Spring 5-13-2021

# Challenges and Prospects of Implementing Mobile Health in Angola: Lessons Learned from Kenya and Denmark.

Maria da Graca Ambrosio

ABSTRACT

CHALLENGES AND PROSPECTS OF IMPLEMENTING MOBILE HEALTH IN ANGOLA: LESSONS LEARNED FROM KENYA AND DENMARK.

By

Maria Da Graca Ambrosio

05/04/2021

INTRODUCTION: The increase of disease incidence and prevalence in developing countries urges governments and health care leaders to invoke a more efficient response to protect populations' health. Mobile health (mHealth) is changing the face of health care and strengthening health care systems. However, its slow growth in developing countries is an actual discussion topic among the scientific community. There is an urgent need to find solutions for the sustainability and scalability of mHealth programs in low- and middle-income regions. We are the first to conduct a case study on an African country's health system, demonstrating that mHealth provides promising opportunities for healthcare system strengthening.

AIM: We conducted a scoping review to examine and understand the mobile health industry's overall value chain and identify the conditions under which mHealth programs perform better in Angola. We learned lessons from Kenya, a global leader in mobile solutions, and Denmark, the first country in the world to adopt the Continua Health Alliance standard, which is a backbone of a robust framework for implementing telehealth nationwide. We also looked to what are the best business models to operate mHealth programs in developing countries.

METHODS: We used the technology-organization-environment (TOE) framework to conduct our scoping review. The theory explains how technology adoption is influenced by an organization's technological, organizational, and environmental context. To assess this scoping review's quality, we used two methodological groups, the PRISMA-ScR reporting guidelines and the JBI Methodological Guidelines.

RESULTS: Our study found a total of 87 studies. One-third (30) of studies covered Denmark's landscape, while two-thirds (57) covered Kenya's landscape. We found eight duplicate studies. We selected eight studies that analyzed the Danish eHealth landscape and nine studies that analyzed the Kenyan eHealth landscape. We included in our analysis studies that focused on evaluating an organizational, technological, or environmental determinant for nationwide eHealth adoption. We found an association of government and hospital organizational determinants in the sustainable implementation of mHealth solutions. Kenya and Denmark's

healthcare reforms were pivotal in the growth of their eHealth market and structure. Both countries have decentralized governance, fiscal, and administrative systems. Technological ICT capacity and human resources were also found as a predictor for their sustainable deployment in both countries. Environmental factors such as competitiveness in the ICT market, hospital market, government support, and trialability mechanisms were also found as critical elements for mHealth technology adoption in both countries.

DISCUSSION: The accelerated growing number of mobile phone subscriptions could provide potential solutions for the healthcare system's current challenges in Angola. mHealth can be seen as a catalyst to achieve national health goals. Mobile Health initiatives could support the process of finance allocation to health, improve health information systems, and facilitate the deployment of electronic health records. Nevertheless, the deployment of mHealth solutions goes beyond the acquisition of technology. It requires organizational changes.

# CHALLENGES AND PROSPECTS OF USING MHEALTH IN ANGOLA: LESSONS LEARNED FROM KENYA AND DENMARK.

by

Ambrosio M. STUDENT

M.D., BELGOROD STATE UNIVERSITY

A Capstone Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
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APPROVAL PAGE

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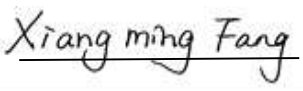
Approved:



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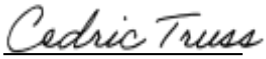

Committee Member

Committee Member

04/19/2021

Date

Dedications

This capstone is first dedicated to the memory of my beloved fiancé, Cameia Filipe, who was taken from me 2 months before the defense of this research in a tragic car accident. His love, assistance and encouragement will never be forgotten. I also dedicate this work to my family, who served as my primary support for the completion of this Capstone project and the completion of the Master of Public Health Degree.

Acknowledgments

I want to first thank God for strengthening me through the course of this program. I acknowledge my parents, brothers, and sisters who stood as strong support for me. I would also like to acknowledge my faith community in Atlanta, the Ebenezer Baptist Church, for your love and continuous support.

My completion of this project could not have been accomplished without the support from the Spring 2019 master's in public health cohort, the faculty, and the Georgia State University Public Health School staff. I cannot express enough thanks to my Capstone Committee, Dr. Xiangming Fang, Dr. Cedric Truss, and Dr. Claire Spears for providing guidance through coordinating the researchand producing the report. I also acknowledge my academic advisor Gina Sample and Dr. ChristineStauber. Both of your efforts are acknowledged and appreciated. I want to extend my gratitude, as well, to Mr. Msuega Tese, Executive Director of Integrated Solutions Angola, for providing me with an overview of the current ICT market in Angola. Similarly, I extend my appreciation to the Fulbright scholarship program for granting me the opportunity to enroll in this MPH program.

Author's Statement Page

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## Terms and Definitions

**Application Programming Interface:** Application Programming Interface (API) is a "set of programming code that enables data transmission between one software product and another" (Altexsoft, 2019).

**Crowdsourcing:** Crowdsourcing is a problem-solving strategy by collecting ideas, service needs, or information from a large online community rather than traditional ways (Merriam-webster, 2006).

**Digital health platform:** Digital Health Platform (DHP) is a "common digital health information infrastructure (infostructure) on which digital health applications are built to support consistent and efficient healthcare delivery" (WHO, 2020).

**eHealth:** Electronic Health (eHealth) "is the use of information and communication technologies (ICT) for health" (WHO, n.d.).

**Interface standards:** Interface standards are predefined functional and physical characteristics such as code conversion, protocol compliance, and mechanical characteristics that allow data interchange between two or more digital systems (Wheatcraft, 2010).

**Interoperability:** Interoperability is the combination of health information and technology systems within and across institutional boundaries to enhance health services delivery and quality (Muinga et al., 2018).

**Mobile Health:** Mobile Health (mHealth) is referred to as the use of mobile and wearable technologies in the exchange of health information to improve access, quality, and affordability of health services (Qiang et al., 2012).

**Open Source:** Open source is referred to as a "software program or platform with source code that is readily accessible and which can be modified or enhanced by anyone" (Frankenfield, 2021) (Christensen, 2014).

**Software ecosystem:** Software ecosystem is referred to as "the interaction of a set of actors on top of a common technological platform that results in a number of software solutions or services" (Christensen, 2014).

**Telehealth:** Telehealth uses electronic communication and information technologies (IT) to deliver medical care and health education, diagnosis, consultation, treatment, and medical data transfer (WHO, 2016).

**Abbreviations**

| | |
|---|---|
| NHS | National Healthcare System |
| TOE | Technology-organization-environment Framework |
| MINSA | Angolan Ministry of Health |
| MoH | Ministry of Health |
| HIS | Health Information System |
| DHP | Digital Health platform |
| mHealth | Mobile Health |
| eHealth | Electronic Health |
| API | Application Programming Interface |
| GOK | Government of Kenya |
| PNDS | National Health Development Plan (Plano Nacional de Saúde) |
| MTTI | Ministry of Telecommunications and Technology of Angola |
| ICT | Information and Communications Technology |
| IT | Information Technology |

# Chapter I. Introduction

## 1.1. Research background

This research focuses on the possibilities of deploying mobile health (mHealth) initiatives in Angola to strengthen the healthcare system and improve access and quality of health services. In the last years, many efforts have been made by the Angolan government to improve the health status of the general population. In 2001, the Angolan Ministry of Health (MINSA) endeavored the creation of a harmonized and integrated national health information system (HIS) and database (Connor, Averbug, & Miralles, 2010). Mobile health applications can be instrumental players for deploying a national digital health platform (DHP) in Angola. The affordability of mobile phones and their rapid proliferation worldwide resulted in innovative mobile health initiatives in many developing countries.

Angola's mobile phone penetration was estimated at 47% in 2020 (Kemp, 2020). Experts believe that by 2023 mobile penetration will experience a 53% increase, reaching 72% of mobile subscriptions (Hedge, 2018). Approximately 98% of the population uses prepaid mobile services (USAID, 2015). For many years, the mobile market was a duopoly with two major operators, Unitel and Movicel (BuddeComm., 2020). The first has a 73% market share, while the latter retains 27% of the market share (Justice, 2020). In the first trimester of 2020, the Angolan Government (GOA) announced Africell Holding SAL as the fourth licensed telecommunication company to operate in the country (BuddeComm., 2020). In 2020, internet penetration was estimated as 28% (Kemp, 2020). The average speed of mobile phones' internet connection was 20.84 MBPS (Kemp, 2020).

The outlook for the future of mHealth applications in Angola is promising. The government's interest in developing the telecom infrastructure to develop the country's economy creates an opportunity for the surge of a mobile health market. Progress in the telecom infrastructure will decrease consumer prices, improve data, and voice services in rural zones, and increase national

network coverage. From a social perspective, mHealth apps can tackle several problems in the health care sector. There is currently an unexplored market with more than 14 million potential users (Kemp, 2020). With no competitiveness, a tremendous opportunity exists for mobile application developers and investors. Thus, we try to understand the threats and opportunities for deploying mHealth initiatives in Angola and provide recommendations based on lessons learned from Kenya and Denmark.

### 1.2. Research aim, objective, and scope

The World Health Organization (WHO) recognizes seven pillars for deploying a national eHealth strategy. Such pillars are leadership and governance, strategy and investment, services and application, standards and interoperability, infrastructure, legislation, policy, and compliance (WHO, 2012). To ensure system, service, and information quality, the WHO stresses the importance of building a national digital platform. The development of digital information infrastructure (infostructure) ensures the interoperability of health interventions (WHO, 2020). The Digital Health Platform (DHP) allows applications and systems to share health information and data. In the report published by the World Bank in 2012, three elements were pointed as essential when framing an mHealth application's implementation: the health system structure, network installation, and distribution and financing (Qiang., 2012). Latif et al. (2017) also stress the importance of a requirement analysis to understand in which context mHealth applications will be implemented. Such a step leads to the creation of people-centric solutions, thus ensuring greater adoption.

Additionally, according to the literature to date, there is no identified business model for the sustainable implementation of telehealth in developing countries (Combi, Pozzani & Pozzi, 2016). From an economic perspective, this knowledge is essential when estimating costs, revenues, and returns on investments. We will analyze the health system and mobile health ecosystem of Kenya, a global leader in mobile solutions, and Denmark, the first country in the world to adopt the Continua Health Alliance standard, which is a backbone of a robust framework for

implementing telehealth nationwide. We will focus our analysis on studies that analyze mHealth initiatives in both countries' landscape. Due to the limited data available, our research scope will include studies analyzing the overall eHealth sector in both countries. We aim to learn from their successes and failures, clarify concepts, and provide implications for implementing mHealth programs in Angola.

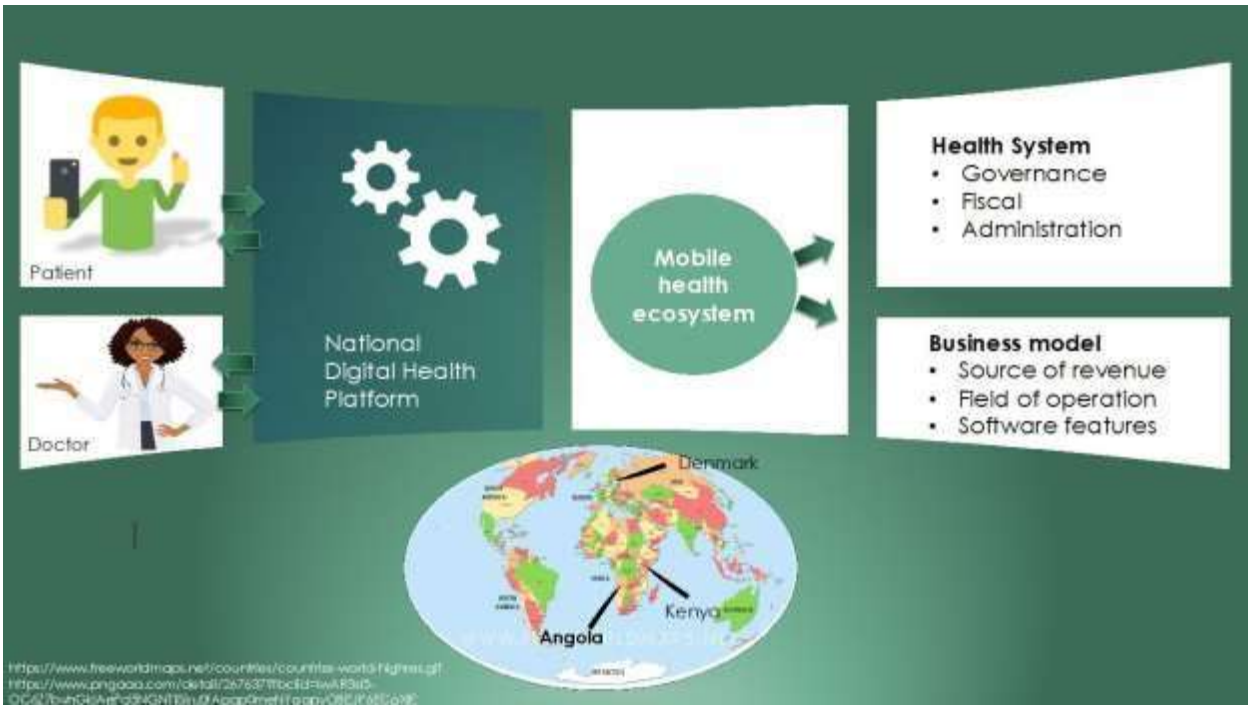


Figure 1.1 Study overview. The ecosystem for mHealth.

The outlook for the future of mHealth applications in Angola is promising. The government's interest in developing the telecom infrastructure to develop the country's economy creates an opportunity for the surge of a mobile health market. Progress in the telecom infrastructure will decrease consumer prices, improve data, and voice services in rural zones, and increase national network coverage. From a social perspective, mHealth apps can tackle several problems in the health care sector. There is currently an unexplored market with more than 14 million potential users (Kemp, 2020). With no competitiveness, a tremendous opportunity exists for mobile application developers and investors. Thus, we try to understand the threats and opportunities

for deploying mHealth initiatives in Angola and provide recommendations based on lessons learned from Kenya and Denmark.

We aim to answer the following questions:

1. What are the necessary reforms in the Angolan health system to implement sustainable mHealth programs in the country?
2. What are the most suitable business models for the implementation of sustainable mHealth programs in Angola?

