to make sure that the road map is shown to them and known to them in the long term. So, they engage and say, oh, I can help in this. It will be more to clarify for them, like how they would like to engage as

a collaborative center and what topics they would like to focus on. And with areas they could focus on.

What benefits do you think African-based institutions can bring as WHO Collaborating Centers in digital health?

That's in. Yeah, definitely scaling up double is not like it is a big organization, but not big enough for the word. So, we do have the mechanism of the collaborative Center for a reason: because we need to be able to work in the field. We need to be able to augment our execution scale-up, our like, our outreach scale-up, our like, inputs, and outputs scale-up of our advocacy. So, yeah, there is a lot that an African-based institution can do, and the fact to be a collaborating center.

It is a way to engage into more of a global execution and, like, kind of coordinates amongst different stakeholders and not decided in your execution and say, oh, I'm executing this and hope as everything goes well, so the idea as well as to, to have more impact. The other thing is that African-based institutions can maybe create linkage with other collaborating centers and entities to provide more impact since there will be awareness of other collaborating centers and start to engage with this community of collaborating centers. The work of meant like the impacts because they can work on small pieces and then Help each other to kind of leverage. Leverage each other to have more original investments, so yeah. Yeah, thank you.

What challenges do African-based institutions face in becoming WHO Collaborating Centers in digital health?

I think the process of becoming a collaboration center must be challenging for them. And not only for African-based institutions but others since it takes two years. So, there is a to use to assess firstly. Like, they are kind of an option to become a collaboration center, so maybe they don't have the bandwidth to execute that for two years where we, you're not like, have the stages of collaborating center. Still, you are doing execution at the same time.

The other thing is maybe the insensitive behind, like what would be a plus for me to become a collaboration center; maybe that needs to be clarified to them more. And as mentioned before, what are the benefits of showing off these benefits to them? So, because it's still like you will put much effort into becoming a collaborating center, and maybe the relationship between the benefits and becoming a collaborative center doesn't flow as much as we think. So, it would be good to show how becoming a collaboration center would help you benefit from an ecosystem as well, like coordination of execution with other entities by WHO. So, let's

say otherwise. Yeah. Now, for sure, I think that provision is like doing the work, but the challenges are also like awareness. This option will happen in the liquid, like becoming an incendiary color, so that can be a small challenge.

What recommendations would you provide to policymakers regarding the role of African-based institutions in becoming WHO Collaborating Centers in digital health?

Yeah, I think it's important, at least, to have some collaboration central that are African-based institutions because it has the benefit that we collaborate. The center is not only one way, but it is two ways. So, it's going to bring information and activities. That is not available at the global level. That's also available at the local level, the regional level, and the global level. So that's kind of help like a user-centric approach when we develop, you know, policies and global policies or guidance in that global, regional, or even the local level. So that's interesting to see.

I believe that policymakers should try to push forward like this kind of collaboration centers to highlight the needs that are not fulfilled within the regional area and the scope of execution. So, it's definitely important. The other aspect is that, as mentioned before, the collaborating center is not too executing all inside of you, executing data. We can engage with other collaborating centers so that we could help Policymakers to engage with other policymakers throughout our collaboration centers, or others, or to their collaborative venture that, like connect with other colleges and sensors to execute, you know, something that should have been executed only at the level of reason. Still, the country would like to become all. This can be executed at the regional level now because it makes more sense and benefits the whole community. So, that's going to be an option.

Interviewee 2

Date of Interview: 19.06.2023

Location of Interview: Online MS Teams Meeting

Interview 2

Would you please state in which institute you work?

I work at an African-based university.

How familiar are you with the work of WHO Collaborating Centers?

So, I got to know about the collaboration center, I think, maybe about two years ago when I started engaging with other WHO on some consultancies. So, there was some work we're doing on a digital health competency framework, and there's a collaborating center in New South Wales. I think it's in Australia or New Zealand. That was when I got to know that they exist and are wicked about what they do with the future.

How do you assess the relevance of African-based institutions becoming WHO Collaborating Centres in digital health?

