Better eHealth

Human, technical and political factors for better coordination and support of eHealth in Africa

D4.3: Strategy and future direction for scaling-up eHealth in LLMICs in Africa (Task 4.3)

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Executive summary

The achievement of universal health coverage (UHC) without the use of eHealth solution is impossible. Use of eHealth in the support of UHC is cost effective and can help to reach the hard-to-reach needy communities of the Low and Lower Middle-Income countries (LLMICs). However, most eHealth solutions in Africa are left at the pilot level without scale-up to larger use to contribute to UHC. This could be related to varieties of challenges. The EU Horizon 2020 BETTEReHEALTH therefore, aimed to identify challenges related to eHealth solutions implementation and scalability in LLMICs and suggest strategy and future direction for scaling-up eHealth solutions in LLMICs in Africa. For which, the team assigned to the task conducted brain storming, review of literature, consultative workshops, online survey and expert review.

The barriers to eHealth solution implementation and scale-up in Africa are summarized under five thematic areas:1) The technological ecology and infrastructure – standards and interoperability, power supply, connectivity, bandwidth, compute software and hardware; 2) Resource and human capacity – adequacy and skill mix ICT professionals and end-user digital competency, , 3) eHealth policy and strategy – supportive national eHealth related policies and plan, 4) eHealth governance – coordination, leadership, monitoring and evaluation strategies, documentation, and promotion, 5) Finance and funding – adequate and sustainable budget allocation and resource mapping.

Strategic South-South collaborative partnerships among African countries are important in the implementation and scale-up of eHealth solutions in such a way that it helps to overcome common cross border health problems and contribute to achieve UHC.

To effectively scale-up eHealth solutions the team suggested a contextualized scalability strategies and future directions supported by scalability conceptual framework. The framework considered readiness for scale-up, collaboration among countries, correct selection of eHealth solutions and strategic decisions. The process of scale-up is cyclical, where there should be an M&E framework, evidence production, amendment, and addition of new solution. These framework helps to creating awareness amongst African public health and ICT stakeholders, donors, decision makers, public health managers and employees at different levels.

Abbreviations and Acronyms

CAD: Computer-aided detection

CHW: Community Health Workers

DHIS2:   District Health Information System 2

eCHIS: electronic Community Health Information System

EPHI: Ethiopian Public Health Institute

FHW: Frontline Health Workers

GDP: Gross domestic product

HIS: health information system

iCCM: integrated Community Case Management

ICT: Information and Communication Technologies

iHRIS: Human resource management system

JSI: John Snow, Inc.

LLMICS: Low and Lower Middle-Income Countries

M&E: Monitoring and Evaluation

MOH: Ministry of Health

NGO: Non-governmental organization

NITA: National Information Technology Agency

RDTs: Rapid diagnostic tests

SDGs: Sustainable Development Goals

SMS: Short Message Service

UHC: Universal Health Coverage

WAPCAS: West Africa Program to Combat Aids and STI

WHO: World Health Organization

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General project information

In BETTEReHEALTH, we aimed to inform eHealth policymaking towards better health outcomes through a bottom-up evidence-based holistic approach. BETTEReHEALTH has set up four Regional Hubs based in Tunisia, Ghana, Ethiopia, and Malawi, already endorsed by each country's Ministry of Health. Each hub organizes coordination and networking activities involving national, regional (including two regional workshops), and international actors. BETTEReHEALTH currently creating open access registries by collecting information regarding eHealth policies and existing eHealth solutions from African countries. The knowledge produced in the registries, together with the input from the other work packages, will contribute to the synthesis of eHealth policy roadmaps and strategic implementation plans for better eHealth services in LLMIC's. It will increase opportunities with high relevance for other African countries and European stakeholders. Furthermore, BETTEReHEALTH increases international cooperation in e-health and strengthens end-user communities and policymakers.