# Chapter II. Review of the Literature

## 1.1. Potential of mobile health applications in developing countries

Today, the incorporation of technologies in the healthcare field is a phenomenon verified worldwide. The terms eHealth, telehealth, and telemedicine have become more present around patients and health professionals. The WHO (n.d.) defines Electronic Health (eHealth) as "the use of information and communication technologies (ICT) for health." According to the WHO, telehealth uses electronic communication and information technologies (IT) to deliver medical care and health education, diagnosis, consultation, treatment, and medical data transfer (WHO, 2016). As one of the eHealth modalities, mHealth has shown great potential in managing patients with genetic diseases and non-communicable chronic diseases. Mobile health is referred to as the use of mobile and wearable technologies in the exchange of health information to improve access, quality, and affordability of health services (Qiang et al., 2012; Latif et al., 2017). Mobile technologies carry information in coded data, text images, audio, and video (Qiang et al., 2020). Despite the various technologies used today in this field, our focus will be mHealth applications that use mobile phones. Different criteria have categorized mobile health solutions. This study will adopt Ngongo et al. re-categorization as per WHO, as can be observed in Table 2.1.

| m-Health Intervention Taxonomy | m-Health intervention sub-grouping |
|---|---|
| Patient-Centered (PC) | Health call centers/telephone help line |
| | Emergency toll-free telephone services |
| | Treatment compliance |
| | Appointment reminders |
| | Community mobilization |
| | Awareness raising over health issues |
| | Mobile surveys (surveys by mobile phone) |
| | Surveillance |
| | Patient monitoring |
| Facility-Centered (FC) | Mobile telemedicine |
| | Information and decision support systems |
| | Patient records |

Table 2.1 “m-health applications categories and re-categorization as per WHO” (Ngongo et al., 2019).

The latency of long-life health conditions requires a holistic approach. Developing countries are facing the dual burden of communicable and non-communicable diseases. Approximately 66% of global annual deaths were due to non-communicable diseases (WHO, 2011). More than three-fourth of such deaths occurred in developing countries (WHO, 2011). Communicable diseases are still among the five major causes of death in middle and low-income countries (IHME, 2017). mHealth offers the opportunity for personalized care, early detection of emergency states, and patient education (Latif et al., 2017). Text me! Flash me! is an mHealth program implemented in Ghana that provides HIV/AIDS information to encourage patient self-care and self-management (Donner & Mechael, 2013). Autocare in Bangladesh uses wearable sensor technology to remotely monitor breast cancer patients (Latif et al., 2017). In the management of pediatric patients, mobile applications are being used widely to reduce infant mortality. Since 2007, Chidcount+ in Ghana provides active monitoring of children under five years old (Latif et al., 2017). Evidence has proven that mobile health applications can improve medication adherence among pediatric patients with sickle cell anemia (Curtis, Lebedev, Aguirre & Lobitz, 2019). mHealth can accelerate and improve the delivery of medical care and public health services. It can strengthen health systems by offering the opportunity for data collection, implementation of electronic health

records, and crowdsourcing (WHO, 2020). The latest is essential to help solve complex and emerging health problems, thus ensuring that a country's health goals can be achieved more efficiently and with reduced risks. Lastly, the affordability of mobile phones offers an excellent opportunity for their integration into health solutions. Evidence has shown that mobile phones' access in developing countries is greater than access to electricity or clean water (World Bank, 2016). Only less than one-third of the bottom fifth of the population in low- and middle-income countries does not have access to mobile phones (World Bank, 2016).

### 1.2. Challenges for the implementation

Despite the great expectations among the multiple gains mHealth may bring to developing countries, developers and governments face challenges to scale, nationalize, and sustain mHealth programs. Opponents claim that there is a lack of evidence of mHealth apps' effectiveness and efficacy (Kahn, Yang, & Kahn, 2010). Experts argue that some risks for mHealth sustainability lie in the health system (Aranda-Jan, Mohutsiwa-Dibe & Loukanova, 2014). Many factors can complicate the integration of applications in the clinical workflow and reduce the value they can add to patient care (Handayani et al., 2018). Latif et al. (2017) point out as an important determinant for mHealth apps' sustainability the lack of interconnectivity among the country's health systems and digital health system. The isolated operation, data management, and processing of mHealth apps result in islands of isolated information (WHO, 2020). The absence of a unified national electronic database limits mHealth apps' integration into the healthcare system (Aranda-Jan, Mohutsiwa-Dibe & Loukanova, 2014).

The complexity of the business model and different stakeholders' interest are also important factors emphasized in the literature (WHO, 2020). Developers cannot scale up mobile apps without secure funds (Tomlinson et al., 2013). Policies and financial support within the ministry of health and government are vital to implementing mHealth programs as they are regarded as causes for failure (Aranda-Jan, Mohutsiwa-Dibe & Loukanova, 2014). Lack of software flexibility and availability limits innovation and prevents interconnectivity between apps (Qiang et al.,

2012). Lastly, cultural constraints also represent a barrier for mHealth scalability in many developing countries (Latif et al., 2017).

### 1.3. Potential solutions

Mobile Health solutions should be backboned by a strong health system and sustainable business model. The WHO (2020) recommends that governments design a national eHealth strategy. The assessment of the country's health system is vital to redefine and identify issues that should be addressed and realize which national objectives should be prioritized. The creation of a national DHP prevents the problem of data fragmentation (WHO, 2020). It allows interoperability and the integration of mHealth initiatives into the current healthcare structure (Kuo, Kushniruk & Borycki, 2011). The DHP also helps define clear roles and responsibilities between stakeholders (governments, managers, developers, and health workers) at various hierarchical levels during the implementation and operation process (WHO, 2020). Policies to strongly defend intellectual property rights, data security, and privacy protection are vital to ensure mHealth apps' feasibility and acceptability (Qiang et al., 2012). The literature also recommends using coded information and encryption to enhance data security and recurrent audits of security systems (Aranda-Jan, Mohutsiwa-Dibe & Loukanova, 2014).

# Chapter III. Research Methods and Procedures

## 3.1 Methodology overview

Due to the complexity and heterogeneity of the literature, we are unable to conduct a systematic review. This review requires a much broader scope than the traditional systematic review. We used two methodological groups, the PRISMA-ScR reporting guidelines, and the JBI Methodological Guidelines, to assess the quality of this scoping review. We used the technology-organization-environment framework (TOE) to conduct our study. The theoretical framework TOE was created in 1990 by Tornatzky and Fleisher (Baker, 2011). Figure 3.1 demonstrates how the theory explains an organization's technological, organizational, and environmental context and how it can influence technology adoption (Baker, 2011). The technological determinants analyzed are ICT infrastructure and human resources (HR). We also analyzed organizational determinants within the healthcare system and hospitals, such as financial resources, governance, and leadership. Environmental determinants evaluated are government support, health and ICT industry competition, and validation mechanisms. Our review evaluated how those determinants represent constraints and opportunities for the sustainability and scalability of eHealth initiatives in Kenya and Denmark.

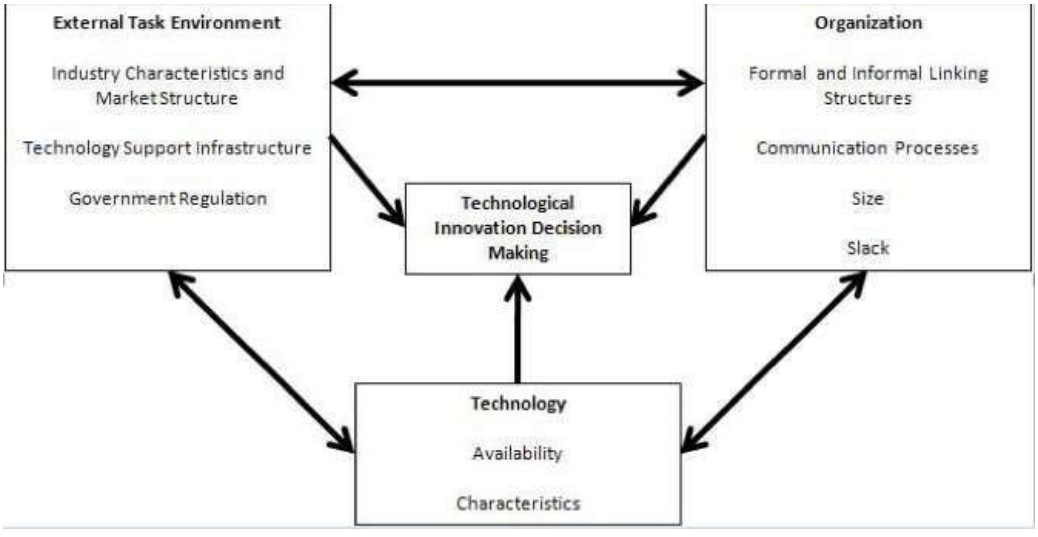


Figure 3.1 Technology-organization-environment (TOE) framework (Baker, 2011).

### 3.2 Analysis technique

A scoping review is defined as a research method used to synthesize research evidence (Munn et al., 2018). This approach has slightly different objectives than a systematic review. Scoping reviews are used to identify knowledge gaps in the literature, clarify concepts, examine research on a particular topic, and provide indicators for subsequent systematic reviews (Lockwood, Dos Santos & Pap, 2019). The literature recommends that researchers adopt four steps when conducting a scoping review to ensure the validity and reliability of results. Those steps are as follows: pre-planning, the protocol phase, the conduction, and report of results (Lockwood, Dos Santos & Pap, 2019).

### 3.3 Eligibility criteria

Total studies included (87). Studies were listed and grouped by their focus of research. We listed studies into three categories: health-focused studies, global-focused studies, and stakeholder-focused studies. Health-focused studies evaluated eHealth initiatives for a specific disease or primary care area. Studies with a global perspective analyzed the effect of policies in the adoption of eHealth programs and the overall landscape of eHealth in the country. Stakeholder-focused studies measured the determinants for user adoption, such as hospitals, patients, or health providers. Our research was limited to studies that covered the regions of Kenya or Denmark. We included all studies associated with eHealth and comparative studies with a study case for Kenya or Denmark. Generalized studies about mHealth in Africa or developing and developed nations were excluded. Based on our literature review in the last decade, mHealth applications had a more significant urge in developing countries. For this reason, the timeline for the studies and article publication was from 2010 to 2021. We searched literature from published articles. The current scoping review adopted an "open" source for information that included empirical studies with qualitative or quantitative data published in English. The review also included all types of reviews, protocols, book chapters, white papers, editorial letters, guidelines, websites, primary research studies, systematic reviews, and meta-analyses.

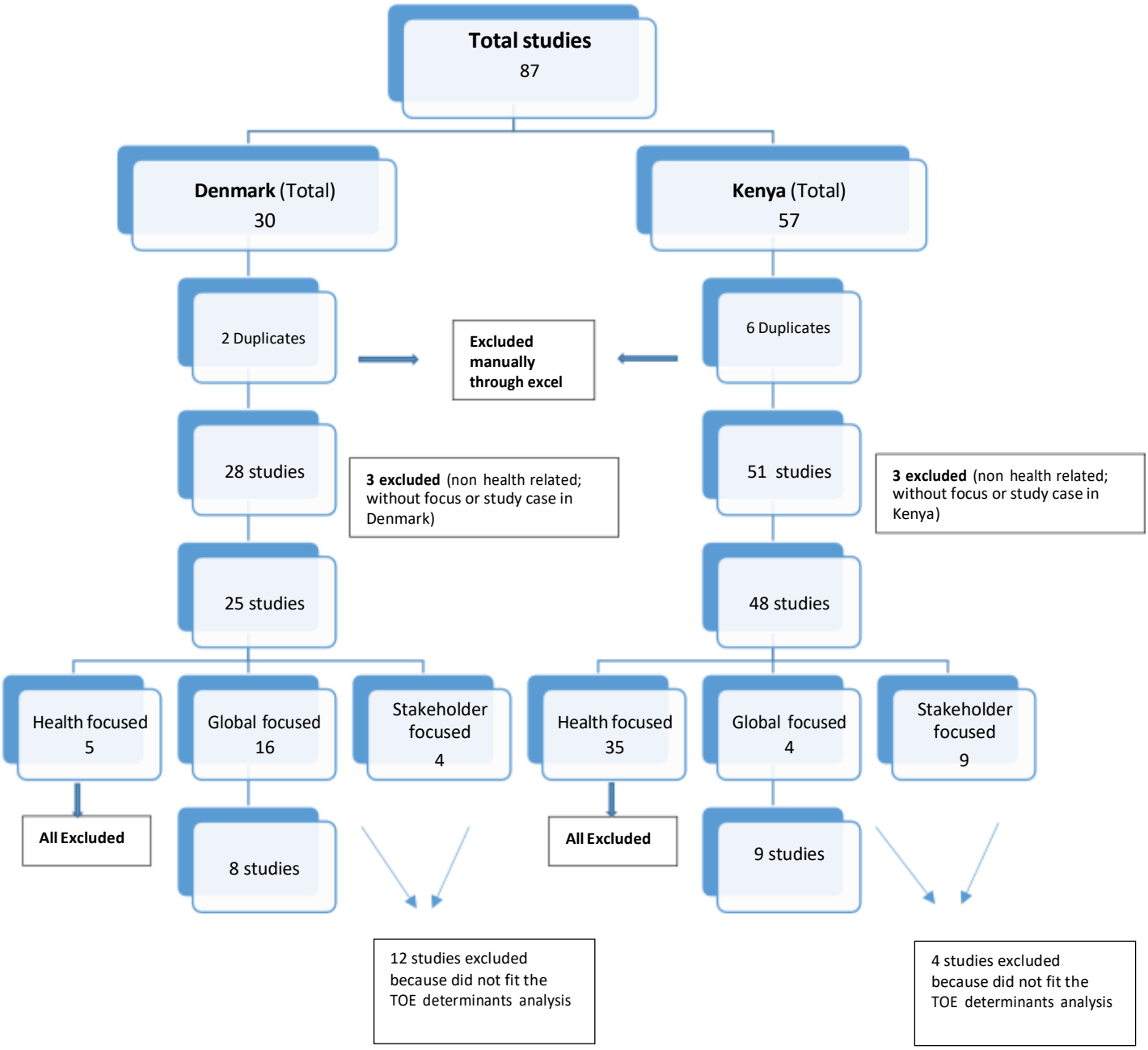


Figure 2.1 Process of study selection.

### 3.4 Studies selection and information collection process

We collected information using virtual libraries such as Cochrane, Google Scholar and PubMed, and the Georgia State University Library. One study was provided through the Georgia State University interlibrary loan service. Search terms used were mobile health Kenya, digital health Kenya, mobile health Denmark, Denmark digital health information, telemedicine Denmark, and unique identifier number Denmark. Our study found a total of 87 studies. Approximately one-third (30) of studies covered Denmark's landscape, while two-thirds (57) covered Kenya's landscape. We found eight duplicate studies. Studies were listed and grouped by their focus of research. We established three categories of analysis: health-focused studies, global-focused studies, and stakeholder-focused studies. Our inclusion criteria required that studies were focused on evaluating an organizational, technological, or environmental determinant for nationwide eHealth adoption. Health-focused studies were excluded because their analysis was narrowed to the effects of eHealth on a specific disease outcome.