I think there's a lot of work going on in the African region, and it's important that African-based institutions work directly with the WHO because we have many instances where we have foreign partners. We have foreign institutions coming into Africa to do relevant digital health work, but I think it's important that Africans within Africa who have lived experience. Undertaking these activities because it forms a good source of knowledge for the African region. We are able to pass on the information and then also build capacity within Africa rather than bringing in people who would do the work and then take the knowledge and skills back to the country.

What are the most significant factors influencing the relevance of African-based institutions in becoming WHO Collaborating Centers in digital health?

I think, first of all, that knowing about the collaborating centers to having expectations in new faculty or departments, knowing that they have the capacity to conduct research or conduct activities at a high level. And then also Having the right setup. You have an institution that has all the right governance structures to be able to manage it and such a center if it were to be set up. So yeah, I think governance structures have the capacity as the human resource and then also be our way of the collaborating centers, and it's important.

How can WHO and other stakeholders support African-based institutions in their efforts to become WHO Collaborating Centres in digital health?

I think support from WHO and other stakeholders is essential. You can get stakeholders' support in capacity building and network access to establish WHO CCs. Maybe this is because it's been my experience getting support and work together from stakeholders, and after Working with some of the units, based on the expertise that we could put across the projects we worked on, WHO felt that now maybe. You could form your department, or my department or faculty could be a good place because we do have that capacity. And the resources to do that. And there's also the history of doing what we don't need to. So that's a step. So, it's been more of the way to encouraging and proposing that we consider it. So, I think when they work with institutions whom they have a good history with and making that proposition and are using So that the departments can actually become aware of them because I think it's not something that is readily available for people to do that. These collaborative centers exist, and maybe showcasing how they are doing with collaborating centers may also help if I read a specific report or learn about another project. I know that the collaborating center has an excellent opportunity in it. Then, it creates visibility. So then people know these collaborative centers exist and will even want other partners to work with them and outside the projects.

What benefits do you think African-based institutions can bring as WHO Collaborating Centers in digital health?

As for the benefits, I think they are immense. First of all, the benefits are building capacity and enabling more research in Africa because we have a lot of good ideas and intelligent and resourceful people in the African region. Sometimes, they need to be given a chance to do work. And so I think when we are able to bring such into Africa, it will help to build capacity because, for example, I see that my department is able to do or is it is, this is approved to be a collaborative center? I can imagine the number of people who are trained as Master's students, Ph.D. students, and even some undergraduate students. There will also be the opportunity to make research come alive for many people. There are a lot of answers to questions within the African region. We need people with the right mindsets. People who understand research but only conduct it. And so come for my capacity. Building is the most important thing, as well as ensuring that data is generated or within a spearheaded by Africans. And so, they are the ones who are considered the expect and not. But they are considered aspects of African issues. So, we have to own the research. We do have to own the data. Yeah, and then speak to the data as well.

What challenges do African-based institutions face in becoming WHO Collaborating Centers in digital health?

From challenges: I haven't looked at the older requirements that you need to meet to become a collaboration center. I do, but I am informed that it's quite a tall list because I had a research assistant look at them, and I'm told it's quite a process. So, maybe one of the challenges would be meeting all the requirements. But I can't pinpoint just specific.

Regarding the checklist provided by the WHO Collaboration Centers, there are certain key items to consider as challenges. Additionally, it may be beneficial to have adequate resources in place during the initial setup of the center, depending on the specific knowledge areas involved. In my experience with Digital Health, obtaining sufficient resources for some knowledge areas has been relatively straightforward and worthwhile. Overall, I do not foresee any significant challenges beyond these considerations. The WHO Collaboration Centers have identified certain checklist items as well as initial resources as potentially important considerations for establishing a new center. However, the exact requirements may vary depending on the specific knowledge area. From my experience in Digital Health, it seems relatively straightforward to meet the necessary expectations and become a part of it. Still, there may be other areas where challenges could arise.

What recommendations would you provide to policymakers regarding the role of African-based institutions in becoming WHO Collaborating Centers in digital health?

And I think you mean policymakers in the country. It's a country from the perspective of countries. So, the policymakers in the country should also be interested in engaging with incentives. Once they are set up, the policymakers should also be ready to work with the sentence so that that is how we can continue to do work. It is not just relevant for WHO to have a relevant country where the collaborating center exists. I think every government or policymaker within the health sector, or even the allied health sectors, needs information that is relevant evidence that is relevant to the country. So, if they are willing to work with their senses, policymakers should support not just work but also provide some funding sources that can help the Collaboration Centers run. I think that one that will be helpful.