1. Introduction

Universal health coverage (UHC) is the main goal of Sustainable Development Goal (SDG) 3, which is to ensure healthy lives and promote well-being for all people of all ages and allowing them to get access to the health services they need, when and where they need without financial limitation' (1). Digital health (DH) technologies hereafter used interchangeably with eHealth solutions are becoming more important for improving access to health care services (2). DH or eHealth is the application of information and communication technologies (ICT) to support health (3). eHealth solutions encompass telehealth, telemedicine, mobile health (mHealth), electronic medical or health records (eMR/eHR), big data, and artificial intelligence. The value of eHealth in achieving overarching health goals such as UHC and the SDGs has been acknowledged (4).

Global health communities including the WHO, suggested that eHealth is the one of the best ways to achieve UHC. For instance, according to the third global survey report by the WHO, the number of WHO member countries adopting eHealth policies and strategies increased over time. Hence, eHealth could have a significant strategic role for achieving the UHC in 2030 (5).

Evidence shows that eHealth solutions contribute to a more equitable, high-quality health care and resilient healthcare system in the future by expanding healthcare service coverage, increasing the healthcare financial efficiency, enabling connectivity in health systems and improve information flow, and building the capacity of healthcare (6, 7). However, information on challenges and barriers related data access, data security, interoperability, usability, scalability and access to infrastructure are limited and not well-documented in LLMIC's of Africa.

Cognizant of these gaps, the EU funded BETTEReHEALTH project that aimed to increase international cooperation in eHealth, strengthen end user communities and policy maker in making the prior decisions for the successfully implementation of eHealth LLMIC in Africa. Under the technical factors (one of the WP), the project aimed to explore possibilities and strategies for inter-governmental collaboration and propose for eHealth scale-up framework towards UHC by taking into account the barriers for UHC in the context African countries.

2. Purpose of the Work Package 4.3

Under this work package we aimed to develop a conceptual framework for the effective scale up of eHealth and their use as tools to achieve the SDGs and UHC with a focus on creating awareness amongst African public health and ICT stakeholders, donors, decision makers, public health managers and employees at different level through:

1. Identifying the barriers for UHC in African countries in the context of data access, security, interoperability, usability, scaling and access to infrastructure.
2. Exploring possibilities and strategies for inter-governmental partnership and collaboration in the use of new technological platforms and systems that can support remote diagnostic processes and procedures.
3. Proposing strategies and future directions for scaling up the use of integrated eHealth for UHC on the continent and contribute to the attainment of the target for the third SDG.

3. Methodology

To identify barriers to use eHealth solutions for UHC, suggest possibilities and strategies of intergovernmental collaboration and propose strategies of eHealth solutions scale-up in LLMICs we conducted scoping review, consultative workshops, online survey and expert review methodologies.

The scoping review was conducted mainly to identify barriers to eHealth implementation and use for enhancing UHC in LLMICs. The following search terms were used to find literature from PubMed engine: ""eHealth" AND barriers AND "developing countries"", ""digital health" AND barriers AND "developing countries"", ""digital health" AND "universal health coverage"", ""challenges of eHealth" AND "universal health coverage" AND "developing countries"" and ""eHealth" AND barriers AND "Africa"". Additional manual one-by-one search was made using Google Scholar and Google. Major findings on eHealth implementation and use barriers in to enhance UHC in MLIC is attached in Annex I.

We used the East and Central Africa BETTEReHEALTH Regional Hub establishment workshop, West Africa BETTEReHEALTH Regional Hub establishment workshop and conducted inhouse consultative workshops in Ethiopia and Ghana to get expert opinion of different countries using the discussion guide developed based on the literature review findings.

The East and Central BETTEReHEALTH regional workshop was held through a hybrid platform (in person and virtually) from August 26-27, 2021. A total of 29 participants from different countries participated on the workshop. The participants were composed of eHealth experts, academicians, researchers, health system managers, government representatives from MOH, non-governmental organizations (NGOs) and health informatics leaders. The participants were from seven African countries (Cameroon, Democratic Republic of Congo, Ethiopia, Kenya, Malawi, Tanzania and Uganda) and Norway (for the detail of participants refer to Table 1 of the First East and Central Africa BETTEReHEALTH regional hub establishment workshop report). Discussion was made by grouping the participants in two where participants from Ethiopia such as the Federal Ministry of Health, University of Gondar, Jimma University, JSI/Data Use Partnership, and Digital Health Access Initiative/JSI made face-to-face discussion, whereas participants from other countries had virtually discussion. The discussion was guided by a pre-prepared brief presentation with follow-up discussion points. The reflection of each group was presented to the main group, followed by discussion and feedback.