We excluded 40 studies because they addressed isolated disease states and isolated maternal and child health problems. We included any study design, which could be quantitative, qualitative, or descriptive, that aimed to describe organizational, environmental, and technological factors at government and health institutional levels associated with eHealth adoption. We also included all types of reviews, articles, white papers, and book chapters analyzing TOE determinants for eHealth adoption among stakeholders such as clinicians, patients, and health institutions. The total number of studies included for an in-depth evaluation was 17. We selected eight studies that analyzed the Danish eHealth landscape and nine studies that analyzed the Kenyan eHealth landscape. We used the JBI data charting guidelines to chart each paper (JBI, 2020). The key information selected from each study is the author's name, year of publication, country of focus, the aim of the study, methodology, study results, type of eHealth initiative analyzed, the focus of analysis, and key findings.

| Country | *Citation* | *Information type* | *study methodology* | *eHealth initiative* | *eHEalth adoption determinant* | *Key findings* | *Study implications for mHealth ecosystem* |
|---|---|---|---|---|---|---|---|
| **Denmark** | (Andersen, Nielsen & Kim., 2019). | Research Article | Observational descriptive study | e-Consultation | Environmental | 2009 Government mandate for GPs to offer e-visits increased supply of e-consultations. E-Health communication channels did not reduce the frequency in use of existent channels, such as walk-in visits. E-visits may result in better population health and reduce healthcare costs in the long term. Nevertheless, as e-consultations add to healthcare costs, there is a challenge on how to finance new communication channels while keeping existent ones open. | e-consultations are facility-centered and thus require more investment in ICT technology. Government support is indispensable for the sustainability and scalability of eHealth programs. The legal and regulatory environment are important determinants for their deployment and development. |
| | (Kushniruk, Borycki & Kuo., 2010). | Professional paper | - | Electronic health records | Environmental | Key development factors in the sustainable and scalable deployment of HER in Denmark are the creation of the national health data network, which facilitates the interchange of standardizing medical documents such as lab orders, prescriptions, referrals, and the nationwide electronically accessible patient summary. Regions are linked through secure intranets. | The establishment of national EHR user interface standards facilitates the adoption and scalability of eHealth solutions. |
| | (Kierkegaard., 2015). | Article | - | Electronic health records | Organizational and technical | Healthcare system governance restructuration played a pivotal role in developing and disseminating the Danish unified national electronic health records system. Interoperability strategies are best managed at regional levels. The replacement of the national EMR system and devolved responsibility for its deployment to regions accelerated the national implementation process. | Even though eHealth policies should be set at the national level, eHealth initiatives should be deployed at regional and local levels. The replacement of technology was a key player in the new eHealth strategy. However, the implementation of new ICT platforms can be extremely costly for a country without slack resources. |
| | (Kierkegaard., 2013) | Article | - | Electronic medical records | Environmental and organizational | Lack of interoperability is found as a threat to patient safety. The delay of treatment and diagnosis of 26 cancer patients was verified due to failures in transferring appropriate medical information. The establishment of 4 EMR systems increased vendor competition in the Danish EMR market and ends with monopoly. | The deployment of eHealth should not be rushed. Pilot phases are essential to ensure patient safety and verify project viability. Governments' policies and strategies are essential to creating competitiveness in the ICT and software market and improve vendors' performance. |
| | (Christensen et al., 2014). | Research article | Observational descriptive study | eHEalth | Organizational | The 4S software ecosystem architecture is being used as an important vector to address the scale and quality of eHealth solutions. The Cansas business model was found as a model for system integration and integration of cross-sector and supplier. Weak organizational, business, and software structures and lack of connectivity are translated into a fragmented telemedicine market. New eHealth market players have low access to public healthcare infrastructures. | A software ecosystem architecture based on open standards and integrated into the healthcare structure results in lower deployment and running costs. Integrated systems ease market access and provide enhanced eHealth community services. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (Kaipio et al., 2014) | Article | Comparative analysis | Electronic health records | Environmental | Physicians work in different hospitals throughout their careers and are exposed to different IT systems with different icons and buttons. The study found that clinicians could take up to 30 minutes to start a new prescription. | There is an evident advantage of adopting EHR user interface standards to improve workflow and enhance eHealth adoption among health professionals. |
| | (Arendt et al., 2020) | Article | Descriptive review | Unique identifier number | Environmental | The unique identifier number allows the linkage of biomarker results with other Danish registries such as hospital diagnosis, causes of death, and prescription drugs at the individual level. A common electronic clinical user interface allows biomarker requisition in public and private health institutions. | The unique identifier number should be set as a long-term goal for unified health information systems. It provides the opportunity for research and the opportunity for evidence-based decisions in the clinical practice. |
| | (Meister, Burmann & Deiters, 2019). | Book Chapter | - | eHEalth | Technological, organizational and environmental | Hospital digital innovation should combine operational and strategic dimensions and fulfills users' demands. A clearly defined vision needs to be developed by the CEO level in collaboration with underlying levels. The authors also state that technology defines how humans interact within and with digital health transformation. A human-centered approach that integrates user education and training programs is crucial for the acceptance of new technologies. | The development of national eHealth initiatives should englobe a multidisciplinary team of hospital CEOs, nursing management, and clinical directors. The responsibility assignment matrix (RACI) matrix template is a powerful tool to be used at government and hospital levels to define a clear vision of digital health processes. |
| **Kenya** | (Kiongo, 2014). | Research project | Non-experimental quantitative research with correlational design. | mHealth | Environmental | Adoption of m-health by users is directly associated with eight determinants: Perceived Usefulness, Perceived Ease of use, Perceived Usefulness, Effectiveness, Reliability, Cost, Awareness, User satisfaction, and Confidence. | When designing mHealth solutions, the government and tech developers should take into account behavioral and cultural aspects. It is essential to obtain user feedback, such as how the app improves performance and accelerates workflow. Additionally, it is important to make apps as simple as possible. Lastly, technologies should be affordable to the public. |
| | (Ngongo et al.,2019) | Research article | Logit regression model | mHealth | Tecnological and environmental | Technological determinants had no statistical significance in patient-centered (PC) mHealth apps adoption. Compatibility, trialability, and acquisition strategies were directly associated with PC mHealth apps in Kenyan Hospitals. The study found statistical significance on ICT HR capacity, slack financial resources, and pursuit of market growth through technology leadership and adoption of PC and FC mHealth apps. Environmental determinants associated with mHealth adoption include patients' demand for mHealth services, industry competition for patients, government support, and support from health insurance companies. | A national digital health strategy helps to frame the implementation of pilot mHealth solutions at a national level. It also ensures the allocation of resources in their development and operation. Additionally, policies in place that integrate mHealth initiatives in national health insurance ensure their sustainability. |
| | (Ngongo et al.,2019) | Research article | Logit regression model | mHealth | Organizational | The adoption of transformational leadership style by Hospital Management Boards has a significant effect on the adoption of PC mHealth apps in Kenyan hospitals. | Education programs are required to increase clinicians, health providers, and hospital top executives' digital literacy. |
| | (Namuhisa, 2020). | Article | Emperical review | mHealth | Organizational | The governance system has a direct impact on mHealth adoption. In a system of devolution, major challenges are the empowerment of citizens for greater power in the decision-making process in the local health strategy. Resource allocation at the local level is associated with the sustainability of mHealth apps. | Decentralized governance allows for greater community engagement. However, there is a great need to empower local communities to enhance their involvement in health decisions. It is important to define roles and responsibilities at a local level. An accountability system could be strengthened by mHealth apps focused on crowdsourcing such as Ushahidi. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | (Obadha, Colbourn & Seal, 2019). | Research article | Probit and bivariate probit models | mHealth | Environmental | Mobile money increased by 4.6% probability of being enrolled in the National Hospital Insurance Fund in Kenya among rural residents working in the informal market. The technology reduced transport costs and travel time. | The increase of national mobile penetration impacts positively the adherence of health insurance among individuals who work in informal market. Mobile money also supports the development of private initiatives such as mamakiba and chamkanga that offer insurance plan for a target population. |
| | (Njoroge et al., 2017) | Research article | Systematic review | mHealth | Environmental | The growth of mobile phone penetration is not necessarily translated into enhanced access to eHealth. The deployment of mHealth initiatives in Kenya is mainly concentrated in big urban centers such as Nairobi and Mombasa. Such areas have more equipped infostructure, ICT human resources, and the population with higher literacy rates. | Policies to incentivize investors to take projects to marginalized regions and programs to increase population literacy are essential to tackle the digital divide problem. |
| | (Ngongo et al.,2019) | Research article | Logit regression model | mHealth | Organizational | Being a male top executive with higher knowledge of mHealth was associated with higher adoption of mHEalth initiatives by Hospital Management Boards in Kenya. | When designing mHealth solutions, strategies should be created to increase mHealth knowledge among hospital leaderships. |
| | (Juma et al., 2012) | Research article | Literature review | eHealth | Environmental | The development of eHealth in Kenya is fueled by a legal and regulatory environment and an educated and entrepreneurial public. The Standards and Guidelines for Electronic Medical Records (EMR) (2010) and Strategic Plan for Health Information Systems (HIS)(2009-2014) are an example of policies that support the national development goals. | National ICT policies and eHealth policies are important determinants for eHealth scalability. A digital literate populace is a key determinant for deploying telehealth nationwide. |
| | (Muinga et al., 2020) | Research article | Cross sectional | eHEalth | Environmental | Some of the benefits of eHealth reported by health professionals in Kenya are auditing for patients' medical records more easily, less paperwork, and improved ability to generate reports required by the hospital and MoH. Vendors pointed inexistence of a unique identification number as a challenge to implement digital health systems. | The establishment of unique identification numbers or digital ID ensures better coordination in healthcare services and access to information. |

Table 3.1 Key issues and concepts emerged from qualitative synthesis of studies from scoping review of literature.

### 3.5. Concept definition

Rex Freiberger states that "a sustainable business model is one that generates value for everyone involved without being a drain on the resources that help create it" (Hendricks, 2020). Based on this definition and on the literature review, we will define a sustainable mobile health app as one with financial sustainability and scalability, with high stakeholder adherence while presenting the expected health outcomes and enables integrating app data with electronic health records.

### 3.6. Participants and context

#### Country selection

We used the WHO telehealth reported data to start the country selection (WHO, 2018). We identified countries according to their UN online services index (OSI). The OSI is an index that measures a government's capability and willingness to provide online services (UN, 2020). We selected two countries from the list to analyze the health system and mobile health ecosystem in depth. We selected one developed country and one developing African country with the highest OSI. Kenya is the African country with the highest OSI, and Denmark the country in the world with the highest OSI, 0.6765 OSI, and 0.9706 OSI, respectively (UN, 2020). Additionally, Kenya, a global leader in mobile solutions, was selected for being an African country with a closer context to Angola. Similarly, Denmark is the first country in the world to adopt the Continua Health Alliance standard, which is a backbone for implementing telehealth nationwide (Petersen et al., 2018). The lessons learned from Denmark can be used as a long-term goal for Angola, while the lessons from Kenya can serve as a short-term goal.

| | Governance | Fiscal | Administration |
|---|---|---|---|
| **Angola** | Three tier government which encloses the central government, 18 provinces and municipalities. | Single-payer system. At the subnational level, health is funded through government block grants based on historical costs. Provincial governments prepare and submit a budget proposal through provincial directorates of health and education | The central government is responsible for the management, planning, and delivery of healthcare services. |
| Kenya | Public sector reform: 2010.<br>Two tier government (national and county) with 47 counties. | Single-payer system. At the subnational level, health is funded through government block grants, locally generated revenue, donor funds, and equalization funds. | Counties are in charge of planning, management, and budgeting responsibilities. They are also responsible for health service delivery such as primary care, ambulance, community health services, and county hospital services. |
| Denmark | Public sector reform: 2007.<br>Three tier government which encloses the central government, 5 regions and 98 municipalities. | Single-payer system. Health is financed through government block grants, activity-based subsidies from the government, and municipalities co-financing at the regional level. Hospital reimbursement is made through the global budget and DRG. The MoH and Ministry of finance negotiate annual health budgets with Danish regions and municipalities. | Planning, management, and budgeting responsibilities are imposed on regions. They are also in charge of detailed planning and delivery of health services provided by hospitals and self-employed health providers. Municipalities provide social and community health services. |

Table 3.2 Comparison of the Angolan health system with the Danish and Kenyan health systems.

# Chapter IV. The Healthcare System in Angola. Overview.

## 4.1. Country profile

The Republic of Angola is a country located in South West Africa. In 1975, as a former Portuguese colony, the country declared its independence (BBC, 2018). As of 2019, the Gross Domestic Product was evaluated as 94.64 billion US dollars in 2019, and GDP per capita as $3103.50 (Tradingeconomics, 2019). During this period, neonatal disorders were the number one cause of death, followed by communicable diseases. HIV/Aids, malaria, diarrheal diseases, lower respiratory infections, and tuberculosis were among the top five major causes of death. Complications from non-communicable diseases such as stroke and ischemia were found among the eighth and ninth major causes of death (IHME, 2019). With a population of 33,733,112 people, life expectancy in the country was estimated as 65.5 to females and 60.7 to males (Worldometers, 2021; WHO, 2016). Behavioral risks were responsible for 50% of the major risk factors for death and disability. Malnutrition, unsafe sex, alcohol abuse, tobacco, and dietary risks were among the top ten most significant risks (IHME, 2019). Since the beginning of this century, health outcome indicators have significantly improved. Infant mortality reduced by more than a half, and maternal mortality dropped approximately by 50% (Worldbank, 2018). After 40 decades of conflict, Angola embarked on a decentralization strategy that also englobed the public health system (Worldbank, 2018).

## 4.2. Health system

Angola's healthcare system consists of the private and public sectors. Nevertheless, the healthcare system has suffered many changes through the historical evolution of the country. The Angolan National Healthcare System (NHS) is characterized by two periods: the pre-colonial period, in which Angolans did not have much access to healthcare services, and the post-independence period (QUEZA, 2010). In the post-independence period (from 1975 to 1992), the healthcare system was based on the principle of free and universal access to health, in which the government uniquely provided all the services (QUEZA, 2010). During this time, the country had

no more than 20 doctors, so the Angolan government established cooperation mainly with Cuba and Russia to contract foreign health professionals (Macaia & Lapão, 2017). Today there is one doctor per 10,000 people (Worldbank, 2018). After 1992, the state lost exclusivity to provide health care services allowing the private sector to enter the market (QUEZA, 2010). This period was also characterized by the beginning of a civil war that caused a negative impact on the NHS (Gambari, 2003). In April 2002, the country reached reconciliation and, as a result, macroeconomic stability (Gambari, 2003). This factor has contributed to the increase of the government's financial resources to the public health sector and the construction of many infrastructures.