Interviewee 3

Date of Interview: 30.06.2023

Location of Interview: Online MS Teams Meeting

Interview 3

Would you please state in which institute you work?

I work at the African-based Institution.

How familiar are you with the work of WHO Collaborating Centers?

I am aware of this WHO Collaboration Centers initiative and the process of establishing a collaboration center. But there are no resource settings, especially for African subscribers. As part of the mixture of heads of Ethiopia's ambition to roll out the example's roadmap, I was engaged from the outside in the dark, which was the first experience that I was aware of. The WHO is in the inception stage of rolling out this digital health insurance in Africa.

How do you assess the relevance of African-based institutions becoming WHO Collaborating Centres in digital health?

Collaboration Centers are relevant for African-based Institutions for many reasons, to mention the least information. Getting digital health in the first place is vital for improving the health system. So, African institutions need to get the necessary infrastructure, human resources, and technical support from WHO through the collaborating centers and establish these Collaboration centers. Hospital institutions will be vital to enable the initiatives to form a viable, stable, and sustainable infrastructure.

What are the most significant factors influencing the relevance of African-based institutions in becoming WHO Collaborating Centers in digital health?

The key factors would be the emergence, the emergence we emerge, and existing healthcare challenges for the infectious. And non-infectious pieces are on the rise. It necessitates a diligently established digital health infrastructure in the context of first subservient Africa or entirely in Africa. That will enable the healthcare system to respond prepared. And, at the same time, chart the progress of these common governments in the region.

So, the factors would have an organizational domain, the technical domain, and the human resource domain combined and would need the efforts to support the WHO collaborating centers. Streamline the best experiences and practices in terms of digital infrastructure from

well-established settings to extrapolate them into the digital housing infrastructures and systems in sub-Saharan Africa. To kick start the initiative, we need to establish a well-collaborating system in Africa and focus on the infrastructure, organizational, human resource, and technical domains. These are the four key driving factors necessary for success.

How can WHO and other stakeholders support African-based institutions in their efforts to become WHO Collaborating Centres in digital health?

A point in a case would be establishing a community of practice that consists of technical working groups from each WHO member state in Africa. Responsible support from WHO and other stakeholders is essential for forming this digital health collaboration center in the respective countries. So, the Ministry of Health and its partners, particularly those working on the projects and initiatives, should come together and form a viable state called stakeholders consortia to follow the track and maintain and sustain the development of this collaboration, collaborating centers.

What benefits do you think African-based institutions can bring as WHO Collaborating Centers in digital health?

Africa is in a first hostess growth, and it's becoming promising. Digital health hotspot, a global data sports part. Many digital health and data platforms, including private firms, are coming into many African countries and establishing their best. So, these different projects and initiatives, including the African cities and digital transformation strategy, make Africa an ideal platform for WHO to launch these Collaboration Centers. This would ultimately become a learning platform, and it would have a great benefit to the continent. That is based on the updated evidence coming out from Africa to inform the global health friends, track the challenge, and respond to the rising. Bottle next to any healthcare system in the context of global health.

What challenges do African-based institutions face in becoming WHO Collaborating Centers in digital health?

The first challenge would be. It is maintaining the technical working groups that are established from the outset and sustaining this expertise. The experience coming out from this technical working group comes from the minister of health of respective WHO member states in Africa and the respect of stakeholders. Ideally, there is an around and people mostly chained, their

employment status and move out from the whenever a project faces out then for me and my experience these are this is the key challenge for sustainment of initiatives that are emerging like this one. It was addressed in due diligence.

What recommendations would you provide to policymakers regarding the role of African-based institutions in becoming WHO Collaborating Centers in digital health?

On that, I would outside recommend that. Remember the minister of health. African member states should gather their academia, research universities, and international partners to establish a Collaboration Center. This will bring together key stakeholders and enable collaboration between members, creating a strong and well-equipped hotspot. This way will lead to a Stable and sustainable collaborating center. That could ultimately serve as an information hotspot or outside healthy digital health, date hotspot to receive always updated information regarding the emerging existing and reimaging healthcare challenge in the company.