On the West African BETTEReHEALTH regional hub establishment workshop held from July 27-29, 2021, 44 participants from Ghana took place on the discussion on barriers of eHealth solution implementation in Africa. Participants were from MoH, Ghana Health Service, Christian Health Association of Ghana, WHO, 37 Military Hospital, Trust Hospital, Telecom (Vodafone), teaching and regional health facilities, private facilities, research institutions, training universities, health professional associations, West Africa Program to Combat Aids and STI (WAPCAS) – patient association, National Information Technology Agency (NITA), Advance Information Technology Institute and Kofi Annan Centre in Excellence in ICT.

After the regional workshops online survey tool using Google Form was prepared, reviewed and approved by the task participants of the consortium member countries (Annex II). The tool was then dispatched to the consortium member countries to invite relevant experts in the area to capture their opinion regarding strategies of intergovernmental collaboration and scalability strategies. The consortium member countries then reflected their opinion as a team and reported back the T4.3 coordinator.

Two inhouse consultative workshops were also conducted in Ethiopia and Ghana. The Ethiopian inhouse consultative workshop was conducted in Addis Ababa, Ethiopia for two consecutive days (November 26-27, 2021). The aim of the workshop was to obtain additional input and validation of the draft report. The participants were from MOH, Jimma University, University of Gondar and Ethiopia Data Use Partnership – JSI. The participants made an in-depth and point-by-point discussion on the barriers of eHealth solution use in Africa, possibilities and strategies of intergovernmental collaboration and eHealth scalability strategies using the pre-prepared discussion points (Annex III). The draft report was sent to the participant week before the workshop. The draft report was also shared among WP4.3 task team members for further enrichment and comments. Likewise, the Ghana inhouse consultative workshop was held from November 17-18, 2021 with 22 participants from MoH, Ghana Health Service, National Information Technology Agency (NITA), teaching and regional health facilities, private health facilities, 37 Military Hospital, Trust Hospital, Vodafone (Telecome), WAPCAS and University of Ghana Legon.

4. Result and discussion

4.1. Barriers to use eHealth solutions to improve UHC

Access to safe, effective, and affordable, healthcare services for all is an essential element of UHC (8). Expanding access to affordable healthcare services in LLMICs can be difficult due to a lack of resources, alarming population growth, and dispersed and permanent village residency. However, living in scattered and permanent villages has sparked interest in eHealth technologies in LLMICs (9-11). Evidence has also shown that eHealth solutions have promising effects in achieving UHC in Africa (12).

LLMICs face several constraints when implementing eHealth solutions. Understanding eHealth barriers from various perspectives could aid in implementing, scaling-up and using eHealth solutions to improve UHC (9, 13, 14). Thus, to identify barriers to eHealth solution implementation, scale-up and use in LLMICs we conducted scoping review, expert feedback and consultative regional and inhouse workshops.

The emergence of the COVID-19 pandemic has brought a window of opportunity and a threat to the health care system. One of the opportunities is to assess how eHealth solutions can be applied to reach people in need with basic healthcare services (3). The result of the review showed that a wide range of eHealth solutions are available, ranging from mobile phone-based apps to highly advanced satellite technologies and robotics. Telehealth, mHealth, and electronic health records are the most common eHealth solutions used in LLMICs which are applicable at the individual, facility and system levels (3, 12).

According to the review, eHealth solutions in LLMIC are used to strengthen the health care system, health records, health information systems and medical supplies to the remote health facilities. Additionally, eHealth solutions are used to facilitate remote diagnosis, manage health problems, monitor patient conditions, connect medical devices, secure and share health records, prevent and predict the diseases. Moreover, eHealth solutions contribute to improve healthcare quality and leadership (3, 9, 13-15). However, the current review has identified several factors that impede the successful implementation of eHealth solutions in LLMIC. The barriers can be broadly divided into five areas/themes: technological ecology, human resource and capacity, eHealth policy and

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strategy, eHealth governance, and budget-related barriers for eHealth solution implementation and use.