Angola's health care system is closer to a single-payer system. Government is the main entity responsible for paying health care claims, managing health infrastructure, and reimbursing health services (Queza, 2010). Law no. 21-B/92, the Fundamental law of the NHS, stipulates that the State should promote and ensure access of all citizens to health care within the limits of the human, technical and financial resources available (Queza, 2010). According to article 21 of the 2010 constitution, it is "a responsibility of the government to promote universal and free primary healthcare" (Constitute., 2010). The NHS has three levels of administration which englobes the central, provincial, and municipal authorities. At the primary level are the Minister and Secretary of State Bodies and the Agencies Central Support Executive (USAID, 2018). Provincial Health Departments and local health administrations comprise second and tertiary levels of administration (USAID, 2018). At the national level, MINSA develops and promulgates policies and regulations and prepares, evaluates, and monitors annual strategic plans. Provincial governments manage and monitor the province network of health services, while municipal governments manage the primary healthcare network (Worldbank, 2018). The NHS is constituted by three levels of care. Services of low complexity levels are assisted by structures such as health posts, district hospitals, nurses, and doctors' offices. Intermediate complexity services comprise provincial and general hospitals, while services with high complexity integrate central and specialized hospitals (WHO, 2012). The national health system owns and operates most health facilities in the country. The MINSA's facilities comprise 1.305 health posts, 291 health centers,

34 maternal-child centers, 146 municipal hospitals, 22 provincial hospitals, 20 central hospitals, and 36 non-specified units (Worldbank, 2018).

### 4.3. Financing

Health in Angola is financed by a mix of government funding, out-of-pocket (OOP), insurance, and employer-sponsored health plans (WHO, 2018). The total expenditure on health as a percentage of GDP had grown from 3.31 percent to 7.7 percent by 2017 (HPP., 2016). Government funding is through natural resources revenues. In 2010, MINSA assessed the possibility of allocating part of the sin taxes revenues from alcohol, nightclubs, and gambling to finance health (Connor, Averbug, & Miralles, 2010). From 2012 to 2018, government health spending as a percentage of health spending (GGHE-D%CHE) suffered a 35.83% decrease, from 65.3% to 41.9% (WHO, 2018). In the same period, out-of-pocket spending as a percentage of health spending (OOPS%CHE) suffered more than a 100% increase, 17.6% to 36.8% (WHO, 2018). Health spending per capita (CHE) suffered negligible changes, US$2,377 to US$ 2,699 (WHO, 2018). At the end of the period, external aid accounted for less than 4% of total health spending while voluntary health insurance contribution accounted for 6.69% (WHO, 2018). The Ministry of Finance (MoF) is responsible for allocating budgets at national and sub-national levels (Worldbank, 2018). MoF sets initial expenditure limits based on historical costs (Worldbank, 2018). The MoH prepares and submits its budget to support the policy and operations department (Worldbank, 2018). Provincial governments prepare and submit a budget proposal through provincial directorates of health and education (Worldbank, 2018).

### 4.4. Challenges

Today, the national healthcare system's most significant challenges are management and maintenance of health facilities, workforce shortage, lack of universal coverage, inconsistent financing, insufficient allocation, planning, and spending at subnational levels (Connor, Averbug, & Miralles, 2010). Insufficient laboratories are also an obstacle to fight the problem of counterfeit pharmaceuticals (Worldbank, 2018). In 2005, a USAID report revealed that 70% of drugs in the

country were acquired in the informal market, and more than one-third were counterfeit drugs (Worldbank, 2018). Additionally, lack of accountability and coordination means between central and local administrations limits interventions at the different levels of the NHS (Worldbank, 2018). In response to those challenges, MINSA implemented a National Health Development Plan 2012-2025 (PNDS) that envisioned the transition of a largely government funded system to one with diversified revenue sources (Connor, Averbug, & Miralles, 2010). The decentralization of health services was also a key factor to improve access to health, which intended to take services from the provincial levels to the municipal levels. MINSA also established a district health strategy policy that envisions the transition for more management responsibility to districts and more resource allocation to primary care and public health (Connor, Averbug, & Miralles, 2010). The Community Health Worker Program launched in 2007 has provided services to more than 261,375 people (Worldbank, 2018). In the last decade, the implementation of regional health maps (mapas de saúde) has also significantly enhanced the quality of health services delivered (Connor, Averbug, & Miralles, 2010).

# Chapter V. Kenya Case Study

## 5.1. Country profile

The Republic of Kenya is located in Eastern Africa and has a population of 54,439,067 people (Worldometers, 2020). In 1963, Kenya became independent from the British colonization (BBC, 2020). Since its independence, the country has had a centralized republic. It was not until August 2010 that Kenya adopted a new constitution that devolved political, fiscal, and administrative power to its 47 new counties formed (Worldbank, 2020). Such reforms have been pointed as the base for the country's sustained growth and social development in the last decade. As of 2019, the country's GDP was estimated as $95,503,088.54 and GDP per capita $ 1,816.5 (Worldbank, 2021). Life expectancy was estimated as 68.4 for women and 63.7 for men (WHO, 2016). As of 2017, only 36% of the population had access to healthcare (Mogen, Masese, & Mbithe, n.d.). HIV/AIDS remains the primary cause of death in the country. Lower respiratory infections, diarrheal diseases, and neonatal disorders are among the top five causes of death (IHME, 2019). Non-communicable health conditions such as diabetes, ischemic heart disorders, stroke, and cirrhosis account for 40% of the top 10 most significant causes of death (IHME, 2019). Behavioral risks account for 50% of major risk factors of death and disability (IHME, 2019). Those risks are malnutrition, unsafe sex, alcohol abuse, dietary risks, and tobacco (IHME, 2019). With projections of real GDP growth to around 6.2% in 2021, macroeconomic stability in Kenya is expected to continue (ADBG, 2020). In the last years, the country has met several Millenium Development goals in education and healthcare (Worldbank, 2020).

The 2010 changes in the country's constitution have also been reflected in Kenya's healthcare system performance. The government's efforts to reach universal healthcare coverage have been reflected in outcomes such as reduced child mortality and improved maternal healthcare (Worldbank, 2014). The adoption of a two-tier devolved government that integrates national and county level authorities transferred planning, management, and budgeting responsibilities from central government to subnational governments (McCollum, 2020). The new 47 subnational

governments received the responsibility to manage and develop local services, including health (Masaba et al., 2020).

### 5.2. Health system

In 1970, after seven years of independence, Kenya nationalized its health system, and free healthcare was provided by more than 3200 government healthcare facilities nationwide (WHO, 1994). Nevertheless, 19 years later, due to the country's economic stagnation, the Ministry of Health (MoH) reinstated user fees (Mogeni, n.d.). During this period, the Government of Kenya (GOK) continued to face financial restraints, and in 1992 Kenya started a reformation process that two years later culminated in the 1994 Kenya's Health Policy Framework (WHO, 1994). The document envisioned a way to map strategies to address priority problems and define the horizon for government policies for the next century (WHO, 1994). It also provided a long-term vision for 2010 reforms emphasizing that health should be accessible, affordable, and acceptable to all (Roux-Kemp, 2019). In 2014, the Kenya Health Policy 2014-2030 was published by the MoH (Republic of Kenya Ministry of Health, 2014). The document stressed the main 2010 constitutional articles that have implications to health, including the article 43 section (a), "every person has the right- (a) to the highest attainable standard of health, which includes the right to health care services, including reproductive health care" (Oxfam., n.d.).

Today, the healthcare system of Kenya is structured in a hierarchy system with six levels of care. Community and dispensaries are the first and second levels, including health centers and primary referral facilities at the third and fourth levels, secondary referral facilities, and tertiary referral facilities at the fifth and sixth levels (Republic of Kenya Ministry of Health., 2014). Healthcare services are provided by public health hospitals, private for-profit, and not-for-profit facilities (Republic of Kenya Ministry of Health., 2014). The public health system is structured in four levels. Community services, primary health services, and county referral services are provided by county governments, while the national government oversees national referral services (Republic of Kenya Ministry of Health., 2014). County governments are responsible for providing services for

the first, second, and third levels, while national governments provide services at the fourth level (Masaba, 2020). There are six major semi-autonomous government agencies (SAGAs). The National Aids Control Council (NACC), the Kenyan Medical Training College (KMTC), Kenya Medical Research Institute (KEMRI), MOI Teaching and Referral Hospitals (MTRH), Kenyatta National Hospital (KNH), Kenya Medical Supplies Authority (KEMSA), (Republic of Kenya Ministry of Health., n.d.). As of 2016, Kenya had registered 12 national referral hospitals, 541 county hospitals, and 8,762 primary care facilities (Phamacess, 2016). More than one-third of private facilities operate in Nairobi and Mombasa (Phamacess, 2016). Public facilities account for more than half of all healthcare facilities, while faith-based facilities account for 11% (Phamacess, 2016).

### 5.3. Financing

The source of health expenditure in Kenya is a combination of government funding, external aid, out-of-pocket, social insurance, and voluntary health contributions (WHO, 2018). From 2012 to 2018, government expenditure as a percentage of health spending experienced a 9.7% increase, 32.4% to 42.1% (WHO, 2018). Similarly, GDP per capita increased from $1,137 to $1,710 (WHO, 2018). OOPS%CHE decreased from 31.6% to 23.6% and CHE increased from $63.8 to $88.4 (WHO, 2018). At the end of the period, social insurance accounted for 9.42% of total health expenditure, voluntary health contributions accounted for 8.7%, and 15.51% of expenditures came from external aid (WHO, 2018). As a percentage of the GDP, the total health expenditure experienced a 17.9% increase from 2012 to 2018, 7.8% to 9.2% (McCollum, 2020). An estimate of 15% of national revenue was allocated to every 47 counties, which in turn allocated a minimum of 27% of the total county budget to healthcare (McCollum, 2020). The national government budget to the MoH also experienced significant growth from 3.7% in the preceding years to 5.1% at the end of the period (Republic of Kenya Ministry of Health., n.d.). The highest share of the MoH recurrent budget, 58.9%, was allocated to grants and transfers to SAGAs (Republic of Kenya Ministry of Health., n.d.). In the same way, 15.5% of the budget was allocated to personnel emoluments, while 22.3% to universal health care transfers and primary healthcare service and 3.3% to

operations and management (Republic of Kenya Ministry of Health., n.d.). During the same fiscal year, 79% of the development budget was used to hire medical equipment and provide free maternity health programs, 54%, and 24% respectively (Republic of Kenya Ministry of Health., n.d.). In the same period, 58% of the budget allocated for development programs that target core health problems such as malaria and HIV was derived from donors (Republic of Kenya Ministry of Health., n.d.). Health insurance is obligatory only for employed individuals (Obadha, Colbourn, & Seal, 2019). Almost one-quarter of the population is covered by the national hospital insurance fund, which represents 93.4% of the total national insurance coverage (Obadha, Colbourn, & Seal, 2019). Monthly premiums vary from 150 (US $ 1.5) to a maximum of KES 1700 (US $ 17) (Obadha, Colbourn, & Seal, 2019). Payments are deducted from employees' salaries and paid at four approved branches or through mobile money by voluntary contributors (Obadha, Colbourn, & Seal, 2019).

### 5.4. Ecosystem for mobile health applications

From the beginning of the 21st century, Kenya has called the world's attention due to the rapid growth of mobile solutions. With 90% of mobile penetration, the country is a global leader in mobile initiatives to solve social issues (Kemp, 2020). The ownership of smartphones is around 88%, against 10% of the non-smartphone (Kemp, 2020). Data from 2019 revealed that less than half of the population has access to internet connection, and mobile devices represent 68.7% of total web traffic issues (Kemp, 2020). In 2007, M-Pesa, translated from Swahili "M-money," started a revolution in the country's banking system (Qiang et al., 2012). The mobile payment service created financial inclusion of 70% of households in the country, while 50% are from lower-income households (Kendall et al., 2011). Kenyans can send money, pay bills, invest and make savings through text message technology. M-Pesa mobile wallet transactions represent at least 15% of the country's GDP (Kendall et al., 2011). Since then, many other mobile solutions have been successfully deployed in Kenya. Today, M-Pesa integrates more than 20 new startups (Kendall et al., 2011). Ushahidi, translated as testimony from Swahili, is a map-making tool that allows witnesses of catastrophes or other social incidents to send real-time reports using SMS

text message to a designated phone number or submit an online report (Rotich, 2017). Today, the initiative is also operating in the health sector to support drug supply and forecasting and monitor essential medicines' stock-outs in public facilities (Qiang et al., 2012).

Mobile solutions have also been integrated into other sectors of society. The main areas of health apps operation are patient education and awareness, financing, patient tracking, supply chain and management, and surveillance. With more than 70% of the initiatives being government/donor-funded, only 30% are for-profit or hybrid entities (Qiang et al., 2012). The GOK developed the Kenya Health Information Systems Interoperability Framework (KHISIF) to provide a national standard and integration of HIS (Mutahi, n.d.). The framework envisioned establishing three working groups within the Interagency Coordination Committee (ICC), a multi-stakeholder body that brings together all major players in the health sector (Mutahi, n.d.). The health informatics team received the responsibility of leading activities related to HIS and electronic health records (EHR) to avoid duplicates and liaison between national and county governments and stakeholders (Mutahi, n.d.). The health metrics department was designed to coordinate HIS by monitoring stakeholder activities and the progress of the health sector strategic plan (Mutahi, n.d.). The research and innovation team were appointed to oversee and provide inputs to all prioritized research activities (Mutahi, n.d.). All three workgroups were outlined to work directly with the MoH in helping the country reach high quality and patient-centric delivery of eHealth services. In addition, the country also has in place the Kenya national eHealth policy 2016-2030 (Republic of Kenya Ministry of Health, n.d.).

For-profit mobile solutions such as Mamakiba, and Chamgamka are some of the initiatives operating in Kenya's mHealth market sector. Safaricom, the main mobile operator in the country, has 64.5% market share in mobile subscriptions and retains 99% of the mobile money market (Gilbert, 2020). The company garners up to 90% of mobile applications revenues, including mHealth (Qiang et al., 2012). Despite Safaricom's dominance, the company's M-Pesa platform has been defined as a landscape of innovation. As a network infrastructure, M-Pesa has allowed new startups to operate solely within its platform (Kendall et al., 2011). Chamgamka Microhealth

and Mamakiba are two mobile initiatives that operate as digital health savings accounts free of regular premium payments (Qiang et al., 2012). Both startups utilize M-Pesa mobile money service to allow expectant mothers to save money for outpatient and maternity care services. After four years of operating in the market, 25 local providers joined Chamgamka. The startup reached a revenue of Khs 3.2 million while requiring additional sales of Khs 23.3 million to reach break-even (Qiang et al., 2012). By 2013, the startup had sold 3000 maternity plans and 12,000 family health plans. Chamganka smart card facilitates health care financing for Kenyans working in the informal market (Knippler, 2013). The smart cards can be shared with family members and have lower costs than standard insurance (Qiang et al., 2012). Both mobile initiatives help prevent the impoverishment low-income families due to out-of-pocket expenses and meet one of the country's health system's goals by increasing access to maternal health services.

Non-for-profit mobile health solutions are also being used to generate health solutions to improve the lives of HIV patients, reduce child death, and address issues of medicine counterfeiting. M-Pedigree, WelTel, and Childcount+ were developed and deployed in a partnership of GOK, national and international partners (Qiang et al., 2012). Childcount+, launched in 2009, was developed by Millenium Villages Project to support community health workers and enhance child survival (Multiplyd, 2010). Since its deployment in Kenya, the real-time database has been essential in managing acute malnutrition and diagnosing infectious diseases such as malaria and acute diarrhea (Qiang et al., 2012). Childcount+ uses RapidSMS, a framework that processes text messages in a series of phases (Kieti, 2017). By using SMS text messages, the program intermediates field-based health in the process of patient registration and EHR submission to a central database (Kieti, 2017). Community health workers receive an automated treatment response, which facilitates their work with local communities (Kieti, 2017). In addition to that, Childcount+ provides a central web dashboard that provides real-time status of the community's health (Kieti, 2017). In three months, the project has registered 9,500 children and supported 108 health workers from eight clinics in the sub-district hospital of Sauri. (Qiang et al., 2012). Neither costs of development and implementation nor revenues were available in the literature.