Interviewee 4

Date of Interview: 10.07.2023

Location of Interview: Online MS Teams Meeting

Interview 4

Would you please state in which institute you work?

I work for an International Development Cooperation Partner.

How familiar are you with the work of WHO Collaborating Centers?

Even though I work in the area of international development partners, I am familiar with what WHO CCs do. Through involvement, study, and data sharing, these CCs are essential for making progress in global health. I understand their importance in encouraging creativity and helping governments reach their health goals.

How do you assess the relevance of African-based institutions becoming WHO Collaborating Centres in digital health?

How important it is for African organizations to join WHO Collaborating Centers is very important in digital health, especially when it comes to international development partnerships. These local collaboration Centers understand Africa's local situation, its culture, and its health problems. By becoming cooperating centers, they can use their knowledge to help create and use digital health solutions that are tailored to the specific needs of African countries. This makes sure that treatments are long-lasting and effective and that they meet the specific health problems of African regions.

What are the most significant factors influencing the relevance of African-based institutions in becoming WHO Collaborating Centers in digital health?

I think that the importance of institutions in Africa having WHO Collaborating Centers for Digital Health can depend on a few different things. In the first place, I would say that their connection to the local communities could help them understand the healthcare environment and cultural concerns and present the health systems of the area better. This knowledge about the area is very important for making and using digital health solutions that work and make sense in the given situation. So, Digital Health projects would be more likely to work effectively, be sustainable, and last if they had strong ties with the ruling government, international

development organizations, community-based organizations, and local development partners. For digital health choices in Africa to work, there also needs to be enough money, funds, facilities, infrastructure, and access to technology, especially a good connection to the Internet.

How can WHO and other stakeholders support African-based institutions in their efforts to become WHO Collaborating Centers in digital health?

I think that WHO and other interested parties could support African institutions to become WHO CCs in DH by giving them technical help, funds, and programs to build their knowledge and capacities. This support could come in the form of tangible programs that teach these groups about DH projects, data management, and health informatics. Partnerships between African universities and international development partners from other countries can make it easier to share information and resources and work together on research projects. Also, funding frameworks and grants could be set up to help African institutions that could easily work together to create and carry out different digital health projects.

What benefits do you think African-based institutions can bring as WHO Collaborating Centers in digital health?

I would say that African-based institutions, such as WHO CCs for DH, contribute to the global health landscape in a variety of ways. Their participation and inclusion would enable a more complete and inclusive approach to solving health concerns, as they can contribute insights into the particular needs and realities of African communities. These organizations can help to create and adapt culturally suitable and accessible DH technology. By concentrating on and addressing local capacity building and skill development, they may establish sustainable health systems and empower communities to do good work. Furthermore, their involvement increases international collaboration and partnerships in the pursuit of global health goals.

What challenges do African-based institutions face in becoming WHO Collaborating Centers in digital health?

I think this is a very important question to address because African institutions confront several obstacles and challenges in becoming WHO Collaboration Centers for Digital Health. A lack of funds and resources might make it difficult for the African-based institution to start and maintain Digital Health programs. Implementing digital solutions in distant or underserved locations is difficult due to a lack of sufficient infrastructure, including internet access and

technology. There may also be a scarcity of competent individuals in Digital Health and health informatics. To address these difficulties, targeted investments, capacity-building assistance, and coordinated efforts between international development partners and African institutions are required.

What recommendations would you provide to policymakers regarding the role of African-based institutions in becoming WHO Collaborating Centers in digital health?

I think I would say that these Policymakers or the government should acknowledge the crucial role of African-based institutions in joining the WHO Collaboration Centers in Digital Health and take concrete steps to facilitate their participation. Policies that prioritize investment in Digital Health infrastructure, such as internet access, communications networks, and health information systems, can help establish a collaboration Center in Africa. Policymakers should also prioritize financing and resources for capacity-building initiatives that improve African institutions' Digital Health skills and capabilities. South-South collaboration and alliances can help with knowledge sharing and joint research initiatives. Furthermore, policy frameworks for data protection, interoperability, and ethical usage of Digital Health technology should be created. Policymakers can help create an enabling climate in Africa that promotes innovation, local ownership, and the long-term viability of Digital Health programs.