1. Technological ecology and infrastructure related barriers

The technological ecology encompasses the interaction between technological adoption process and the environment in which it operates (16). The environment should consider end-users in the process of implementation of eHealth solutions (17). To ensure the acceptance of eHealth solutions perceived usefulness, perceived easiness of the solution and the unmet needs of the end-users need to be considered (18). Moreover, successful eHealth implementation depends on appropriate ICT infrastructures including electric power supply, availability of bandwidth and access to reliable internet connectivity (19-21).

In the review, we identified a lack of access to a computer with efficient processing and proper storage capacity, regional data center, stable connectivity, and sufficient bandwidth capacity along with high cost as significant barriers. In addition, an intermittent power supply or lack of access to electricity (e.g., 75 percent of the world's population without access to electricity lives in Sub-Saharan Africa), limited mobile penetration, and sporadic broadband internet connectivity are all significant barriers to eHealth implementation in the region (22-25).

The findings of the review are also consistent with the opinions expressed by participants at regional and in-house consultative workshops. According to participants of the workshops, technological barriers that impede the implementation of an eHealth solution include but are not limited to 1) Some eHealth solutions may require higher digital competence than end-users' digital literacy level. For instance, a type of software that necessitates the use of specific technological devices like a mobile application requiring a smartphone, which is less common in LLMICs. 2) Existing digital health solutions in LLMICs may not be interoperable with the new eHealth solution. Furthermore, the available eHealth solutions may not be user-centered or user-friendly. 3) Some eHealth solutions are prohibitively expensive for LLMIC countries to purchase and implement at the individual, facility, and system levels. While some eHealth solutions with closed source code and eHealth enterprise architecture issues may make it difficult to customize to the LLMICs context.

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The workshops discussants views are in line with study report from Ghana. According this study report, eHealth solution implementation depends on socioeconomic development, technology, infrastructure, and operational readiness (26).

On the other hand, successful eHealth solution implementation barriers include technical difficulties in addressing digital health interoperability, standardization, and integration with the health delivery system (27). A report from Tunisia backs up this claim that a lack of interoperability has resulted in systemic performance limitations (28).

Participants in the workshop also discussed the infrastructure-related barriers to eHealth solutions implementation in LLMICs. According to them, infrastructure-related barriers include poor local area internet connection and access (both WAN and LAN), low bandwidth, digital penetrations and divides in terms of access to technologies between rural and urban dwellers, less access to personal computers with good processing capacity, non-suitable health facilities, and a lack of infrastructure implementation guidelines. According to the Ethiopia Health Information System Maturity Assessment, the main barriers to eHealth solution implementation are power outages, a lack of adequate devices per service demand, network inefficiencies, and non-refundable internet connections (29). The infrastructure development also varies by regions within countries, where larger cities are better position with ICT infrastructure (30).

According to the SDG Pulse United Nation's report, Sub-Saharan African region is the least covered with overall mobile network and 4G/LTE (31). This report is in line with the report of global digital status that indicated 20% of Ethiopians, 40% of Kenyans, 14% of Ugandans, and 17.8 % of Malawians had access to the internet. Whereas the same reported showed mobile phone penetration in Ethiopia, Uganda and Kenya is 38.5%, 60.3% and over 80% respectively in 2021 (32). This implies that low penetration of both internet and mobile in the region remain among the major challenges of health digitalization.

2. Resource and Human Capacity Related Barriers

The successful implementation of the eHealth solution is contingent on the ability of end-users to utilize the available eHealth solutions and the availability of skilled human resources in the required amount and competencies (10). However, evidence shows limited competency of end-

users, severe shortage of trained IT professionals and digital incompetency of the healthcare providers hinders the implementation of eHealth solutions in LLMCs. When these limitations coupled with ineffective leadership, resistance to change, profound negative work attitude, work dissatisfaction, and poor staff motivation, the use of the existing eHealth solutions to improve UHC becomes more complicated (33, 34). According to the regional and inhouse workshop participants, these multifaceted challenges can arise from the presence of digitally divided end-users in LLMICs countries in technical competence/digital literacy and affordability. Additionally, the participants pointed out that unsupportive work culture; poor staff motivation; unprofessional attitude towards changes brought about by introduction and implementation of eHealth solutions; critical shortage of IT professionals; unstandardized preservice training and luck of trust, awareness, literacy of end-users on eHealth solutions.