M-Pedigree protects the supply chain by addressing counterfeiting and ensures consumer safety (Mpedigree, 2021). Consumers text an assigned code enclosed in drug packaging to a free SMS number to help verify the authenticity of the drug (Mpedigree, 2021). WelTel supports the treatment of HIV patients by allowing clinic nurses to monitor patients receiving antiretroviral therapy (Qiang et al., 2012).

# Chapter VI. Denmark Case Study

## 6.1. Country profile

Denmark is located in northern Europe and has approximately 5,837,213 population (Indexmundi, 2020). As of 2020, the country's GDP was estimated as 339.63 billion US dollars and per capita GDP as $58,439 (Indexmundi, 2020). In 2017, life expectancy was 82.7 years for females and 78.8 for males (IHME, 2019). In 2019, Ischemic heart disease, stroke, and lung cancer were among the three major causes of death (IHME, 2019). Tobacco and alcohol use and poor dietary habits were pointed to as the three major risk factors for death and disability combined (OECD, 2019). The country's health system covers 100% of the population, and more than three-fourths of the population is satisfied with the services provided (Rosenmeier, 2009).

Denmark has a long history of decentralized welfare administration (Knoema, 2020). Unlike other European countries, Denmark's healthcare system has not experienced reforms since 1970 (Christiansen, 2012). During this period, the country was divided into 13 counties and 271 municipalities (Christiansen, 2012). Additionally, an integrated public system with universal healthcare access was created (Vrangbæk & Christiansen, 2005). However, in 2007 an essential structural reform of the public sector resulted in public services' centralization in distinct ways (Olejaz et al., 2012). The number of municipalities was reduced to 98, and the 13 counties were substituted by five regions (Christiansen, 2012). Both local governments were designed to have elected boards at four-year intervals, but only municipalities had the authority to collect taxes (Christiansen, 2012). Such structural reforms allowed for significant changes in the healthcare system.

## 6.2 Health system

Throughout history, the Danish healthcare system experienced two periods of major structural reforms. Before the 1970 reforms, counties and municipalities owned and managed hospitals (Pedersen, Christiansen, & Bech, 2005). Hospital funds were provided by local and state tax

premiums (Pedersen, Christiansen, & Bech, 2005). Mandatory sickness funds subsidized general practitioners and specialist services through pro-rata premiums (Pedersen, Christiansen, & Bech, 2005). Post-1970 sickness funds were abolished, and the healthcare system became almost entirely funded by tax revenues (Vrangbæk & Christiansen, 2005). Hospitals became the exclusive property of counties (Vrangbæk & Christiansen, 2005). After 30 years of substantial stability, the Danish public sector suffered a second major reform in 2007 (Christiansen, 2012). Following a more centralized path, the five regions established (Capital Region of Denmark, Region Zealand, North, Central, and Northern Region of Denmark) received the responsibility of overseeing hospitals, general practitioners, and the private sector (Vrangbæk & Christiansen, 2005). A significant number of small hospitals were closed (Christiansen, 2012). There was a shift of investment towards the extension and renovation of existing hospitals and the construction of new specialized larger facilities (Christiansen, 2012). Based on Diagnosis Related Groups (DRG), economic incentives were created to enhance hospital productivity (Vrangbæk & Christiansen, 2005). Additionally, establishing government-mandated waiting time guarantees resulted in significant growth of the private hospital sector (Christiansen, 2012). It allowed the use of public funds to cover private healthcare expenses for services with waiting time exceeding two months (Christiansen, 2012). After three years of the policy deployment, the private sector experienced a 2.2% growth of total hospital activity (Christiansen, 2012). It is estimated that there are approximately four doctors for every 1000 people in the country (OECD, 2019).

Denmark's healthcare system is a single-payer system politically, financially, and operationally decentralized (Indexmundi, 2020). It is built upon three administration levels, the national, regional, and local levels (Kierkegaard, 2013). At the primary level, the state is accountable for defining the healthcare system framework (Olejaz et al., 2012). Headed by the MoH, the state issues health legislation, guidelines, protects the rights of patients, monitors and audits hospitals, health providers, and pharmacies (Olejaz et al., 2012). The MoH operates with eight subordinate agencies, such as the Danish Medicines Agency, Danish Patient Safety Authority, and the Danish Health Data Authority (Vrangbæk & Christiansen, 2005). The National Board of Health (NBoH) is responsible for setting guidelines and requirements for future hospital specialties planning

(Olejaz et al., 2012). It also regulates health services coordination among hospitals, GPs, and private practice specialists between regions and their municipalities (Christiansen, 2012).

At the secondary level, regions oversee detailed planning and delivering health services provided by hospitals and self-employed health providers (OECD, 2019). They govern primary and secondary health services and regulate drug reimbursement plans (Vrangbæk & Christiansen, 2005). The primary care sector's principal actors are self-employed professionals such as GPs, specialists, dentists, and physiotherapists (Rosenmeier, 2009). Primary healthcare providers work in solo or group practices and have contractual agreements with the National Health Service (Vrangbæk & Christiansen, 2005). Except for emergency and dental care services, GPs are the first point of contact for patients (OECD, 2019). GPs have a gatekeeping role for referring patients to hospitals and private specialists (Pedersen, Christiansen, & Bech, 2005). At the tertiary level, municipalities provide social and community care through rehabilitation, home and elderly care, and primary and preventive health services (OECD, 2019). They are also in charge of pediatric dental care and school health services (Vrangbæk & Christiansen, 2005).

### 6.3 Financing

Healthcare expenditure in Denmark is a combination of government transfers, out-of-pocket spending, and voluntary health insurance contributions (WHO, 2018). Government funding through taxes accounts for more than 80% of total health spending (WHO, 2018). Out of pocket copayments were estimated at 16% and represented contributions to medication costs and adult dental care (WHO, 2018). In 2019, total health expenditure amounted to 10% of the country's GDP (Elflein, 2020). At the state level, the MoH and Ministry of Finance negotiate annual health budgets with Danish regions and municipalities (Olejaz et al., 2012). The national budget law requires a 2% hospital productivity growth from regions and establishes a four-year expenditure limit for public services (HPP., 2016). At the regional level there are three sources of funds, government block grants, activity-based subsidies from the government, and municipalities co-financing (Tikkanen, 2020). The state block grant covers 75% of total region health expenses (Denmark Ministry of Health., 2016). Regional allocations need to meet specific demographic and

social requirements to ensure equity in the budget distribution (Denmark Ministry of Health., 2016). Municipalities provide activity-based subsidies to regions depending on the number of inpatient and outpatient services (Denmark Ministry of Health., 2016).

Hospital reimbursement is made through a mix of global budgets or contracts and diagnosis-related groups (DRG) systems (Denmark Ministry of Health., 2016). Per diem reimbursement (Pre-established service costs) is adopted for counties using university hospitals. The government reimburses 5% of total health expenditures to regions and 10% to municipalities using the DRG tariffs (Denmark Ministry of Health., 2016). Hospital co-financing between municipalities and regions is also effectuated through the DRG system (Denmark Ministry of Health., 2016). The health care reimbursement scheme is mainly through public health insurance and divides the population into two groups (Tikkanen, 2020). Group 1 membership registers individuals with an appointed GP and allows them to self-refer to certain specialists such as ophthalmologists and dentists (Vrangbæk & Christiansen, 2005). Group 2 membership amounts to less than 1% of the population (Vrangbæk & Christiansen, 2005). Enrollees are subject to copayments and have the freedom to choose health providers except for psychologists, physiotherapists, and podiatrists (Vrangbæk & Christiansen, 2005). Health services are provided at a free charge at the point of delivery (Tikkanen, 2020). Self-employed health professionals receive remuneration on the basis of capitation and fee for service (Pedersen, Christiansen, & Bech, 2005). The workforce in public hospitals is reimbursed on a fixed salary basis (Olejaz et al., 2012).

Private health insurance covers two-fifths of the population but accounts for less than 2% of national health expenditure (Vrangbæk & Christiansen, 2005). From 2006 to 2010, the number of private facilities has grown from 175 to 249 (Christiansen, 2012). Services can be accessed through out-of-pocket payment, employer-based and private health insurance, and public subsidy under the waiting time guarantee policy (Christiansen, 2012). Medicine reimbursement is operated by a system that entitles patients to reimbursement when a prescription is acquired from a private pharmacist (Denmark Ministry of Health., 2016). At public hospitals, medicines are

provided at free cost (Olejaz et al., 2012). Amgros, the public procurement agency, cooperates with the five regional authorities to negotiate medicine prices (Hostenkamp, 2011).

### 6.4 Ecosystem for mobile health applications

Denmark is a global pacesetter in deploying nationwide telehealth. Digital technology has transformed the country's public health care. More than 374 telemedicine initiatives operating in the country mainly address cardiovascular disease, psychiatric disease, and other chronic somatic conditions such as COPD and diabetes (Kierkegaard, 2015) (Nøhr et al., 2015). The nationwide digitalization of the healthcare system is focused on the optimal use of healthcare resources (Petersen et al., 2018). The strategic work with telehealth exists for more than 20 years (Kierkegaard, 2015). In 1996, the first national information technology (IT), Action Plan for Electronic Patient Records—Strategy Report, was deployed (Kierkegaard, 2015). Since then, many other strategies and regulations have been implemented and along with small- and large-scale telehealth projects within the healthcare sector (Petersen et al., 2018). The system's extensive digitization allows the systematic use of data, sustained long-term contact with patients, and electronic communication between healthcare providers (Denmark Ministry of Health, 2016).

The Danish healthcare system is a world leader in the inclusion of information and communication technologies (ICT) into primary and secondary care institutions (Andersen, Nielsen & Kim, 2019). The Danish Health Data Authority is responsible for maintaining national standards for digitization and data security (Vrangbæk & Christiansen, 2005). Within the Danish healthcare system, there are five key IT solutions (Vrangbæk & Christiansen, 2005). Health data interoperability is ensured by the Danish national health network, as observed in Figure 6.2 (Medcom, 2019). The network comprises more than 10,000 users and 4000 organizations, and 100 IT systems (Kuo, Kushniruk & Borycki, 2011). In all hospitals in the country, 97% of GP and approximately 74% of specialists use the platform (Kuo, Kushniruk & Borycki, 2011). Almost 100% of laboratory test results, drug prescriptions to pharmacies, referrals to

hospitals and specialists are made electronically (Olejaz et al., 2012). Medcom, a public agency owned by the MoH, Danish regions, and municipalities, is responsible for setting all the national IT standards (Kuo, Kushniruk & Borycki, 2011). The agency develops and implements digital solutions and cooperates with health providers and IT vendors to build solutions implementable across the national healthcare structure (Medcom, 2018). Medcom also safeguards health data and ensures that it is securely exchanged between health providers, authorities, and private entities (Medcom, 2018). Common IT standards enable data exchange between GPs, specialists, hospitals, laboratories, pharmacies, and local authorities (Kushniruk, Borycki & Kuo, 2011). The actual data exchange uses the point-to-point-oriented model observed in Figure 6.1. This is a flexible and straightforward model in which all contractual parties have mutually agreed on standard coding terminology and messaging protocols (Kushniruk, Borycki & Kuo, 2011).

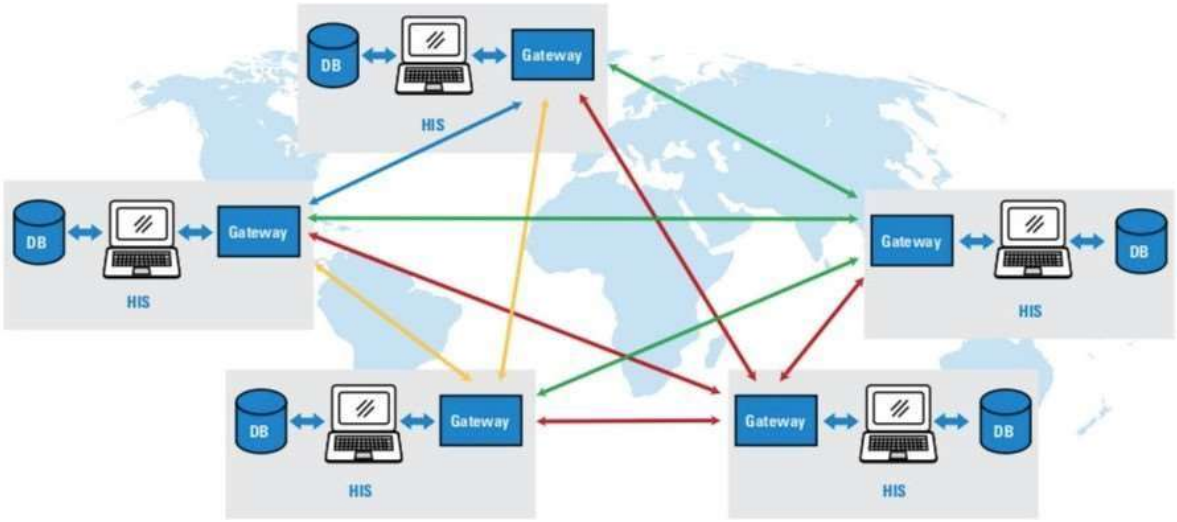


Figure 6.1 “Point-to-point data interoperability model” (Kushniruk, Borycki & Kuo, 2011).

The national web portal Sundhed.dk allows citizens and health providers to access health information and communicate (Petersen et al., 2018). Electronic medical records operate in two systems, the Systematic Columna Clinical Information System (MidtEPJ) and the Epic’s Healthcare Platform (Sundhedsplatformen) (Vrangbæk & Christiansen, 2005). The first is used by the central, north, and southern regions, and the second by the capital and the Zealand region (Vrangbæk & Christiansen, 2005). The Shared Medication Record allows health providers and patients to

access a complete electronic record history of prescription medications (Denmark Ministry of Health., 2016). It is a core database under the Danish Health Data Authority (Medcom, 2019). In 2006, a cost benefit analysis estimated that MedCom cumulative value cost by 2005 was 536 million euros, while the benefit was estimated at 872 million euros (Edwards, 2006). The investment has resulted in a cost benefit of 1.6 (Edwards, 2006). More effective communication reduced administrative costs among GPs and reduced the waiting time for reimbursement (Edwards, 2006). The report revealed that the platform reduced 30 hours of weekly secretarial work (Edwards, 2006). It also lessened the time of patient transfers from hospital to home care (Edwards, 2006).