In line with the discussant view, lack of knowledge and awareness about the potential benefits of eHealth at a different level and a lack of competent employees to design accessible information sharing in local languages were documented in the literature (30). Similarly, a study from Ghana on a national eHealth initiative indicated that shortage of human power poses a significant barrier for successful implementation and use of eHealth solutions (26). Another study also identified the lack of intrinsic and extrinsic motivation and lack of trust about eHealth solutions due to lack of awareness as common barriers in the system (35). On the other hand, according to the study conducted in Ethiopia most of the professionals in Bahir Dar City's healthcare facilities were willing to use the EMR system. However, most of them had low computer literacy (36).

3. eHealth Policy and Strategy Related Barriers

An inclusive and shared inter-sector approach to the development of national eHealth strategies is important in implementation of eHealth solutions. Lack of planning, readiness, and alignment with national strategies are policy related barriers to the implementation of eHealth solutions. Moreover, lack of national health policies supporting the utilization of people-centered eHealth solutions is a limiting factor (13, 37-39)..

Participants of the workshops indicated strategic plan and vision regarding eHealth solution development, adoption, customization, implementation, and utilization to improve UHC is lacking

in African countries. Moreover, they reported lack of policies related to eHealth solution implementation, standards, interoperability and data sharing at individual and aggregate level are challenges of eHealth solution implementation by African countries.

Northern Africa countries, including Tunisia reported that eHealth implementation was not in the political agenda for development of supportive policies (30). Moreover, findings from the maturity level assessment of Ethiopia indicated the HIS and Digital Health initiatives have not yet been endorsed and implemented. Other eHealth policy related documents are being scrutinized for adherence. On the other hand, duplication of rules and regulation regarding data sharing was reported. Where for example data sharing policies are drafted by Ethiopian Public Health Institute (EPHI), MOH, and other partners. Aside from that, the report highlighted that there was a lack of compliance with the existing policies, legal, and regulatory frameworks (29).

4. eHealth Governance Barriers

The term eHealth governance considers implementation and use of eHealth solutions in the health system (39). Lack of top management or political support and commitment; limited senior management involvement in eHealth solution development or adoption process; and weak monitoring system are reported barriers related to eHealth governance (27, 30, 40, 41).

Conversations of experts on the workshops regarding eHealth governance on eHealth solution implementation and use, disclosed lack of a national digital identification system and a lack of/inadequate monitoring and evaluation systems are the most significant barriers to eHealth solution implementation and use. Lack of coordination, leadership, and prioritization of existing eHealth solutions in African countries were also reported as a challenge. Furthermore, there is inadequate promotional activities for existing effective eHealth solutions in African countries that would help further scale-up. Participants also revealed that African countries are reluctant in documentation of the process of eHealth scale-up and implementation, which would be used as a learning experience for others. In relation to engagement of varieties of donors and implementors of eHealth solution, there has been inadequate management of eHealth projects that could contribute to the sustainable governance and ownership. Lack of direction on handling privacy concerns in the process of eHealth implementing and lack of integration of data standards with

routine tasks of eHealth use to enhance exchange of health data in local languages were the governance related challenges reported from Northern Africa countries (42).

5. Finance and Funding eHealth Implementation related barriers

Sustainable funding is one of the key factors that maintain long-term function of eHealth solutions (34). Evidence shows that most eHealth solutions in LLMICs are donor-funded and being operated in a particular area or on specific health program that might not be sustainable, and its use might also be fragmented (10, 12, 43). The third global survey report by the WHO indicated low-income countries are the least to fund for eHealth programs. This could be related to less budget allocation by governments for eHealth implementation which demands high costs that could be used for pre-implementation readiness and post-implementation system maintenances (5, 14).