The nationwide Telehealth initiatives deployed in Denmark demonstrated cost-effectiveness. Since Telecare Project North's deployment in 2013, more than 200,000 chronic obstructive pulmonary disease (COPD) patients are being monitored from home (Petersen et al., 2018). The large-scale project is a public and private partnership that traced the way for national dissemination of telemedicine (Nielsen, n.d). Patients monitor and report from home twice a week their vital data to their health provider using a tablet (Christensen, 2016). Four studies concluded that the project reduced hospitalization rates among severe COPD patients and increased their quality-adjusted life years (QALY) (Petersen et al., 2018). Telesar, the telemedical monitoring of wounds, has improved the quality of treatment delivery. The project enrolls nurses in a specialized education program led by a multidisciplinary health team (medical doctors, experienced podiatrists, and nurses) (Petersen et al., 2018). During the home visits, nurses are allowed to use their personal mobile phones to photograph the wound and upload it to a web based EMR (Christensen et al., 2014). Specialists can access the data and prescribe the treatment accordingly (Christensen et al., 2014).


Figure 6.2 Operational structure of the Danish National Digital Health Platform (Medcom, 2019).

# Chapter VII. Successes and Lessons Learned

## 7.1. Successes and lessons learned from Kenya

Our review found 57 studies analyzing mHealth initiatives operating in Kenya. Among them, six were duplicates, and three were excluded because they were non-health related and did not have a focused analysis on Kenya. Of the 48 remaining studies, 41% (20) of studies were focused on disease-based interventions. 40% (8) of the studies analyzed HIV-based interventions, while 15% (3) focused on malaria-based interventions. The remaining 45% (9) analyzed a variety of disease states. Studies analyzing mHealth initiatives associated with maternity and childcare were 29% (14), and 18% (9) evaluated the determinants of stakeholder adoption (hospitals, patients, and clinicians). The remaining studies were focused on analyzing mHealth apps based on a national perspective. We selected nine studies for an in-depth analysis. Most studies analyzed mobile Health initiatives. The majority of mHealth applications tackle problems prioritized by the country's MoH. Most applications operating in the country address HIV, malaria, and maternal and child health (Njoroge, 2017). SMS-based initiatives were found to be cost-effective in the treatment of HIV patients. Their incremental cost-effectiveness ratio of $1037/QALY is very effective when compared to the WHO threshold of $2154/QALY (Patel et al., 2017). Additionally, health professionals in Kenyan hospitals have reported that eHealth improves workflow (Muinga et al., 2018). It facilitates the audit of patients' medical records, reduces paperwork, and enhances the ability to generate reports required by the hospital and MoH (Muinga et al., 2018).

Regardless of the important advances verified in Kenya, we found that many factors still threaten the sustainability of mHealth apps. The literature demonstrates an extreme concentration of interventions in urban areas such as Nairobi, Kisumu, and Mombasa (Njoroge, 2017). Rural zones where the most marginalized population resides lag in mHealth interventions (Njoroge, 2017). Moreover, we found that challenges in the adoption of mHealth initiatives undermine their sustainability and scalability. Technological determinants and their influence in the deployment

of eHealth strategy have been widely discussed in the literature. Ngongo et al. (2017) found no statistical significance of technological determinants in the adoption of PC mHealth apps in Kenyan Hospitals. On the other hand, the researcher found a direct association of technological determinants in adopting FC mHealth solutions (Ngongo et al., 2017). Smart acquisition strategies should trace the acquisition of new technologies. Resources are scarce, and expensive technologies increase the total cost of healthcare. Therefore, it is recommended that FC applications be implemented in large-sized facilities such as secondary and tertiary hospitals as they are more costly and complex than PC apps (Ngongo et al., 2017). Another challenge in Kenya was theft and damage of technological infrastructure (Muinga et al., 2020). To mitigate such a problem, hospitals required staff to take personal responsibility for the equipment (Muinga et al., 2020).

Organizational predictors for PC and FC mHealth apps adoption found in the literature are those such as slack financial resources, facility size, the pursuit of market growth through technological leadership, and ICT capacity (infrastructure and HR) (Ngongo et al., 2017). Hospital management board leaders define vision and growth strategies for the adoption of mHealth. There is evidence that top executives' (TEs) traits such as gender and level of education and knowledge of mHealth are directly associated with mHealth apps adoption in Kenyan hospitals (Ngongo, Ochola, Ndegwa, & Katuse., 2019). Male TE with higher knowledge levels of mHealth were less likely to reject the implementation of PC mHealth apps hospitals (Ngongo, Ochola, Ndegwa, & Katuse., 2019).

There is great value in integrating digital health training in the medical school curricula and in professional development training (Ngongo, Ochola, Ndegwa, & Katuse., 2019). Additionally, the transformational leadership style (TLS) is pointed as a catalyst in the adoption of mHealth innovations (Ngongo, Ochola, Ndegwa, & Katuse., 2019). To achieve high levels of commitment and motivation, the TLS engages the use of idealized influence, inspirational motivation, individualized considerations, and intellectual stimulation (Ngongo, Ochola, Ndegwa, & Katuse., 2019). The governance and administrative reforms in Kenya played a key role in the sustainable

implementation of mHealth solutions (Namuhisa, 2020). Devolution has resulted in better governance for the Kenyan Health care system. It enabled the greater engagement of diverse stakeholders in the decision-making process at subnational levels (Namuhisa, 2020). However, the literature urges for more coordinated planning and working from national to regional and local levels and empowerment of communities to allow their engagement in health decisions (Namuhisa, 2020).

The scalability of mHealth initiatives is also directly associated with environmental factors. The health industry competition is an important determinant for the adoption of both PC and FC apps (Ngongo, Ochola, Ndegwa, & Katuse., 2019). Simultaneously, government and health insurance industry support are statistically significant for adopting FC apps (Ngongo, Ochola, Ndegwa, & Katuse., 2019). The development and deployment of policies that address compatibility and interoperability of mHealth apps at national and regional levels are crucial (Juma et al., 2012). Mechanisms of trialability are essential for their validation (Ngongo, Ochola, Ndegwa, & Katuse., 2019). Similarly, a more equitable government resource allocation at the local level is recommended to help finance mHealth solutions, especially for underserved regions (Namuhisa, 2020). We found evidence that the implementation of many mHealth initiatives in Kenya has been supported by the exponential growth of the information and communication technology (ICT) sector (Patel et al., 2017). The 2030 government policy recognized ICT as a core element for the country's economic growth (Patel et al., 2017). The policy propelled heavy public and private investment in developing the national fiber optic infrastructure and the growth of the telecommunication and software development industries (Patel et al., 2017).

Similarly, the MoH's eHealth National Strategy 2011-2017 brought a significant role to ICT to leverage access and strengthen the country's health system (Juma et al., 2012). One of the policy's main objectives was to increase health access to underserved populations by strengthening the health system (Njoroge, 2017). The strategy outlined five core areas: telemedicine, HIS, mHealth, eLearning, and health information for the population (Njoroge, 2017). Since then, the small- and large-scale eHealth solutions implemented by public and private

institutions pivot the five strategic areas of the national strategy (Njoroge, 2017). Moreover, the literature also demonstrated that the user adoption of m-health apps in Kenya is directly associated with behavioral and cultural determinants (Kiongo, 2014). Those findings stress the importance of conducting a prior evaluation of cultural and behavioral aspects when designing mHealth initiatives. We also found that the inexistence of a unique identification number is pointed by vendors as a challenge to implement digital health systems (Muinga et al., 2018).

### 7.2. Successes and Lessons learned from Denmark

Our review found 30 studies analyzing mHealth initiatives operating in Denmark. Among them, two were duplicates. From the remaining 28 studies, we excluded three because they were non-health-related and did have a focus or a study case for Denmark. Of the 25 studies selected, 64% (16) studies were focused on analyzing eHealth based on a global perspective. Approximately 16% (4) evaluated stakeholder adoption determinants. The remaining studies were focused on analyzing mHealth apps based on a health perspective. Cardiovascular disease, COPD, and diabetes eHealth initiatives were the main disease states covered by the studies. We selected eight studies for an in-depth analysis.

The Danish healthcare system has greatly benefited from the consolidation of the national digital platform. It has allowed better patient management, facilitated easy access to care, and enhanced financial costs control. Since 2003, ICT support in hospital logistics (Task management, bed, and transportation management) resulted in 30% productivity growth (Meister, Burmann & Deiters, 2018). More than 374 telemedicine initiatives operate in the country (Nøhr et al., 2015). They mainly address cardiovascular disease, psychiatric disease, and other chronic somatic conditions such as COPD and diabetes (Nøhr et al., 2015). eHealth initiatives prioritize elements of the national strategy as they tackle the major death risk factors. eHealth initiatives are significantly well distributed among regions (Nøhr et al., 2015). The most used technology is videoconference, while mobile health initiatives are among the least (Nøhr et al., 2015).

Despite the great progress, there is still room for growth. We found that the digital divide remains a challenge in the country. Individuals with high social income and are young have greater adoption of medical e-visits (Andersen, Nielsen, & Kim, 2019). The 2009 government mandate for GPs to offer e-consultations increased electronic communication rates between patients and providers. However, such an increase did not decrease the use nor the overall running costs of existent channels such as physical visits (Andersen, Nielsen, & Kim, 2019). As e-consultations add to healthcare costs, there is an evident challenge on how to finance new communication channels while keeping the existing ones (Andersen, Nielsen, & Kim, 2019). On the other hand, e-visits may reduce costs in a long-term perspective as it increases the population's health.

We found similar determinants for the sustainability of eHealth projects when analyzing the literature for Denmark. Organizational, technological, and environmental determinants were found as well as strong predictors for their deployment and growth. The replacement of technology was a key player in the new eHealth strategy (Kierkegaard, 2015). However, the implementation of new ICT platforms can be extremely costly for a country without slack resources. In 2012, a national plan for telemedicine based on the continua alliance standard was launched, providing a reference for the development of national standards for the collection, storage, and exchange of clinical data nationwide (Kierkegaard, 2013). The five regions received the responsibility in the administration of hospitals and negotiated and deployed new EMR systems (Kierkegaard, 2015). As the organs that better understand the eHealth needs of local healthcare facilities, regions were able to reduce the number of EMR systems to only six (Kierkegaard, 2015).

Additionally, we found that poor interoperability of systems in Denmark is a challenge faced by the national eHealth program. Failures in transferring appropriate medical information resulted in treatment and diagnosis delay of cancer patients (Kierkegaard, 2013). Failures in transferring patients' medical records result from poor interoperability (Kierkegaard, 2013). Lastly, the aggressive push for eHealth in Denmark has resulted in workflow disruption among clinicians (Kierkegaard, 2013). This finding demonstrates, even more, the need for mechanisms of

validation. Meister, Burmann & Deiters (2018) also emphasize the crucial role of technology in defining how humans interact within and with digital health transformation.

The literature also points to the importance of organizational determinants within hospital boards. Meister, Burmann & Deiters (2018) state that hospital digital health innovation engineering comprises operational and strategic dimensions and fulfills users' demands. A clearly defined vision needs to be developed by the CEO level in collaboration with underlying levels (Meister, Burmann & Deiters, 2018). According to the authors, vision should enclose four dimensions of digitalization: medical care (includes internal and external communication, documentation), logistics and procurement (order management, bed management, and sterile goods), controlling and management, and human (Meister, Burmann & Deiters, 2018).

Moreover, Kierkegaard (2015) concluded that the development and diffusion of interoperable technologies in Denmark are associated with the latest changes in national governance. The national government has established a new national eHealth strategy and standards but limited its influence in the deployment of eHealth initiatives (Kierkegaard, 2015). The redistribution of administrative responsibilities from the state to regions facilitated the consolidation of national Electronic Medical Records (Kierkegaard, 2013). Such redistribution was an important organizational determinant in the Danish national eHealth strategy. In 2007, there was an estimate of more than 40 different hospital Electronic Medical Records (EMR) in Denmark (Kierkegaard, 2015). In 2010, a WHO report revealed a dual process of data storage, electronically and paper-based (Kierkegaard, 2015).

Environmental factors have also contributed to the growth of Denmark's eHealth structure. Through the years, the Danish government has supported the sector, whether by establishing regulations or by providing financial support. Another strategy used was contracting different regional EMR systems to ensure competition in the country's EMR market (Kierkegaard, 2015). Additionally, experts assume that it eliminates the risk of major IT failures recurrent from a

common national system (Kierkegaard, 2013). Market competition forces vendors to perform better (Kierkegaard, 2013). Two pivotal elements in the Danish eHealth system's development pointed in the literature are the existence of the national health data network and the patient summary record (Kushniruk, Borycki, & Kuo 2010). The patient summary record contains key information such as medication allergy and procedures that can be accessed electronically nationwide (Kushniruk, Borycki, & Kuo 2010). The national health data network allows communication between the six EMR systems. Another relevant factor is the existence of a unique identifier number (CPR number) for every resident. The unique identifier number allows the linkage of clinical information with other Danish registries, such as hospital diagnosis, causes of death, and prescription drugs at the individual level (Arendt et al., 2020). The literature also emphasizes the importance of a human-centered approach. Training and education programs are vital to improving digital health literacy among different user groups (Meister, Burmann & Deiters, 2018). Similarly, there is a need for the strong participation of potential users when designing digitally supported processes (Meister, Burmann & Deiters, 2018).

Another important environmental determinant found in the literature is the adoption of national EHR user interface standards (Kierkegaard, 2015). Health providers work in different facilities throughout their careers and thus are exposed to different IT systems with different icons and buttons (Kushniruk, Borycki, & Kuo 2010). It was found that clinicians can take up to 30 minutes to start a new prescription due to exposure to different IT systems (Kushniruk, Borycki, & Kuo 2010).

## 7.3. Implications for deploying mHealth in Angola

### 7.3.1. Health system reforms needed

The healthcare system in Kenya and Denmark has drastically changed its face due to the incorporation of digital technology. Both countries' healthcare reforms were pivotal in the growth of their eHealth market and structure. Both countries have decentralized governance, political and fiscal structure. The district health strategy policy implemented in Angola represents an important step for power decentralization.

However, decentralization raises the need for strengthening accountability and interaction between national administrations and local administrations. Even though the right balance of centralized and decentralized power is hard to achieve, it is important to nurture transparency among stakeholders (Kierkegaard, 2015). MINSA should work closer to municipal health administrations in the elaboration of national strategic planning and budget allocations. The lack of coordination and accountability between MoH and municipal administrations is mentioned in the literature as one of the main challenges in the new decentralized strategy (World Bank, 2018). The election of local leaders is also an approach that supports the decentralized system even though it comes with problems such as patronage and nepotism, as observed in Kenya (McCollum et al., 2020). In Kenya and Denmark, healthcare services delivery is done at the regional and county level. There is a great value observed from changing the responsibility of the delivery of health services from national to sub-national levels.

Additionally, citizen engagement mechanisms should be reinforced to empower local communities in the participation of health decisions. Citizen engagement mechanisms could also be used to reinforce the system of accountability at subnational levels. Mobile health could be used as a tool to help the central government monitor activities at the local level. Crowdsourcing technology could be used to strengthen accountability strategies. For instance, in Kenya, Ushahidi is being used to monitor medication stocks in inner country hospitals (Qiang et al.,

2012). In Angola, citizen engagement mechanisms such as "the office of the user" (Gabinete do Utente) deployed in 2009 could also be reinforced and supported by crowdsourcing technologies (World bank, 2018). Such mechanisms empower local communities in the participation of health decisions. Patients' perceptions and beneficiary feedback could be collected using mobile phone technology. Lastly, mHealth should be included in the National eHealth Strategy. The Kenyan eHealth National Strategy 2011-2017 appoints mHealth as one of the strategic areas for the country's eHealth structure (Republic of Kenya Ministry of Health, n.d.).

The increase of money allocation to NHS and equitable financial allocation to provincial and municipal levels is also necessary. More effective strategies could also replace the historical budget allocation. Kenya has a 15% budget allocation to its 47 counties and has a mandate that 27% of the local budget is expended on health (McCollum, 2020). In Denmark, the annual health budget is negotiated between the central government, regions, and municipalities (Denmark Ministry of Health., 2016). Demographic and social conditions are considered to ensure equitable allocation (Denmark Ministry of Health., 2016). Additionally, activity-based subsidies are also utilized (Denmark Ministry of Health., 2016). Municipalities are required to co-finance hospital and GP treatment services (Schmidt et al., 2019). Municipal authorities have an incentive to invest in preventative care because it reduces their financing costs (Schmidt et al., 2019). Lastly, there is a need to increase the current 7.7% of total expenditure on health as a percentage of GDP. This value falls below the Abuja target that calls African countries to allocate at least 15% of total global health expenditure as a percentage of GDP (Mcintyre, Meheusa & RØttingen, 2017). In 2018, the GOK launched a national universal health coverage pilot program to ease access to health services in its 47 counties (Mwakisha, 2020). Strategic policies to reach universal health coverage should also be put in place in Angola.

### 7.3.2 Potential Business Models

The mobile health market in Angola is still unexplored. The entry barriers for inventors are low, and there is an ample opportunity for investments in mHealth. In the process of developing

applications is essential to identify the rationale behind the project. A business model is referred to as the rationale used by an organization for creating, delivering, and capturing value (Christensen et al., 2014). The concept of value is referring to the incentive an actor gets from the mHealth application. The literature points that, today, the development of mHealth apps is commonly driven by supply rather than demand (Qiang, 2012). Analyzing a country's major health problems can help developers create apps driven by actual demand. In Figure 7.3, we observe that the Telesar addresses one of Denmark's major causes of death by addressing complications mainly associated with diabetes (Christensen, 2014). The initiative uses the Canvas business model, one of the main models used in technology (León et al., 2016).

Market research is essential, and it should include price analysis, marketing plans, domestic and international competitors, and identify trends (Zuzaku, 2015). The mHealth ecosystem consists of different actors with different interests. Programmers and entrepreneurs should determine each stakeholder role and value proposition of the mHealth app. For instance, mobile network operators have the role of providing services and are potential providers of mobile devices. The value mHealth apps offer to the telecommunication industry players is an additional revenue source and increased market share (Qiang, 2012). Likewise, developers should evaluate which areas of the healthcare system they intend to operate. The main business processes in health care are (WHO, 2020):

- Facility-based patient care services.
- Remote patient care services.
- Communications.
- Health sector resource management and regulation.
- Individual identity management and records.
- Financial and insurance management.
- Data management and processing.

Similarly, players in the healthcare industry, such as the pharmaceutical industry and healthcare delivery companies, are potential donors (Qiang, 2012). They have the incentives of increased

market share, branding, and improved care for patients (Qiang, 2012). It is crucial to determine development and running costs (Christensen, 2014). The key players for prospects of mHealth in Angola can be found in the public and private sectors. At the government level, the main stakeholders are MINSA and the Ministry of Telecommunications and Technology (MTTI) (USAID, 2015). In the ICT private sector are mobile network operators and private corporations such as Odebrecht and international oil companies (USAID, 2015). Donors and multinational corporations are also appointed as potential investors (USAID, 2015). Channels of service delivery should be identified (Christensen, 2014). The collection of customers' behavioral and cultural patterns plays a key role in designing a framework for customer relationships with different stakeholders and application features (Latif et al., 2017).

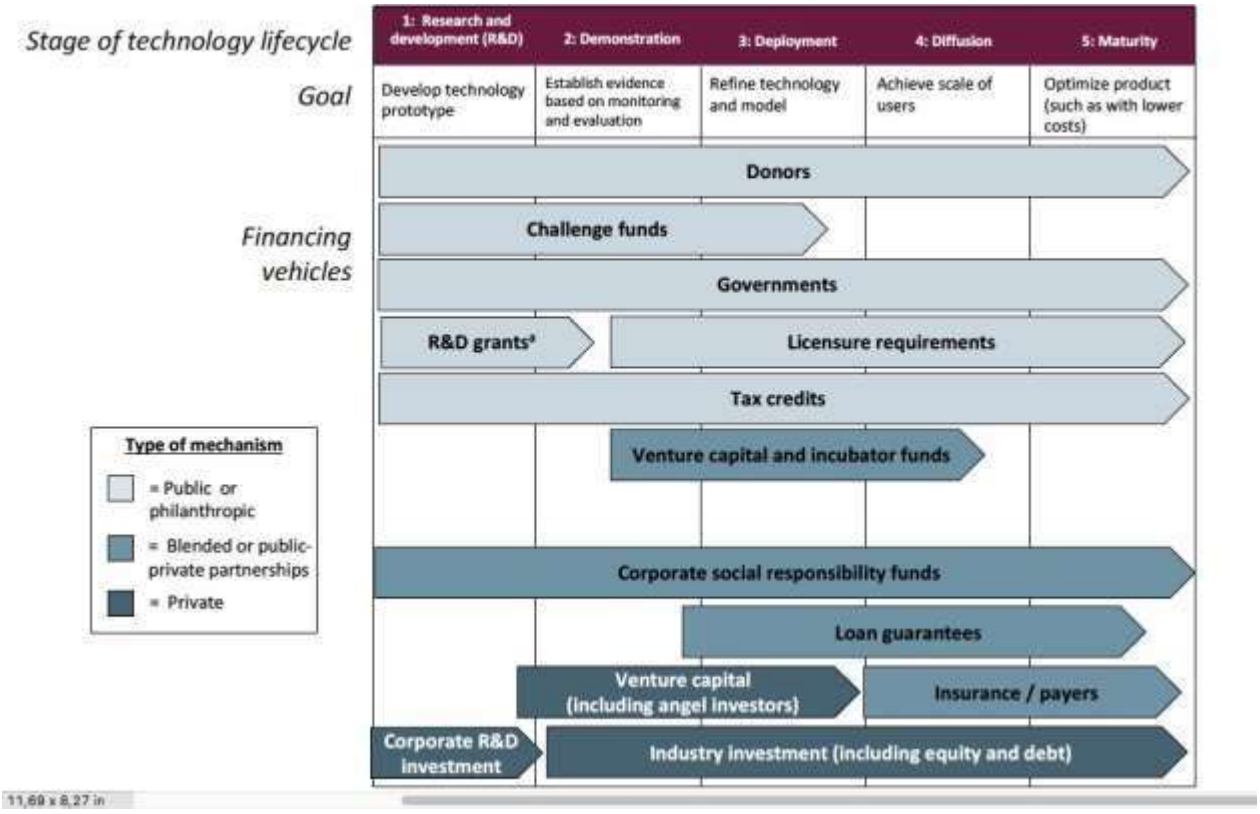


Figure 7.1 “Financing mechanisms for mHealth applications” (Qiang, 2012).

Moreover, it is vital to explore the different technology features in mobile phones and their domains to bring more value to the service offered. Smartphone sensors have different

applications for mHealth. Domains of the camera, video, and photo capture offer potential use in skin disease analysis and wound monitoring, remote diagnosis, and child health supervision (Latif et al., 2017). GPS has domains in location tracking. Thus, amid a pandemic such as COVID 19, they offer contact tracing apps opportunities. The incorporation of customer feedback can help refine the business model. The adoption of wireless technology ensures scalability in a scenario with low national internet coverage such as Angola. Open source and interoperable software such as RapidSMS, Insight, Upland, and iHRIS platforms are some examples widely used to develop wireless mHealth apps.


Figure 7.2 Business Planning Development Outline.

This outline was created based on the WHO (2020) “Type of businesses processes in the health system” and Qiang et al., 2012 “Financing mechanisms for mHealth applications”.

It is important to identify development and running costs and revenue streams. Additionally, developers should define whether the initiative will adopt a nonprofit, for-profit, or hybrid model (Qiang et al., 2012). As observed in Figure 7.1, streams of revenue include stakeholder fees, consultancy, advertisement, and transaction fees (Qiang et al., 2012). Financing sources include

grants or subsidies and government funding, venture capital (e.g., Angel investors), loan guarantees (e.g., Access to credit), and challenge funds (e.g., Gates Foundation Haiti Mobile Money Prize Fund to spur innovation) (Qiang, 2012). Lastly, as demosntrated in Figure 7.2 adopted technologies should be user-friendly and affordable to the public. Engineers should adopt a design for scarcity strategy when developing apps. Most of the Angola population still owns basic feature phones such as Nokia phones (USAID, 2015). Simple technology ensures greater stakeholder adoption. An example is the increased health insurance rate among rural Kenyans (Obadha, Colbourn, & Seal, 2019). By reducing transport costs and travel time, mobile money has increased by 4.6% their probability of being enrolled in the National Hospital Insurance Fund (Obadha, Colbourn, & Seal, 2019).

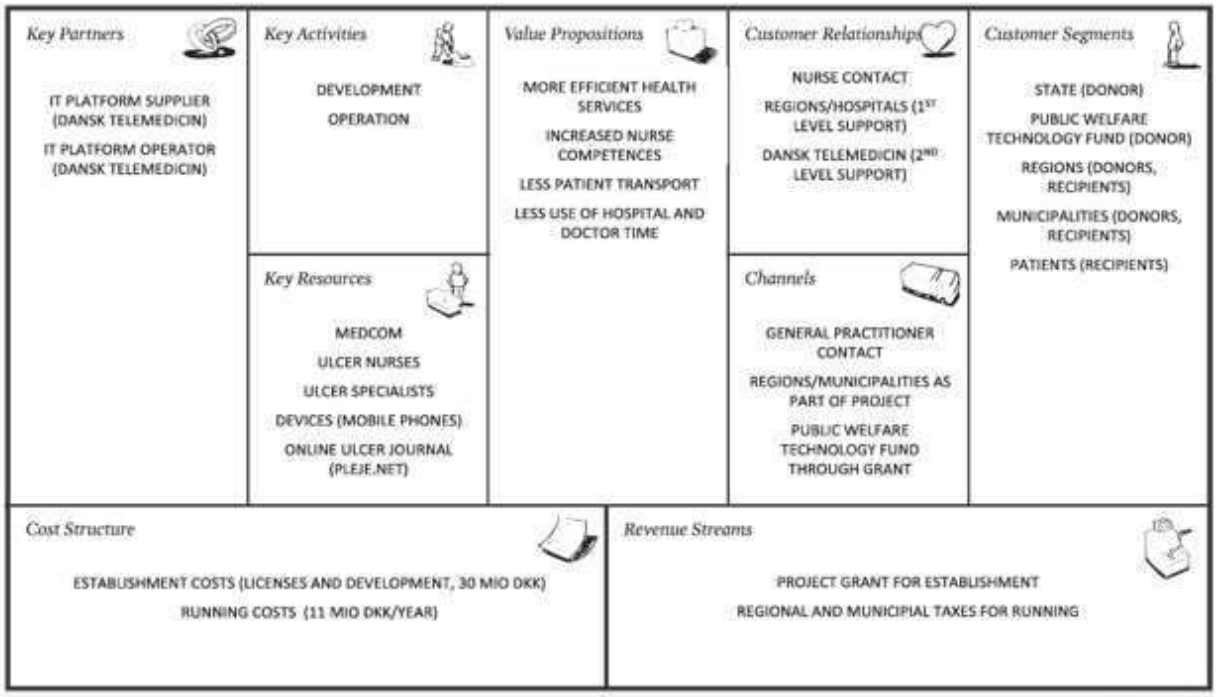


Figure 7.3 Business model of the Telesar telemedicine project (Christensen et al., 2014).

# Chapter VIII. Discussion and Conclusion

## 8.1 Discussion

The regulatory framework for ICT in Angola contains two main policies: The ICT White Paper and the Information Society National Plan (PNSI or Plano Nacional da Sociedade da Informação (USAID, 2015). MINSA launched the national agency Gabinete Nacional de Tecnologia de Informação e Comunicação (GNTIC) through the Project 53 of the PNDS (USAID, 2015). The agency received the responsibility of developing the national health information systems plan (Plano Estratégico do Sistema Informática da Saúde - PESIS) to orchestrate the regulatory and legislative environment for ICT in health (USAID, 2015).

In 2014, the first telemedicine initiative, Peditel, was deployed in Angola to support the Municipal Health Service Strengthening Project (MHSS) (USAID, 2015). The program was an FC mobile clinical decision support system initiative. It provided two services: distance learning and clinical assistance (Correia, 2018). The project faced technological and financial challenges. Reduced rates of clinician's adoption were verified due to low computer literacy and lack of motivation and interest among health professionals (it could mean additional work), and lack of legal policies and guidelines concerning the use of telemedicine (Correia et al., 2018). Since then, several mobile health initiatives have been deployed in Angola, such as the Mobile Polio Campaign, SMS Mulher (SMS Women) initiative, and the USAID/Angola's Malaria IRS Mobile Data Pilot (USAID, 2015). Such initiatives did not surpass the pilot stages due to financial constraints and non-institutionalization within MINSA (USAID, 2015).

In Angola, there is great potential to deploy mHealth apps to reach national health goals. A report from 2015 found that 91% of households in urban areas have at least one member with a cell

phone, while in rural zones the estimate was below one-third of total households (USAID, 2015). mHealth strategies could be widely adopted to achieve universal health coverage, as observed in Figure 8.1. Mobile Health provides a window of opportunity to improve the quality of services delivered to pediatric patients who benefit from The Newborn Screening Sickle Cell initiative launched in 2011 (Mcgann et al., 2015). There is also room to improve overall infant health with mHealth apps such as the one deployed in Kenya, Childcount+ (Kieti, 2017). Additionally, mHealth initiatives can tackle major health issues such as HIV as it is being done in Kenya by Weltel (Qiang, 2012). There is also room for potential market expansion to neighboring countries and strategic collaboration (Lee, Cho, & Kim, 2017). The problem of drug counterfeiting, which is significantly elevated, could also be addressed by mHealth solutions, likewise is being done in Kenya through mPedigree (Worldbank, 2018).

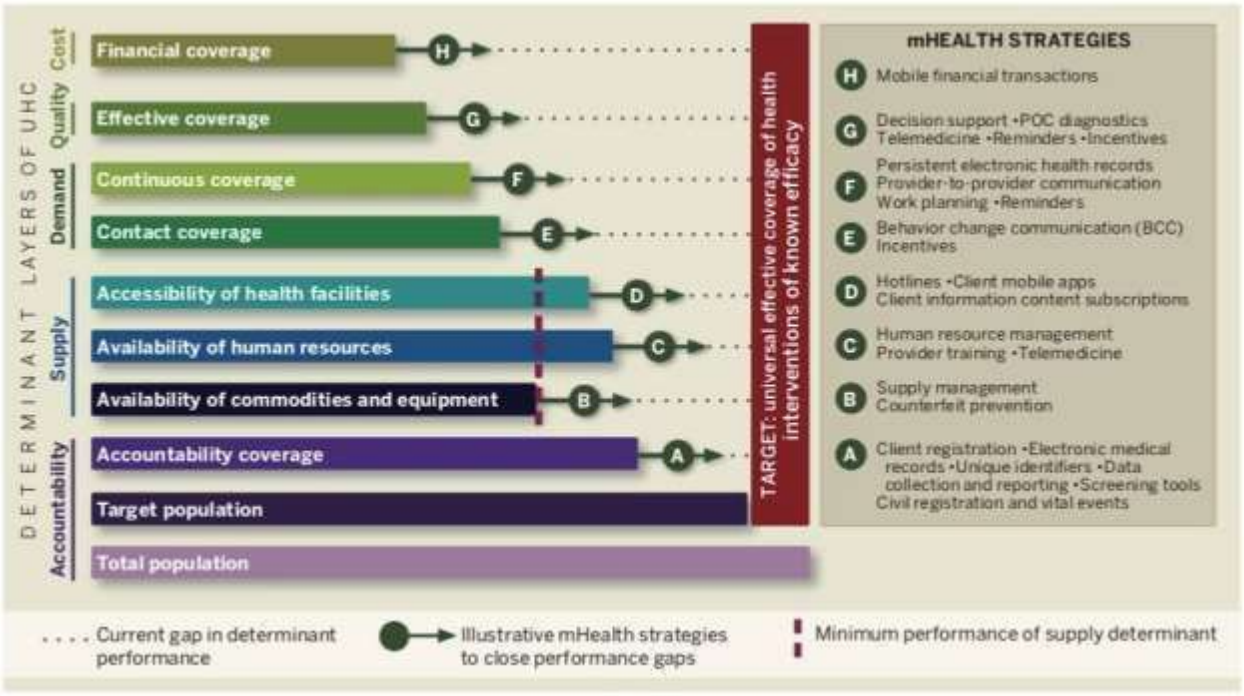


Figure 8.1 “A cascading model to prioritize and select integrated mHealth strategies for achieving UHC” (Mehl & Labrique, 2014).

### 8.2. Study Strengths and Limitations

Our study found that organizational determinants such as the structure of hospital management boards in Kenya were associated with the adoption of mHealth. Handayani et al. (2018) also concluded that organizational factors are important for the sustainable deployment of mHealth solutions. The authors found that "top management support for the organizational dimension" was associated with mHealth adoption in Indonesia (Handayani et al., 2018). Our review demonstrated that the governance system is an important determinant for mHealth adoption. Our results concur with Aranda-Jan conclusions. The author states that unclear healthcare system responsibilities are a threat to the deployment of mHealth in Africa (Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014). We also found the association between the adoption of eHealth initiatives and environmental factors in Denmark. The existence of a national health data network, a unique identifier number, and the patient summary record was at the core of the growth of eHealth services in the country (Kushniruk, Borycki, & Kuo 2010). Latif et al. (2017) also recognized the lack of health information databases in Pakistan as a constraint for the scalability of mHealth. Technological determinants were found as predictors for mHealth adoption in FC apps in Kenya. This conclusion is analogous to a systematic review study that concluded that coverage and accessibility remain the major threat for mHealth implementation in African countries (Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014). We also found the importance of designing validation mechanisms, likewise Tomlinson et al. (2014). Prior to mHealth app implementation, the author recommends at least two separate trials (Tomlinson et al., 2014). Lastly, our analysis's theoretical framework is one of the most important used to understand aspects related to the adoption of new technologies (Baker, 2011).

However, our review has some limitations. Despite the significance of the lessons learned from our study, they cannot be applied to Angola without considering its actual, economic, political, social, and cultural situation. We were unable to find in the literature the right balance between

centralization and decentralization. As we observed, after decades of a highly decentralized model of governance, Denmark's health care reform resulted in the re-centralization of power. This could be an important point of study for future studies. Financial constraints are still the main challenge for mHealth applications. The formulation of a viable business model that generates profit can only be achieved with the appliance of empirical evidence, economic models, and continuous readjustment. Additional economic evaluation studies should be conducted to formulate more concise recommendations for mHealth implementation in Angola and in developing nations. We could not also evaluate the clinician working condition and satisfaction to understand how it affects eHealth adoption. This could be an essential topic for future studies because health providers are an important user group. Lastly, the conclusions from grey literature used in our review can be questionable due to the weaknesses of evaluation procedures.

### 8.3. Recommendations

**Recommendation # 1** Definition of responsibilities at the different hierarchy levels of governanceand creation of a national eHealth regulating agency

The operational framework for eHealth implementations in Angola should define clear roles and responsibilities within national and subnational administration levels (USAID, 2015). The responsibility assignment matrix (RACI) template is a powerful tool recommended by the literature to be used at government and hospital levels to define a clear vision of digital health processes (USAID, 2015; Meister, Burmann & Deiters, 2018). Based on the evidence retrieved from this scoping review, we recommend the creation of an Angolan regulating agency similar to the Danish Medcom. Such an agency will liaise between information technology (IT) vendors and stakeholders in the healthcare industry to facilitate and regulate their integration into the public healthcare structure. A national coordinating body would help to maximize existing resources and avoid duplications (USAID, 2015).

**Recommendation # 2** Articulation of a national eHealth policy and development of national datastandards

We recommend the provision of government incentives to attract investors to the country. Policies such as tax breaks could be provided for initiatives that tackle underserved remote populations. Such policies will help avoid the problem observed in Kenya, where most mHealth enterprises are concentrated in urban centers such as Nairobi and Mombasa. Access to funding and foreign exchange could also stimulate investors and developers. ICT policies and regulations are essential for better market performance. The literature states that there are no overarching national eHealth framework or data exchange standards (USAID, 2015). It is crucial to articulate a national eHealth policy that oversees the development of data standards.


Figure 8.2 Digital Health Platform Architecture (WHO, 2020).

**Recommendation # 3** Deployment of intellectual property rights and data privacy laws

We recommend the deployment of intellectual property rights to stimulate innovation. The legal protection of products will encourage developers and investors to put new products on the market. Data privacy laws will ensure health information security and increase user trust and adoption of new technologies (Qiang, 2012).

**Recommendation # 4** Introduction of new mobile network operators in the country

We also recommend the creation of policies to allow new mobile network operators in the country. Such an approach would create more competition in the telecommunication industry and benefit the mHealth industry. In Kenya, Safaricom garners up to 90% of mobile applications (Qiang, 2012). However, in India, a different scenario is observed. With the second-largest mobile network, operators seek to increase customer loyalty through innovation (Qiang, 2012). As a result, mobile network operators charge lower fees to mHealth developers. Additionally, such competition reduces mobile network costs and increases mobile phone penetration. Investors and tech developers should also consider the adoption of toll-free SMS with reverse billing when negotiating with mobile network operators. Bearing network costs while providing free access to

their online platforms make apps more attractive to consumers allowing faster scalability (Qiang, 2012).

**Recommendation # 5** Implementation of capacity building programs to increase mHealth literacyamong general population, health professionals and hospital management boards.

The investment in innovative policies should be backed by capacity-building programs to increase patient and provider education on mHealth technologies. We recommend the implementation of strategies to improve the population's digital literacy and help reduce the risk for the digital divide, as observed in Denmark and Kenya. Likewise, such a strategy will help to create demand for mHealth initiatives in Angola. Similarly, more investment to build local technological and non-technological capacity is also necessary to leverage mHealth nationwide. The government should increase cooperation and investment in universities, schools, and initiatives such as Startup Angola and the "Microsoft YouthSpark" to boost local talents, ideas, and innovations (USAID, 2015). A strategic plan should also be designed to take similar ICT projects to rural zones. We also recommend cooperation with neighboring African countries with greater experience in digital health information. The literature emphasizes the great value in collaborating with neighboring countries in developing mHealth solutions (Lee Cho & Kim, 2017).

**Recommendation # 6** Introduction of mobile money in the country

We also recommend the entrance of mobile money in the country as it would accelerate the country's mHealth market development. The M-Pesa platform in Kenya opened the doors for innovative mobile solutions in healthcare. Additionally, M-money is supporting remote financial transactions in several countries during the Covid 19 pandemic (Bazarbash,2020). It also reduces the amount of money carried by patients and health professionals for health-related transactions while allowing easier contributions for health insurance plans (USAID, 2015). Nevertheless, it is important that the mobile money platform allow interoperability for a most viable mHealth

ecosystem. One of the main challenges faced by startups that operate upon the Mpesa platform in Kenya is poor API functionality, system downtime, and high transaction costs (Kendall et al., 2011).

**Recommendation # 7** Development of a national DHP and mHealth architecture

Investments in a national digital platform can allow collaboration and contribution from different actors. We recommend that the Angolan government work in partnership with stakeholders in the ICT industry and healthcare sector in the development of a national mHealth architecture, as shown in Figure 8.3 and a DHP as observed in Figure 8.2. Such cooperation can accelerate the growth of the mHealth market in Angola. Nevertheless, it is essential to take a period for an experimental pilot mobile data platform prior to the implementation of a national DHP (USAID, 2015). The pilot stage will be essential to understand the country's specific needs, opportunities, and cost-benefit in terms of financial returns and public welfare (USAID).

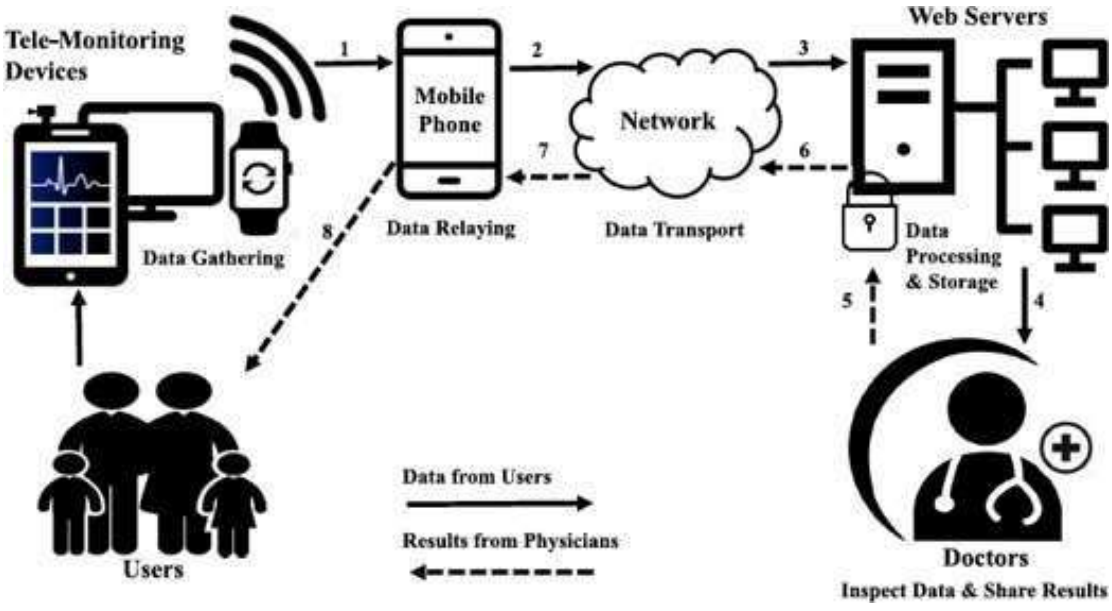


Figure 8.3 Proposed Mobile Health architecture (Latif et al., 2017).

**Recommendation # 8** Deployment of a national PC mHealth initiative through a partnership of MINSA, a mobile network operator and multidisciplinary team such as hospital CEO and underlying levels.

The Kenyan study case demonstrated that facility-centered mHealth initiatives require more capital and financial resources to be implemented. We found similar evidence in Denmark. E-visits did not reduce overall running costs of primary care even though they have the potential of reducing healthcare costs in the long term (Andersen, Nielsen, & Kim, 2019). We recommend that mHealth initiatives deployed in Angola choose patient-centered apps as they are less expensive because they require minimal infrastructure. Such apps require less government support and are more likely to provide health and financial outcomes in the short run. In Kenya, the majority of deployed mHealth apps are patient centered. Denmark's eHealth strategy was traced by the Telecare project initially implemented in 2013. Telecare is a PC initiative for COPD patient's monitoring. The literature also recommends that MINSA collaborates with a Mobile Network operator and the Ministry of Telecommunication and Technology to implement at least one interoperable and open-source mobile platform to address core health problems in the country (USAID, 2015). Such an approach should involve a multidisciplinary team of stakeholders such as hospital CEOs, clinical directors, nursing management, and IT vendors.

**Recommendation # 9** Deployment of a National Patient Data Repository

The existence of a personal identifier number (translated in Portuguese as Bilhete de Identidade (BI)) places Angola in a favorable position of implementing a national patient data repository. The unique identifier number (CPR) in Denmark has allowed access to patients and health providers to health information at the individual level (Arendt et al., 2020). In 2017, the Angolan government launched a new BI with a Quick Response (QR) code technology that allows access to information such as name, birthplace, birth date, gender, civil state, and emission and expiration dates (Massala, 2017). We recommend evaluating the possibility of incorporating additional information such as the history of drug allergies, height, and blood type. Likewise, an

analysis could be done to evaluate the possibility of using the QR technology to create easy access (through a password and hospital credentials) to the national patient's data repository by health providers. The BI QR connection with the national patient's data repository is a potential eHealth innovation that could facilitate health professionals' work and save lives, especially when patients are unconscious and there is no one to provide their health information.

## 8.4 Conclusion

Developing countries have recognized the value of the digital economy (Buckholtz & Oloo, 2020). The forecast market value for global data analytics in healthcare is estimated to reach $50.5 billion by 2024, with a cumulative annual growth rate (CAGR) of 28.3% (Vishwa Gaul, 2018). The mobile technology and services market has an estimated value of $3.9 trillion (GSMA, 2019). From a healthcare system perspective, mobile phones are a health commodity inventory in the hands of the population. The accelerated growing number of mobile phone subscriptions could provide potential solutions for the healthcare system's current challenges in Angola. Mobile Health can be seen as a catalyzer to achieve the national health goals. mHealth initiatives could support the process of finance allocation to health, improve health information systems, and facilitate the deployment of electronic health records. Nevertheless, the deployment of mHealth solutions goes beyond the acquisition of technology. It requires organizational changes. Governments, tech developers, the telecommunication industry, and stakeholders can use the lessons learned from our study to deploy mHealth initiatives in Angola and other developing countries.

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