Sub-Saharan Africa countries are the least in budget allocation of digital health, where the allocated budget accounts for 0.38–0.4% of GDP of countries. In the region there has been poor public-private partnership in funding for effective solutions adoption and the adoption of eHealth solution has remained low (22, 44). The Ethiopian HIS maturity assessment indicated that health system suffers from budget shortage and irregularities to fund for eHealth solution scale-up and implementation. In addition to this, the financial plan development processes lack inclusiveness, poor resource mapping and mobilization and lack of strategic direction to address upcoming digital health demand (29).

4.2. Possibilities and strategies for inter-governmental collaboration and partnership

Purpose of intergovernmental collaboration

Collaboration among countries related to health system can be based on three conditions: 1) having common cross border health challenges; 2) having relatively similar socio-economic conditions and 3) having inter-country engagement in regional or global affairs. Unlike the North-South donor and receiver-based cooperation, the South-South cooperation among the developing countries could have significant role in capacity building, self-reliance, and the sustainable development. Such cooperation could help countries and regions to strengthen their health system, share best-practices and knowledge, accelerate health development, and advance mutually beneficial health development projects. Moreover, collaboration among countries could improve efficiency and effectiveness with minimum resource allocation for the adaptation of existing eHealth solutions (45, 46).

Development and use of eHealth solutions in Africa is growing exponentially. However, countries are at different level of implementation and use of eHealth solutions, which demands a collaborative partnership that could create an opportunity for them to share their experience (47). For which the BETTEReHEALTH EU Horizon 2020 project aimed to suggest possible strategies for countries to collaborate in the use and scale-up of eHealth solutions in such a way that it contributes UHC.

eHealth solutions could help to advance local, regional, and global problem-solving initiatives when countries collaborate to solve their shared problems by pooling their resources to achieve UHC. Effective collaboration helps to share knowledge and transfer innovations among countries (7, 48, 49). To this end, the BETTEReHEALTH project established a consortium consisting of African and European countries. The project has developed an electronic platform for eHealth solutions and eHealth policies registration to improve accessibility and enhance the use of new technological platforms and systems that can support remote diagnostic processes and procedures.

Possibilities and strategies of inter-governmental partnership and collaboration

Strengthening or establishing collaborative partnership among different countries ministries (like ministry of health and ministry of science and technology), private companies and telecommunication operators could contribute to scalability of eHealth solutions, interoperability and capacity building (12). For African countries to establish collaboration and partnership in the use and scalability of eHealth solutions varieties of possibilities can be considered. The following suggestions and possibilities are based on review of literature, consultative meetings and discussion questions distributed among the consortium member countries of Africa.

1) Regional and continental economic collaborations could be an opportunity to extend the collaboration to eHealth solution. These may include African Union (AU) AU regional economic communities, including East African Community (EAC), Economic Community of Central African States (ECCAS), Economic Community of West African States (ECOWAS), Intergovernmental Authority on Development (IGAD) and Southern African Development Community (SADC) (50).

2) Using digital health related professional associations, client /patient organizations, and technical groups/unions could be a possibility for the countries to start and establish collaboration related to use and scale-up of eHealth solutions. To name some of these associations/unions/offices: Africa regional office of WHO (51), African Telecommunication Union [ATU] (52), Digital Regional East African Community Health Initiative [Digital REACH] (53), and HealthE Africa (54).

3) Countries using similar solutions can also collaborate in the scale-up of other solutions, exchange of health statistics and big data. The intergovernmental collaboration could create an opportunity to share and scale-up the existing eHealth solutions that have been used in few of African countries to more countries. The computer-aided detection (CAD) of tuberculosis by digital chest x-ray that has been used in Zambia, South Africa and the Gambia could be a good use case. The use of digital X-ray with CAD software reading on other computer was found to have a comparable specificity and sensitivity in the detection tuberculosis as compared that made by clinical officers. The CAD solution receives image from digital x-ray for analyses and result production. Such solution can be a potential for scale-up and use for tuberculosis screening at other resource limited remote settings of Africa (55, 56).

Other eHealth solutions that can be named as an example and are being used in different countries that could create opportunity for the intergovernmental collaboration include: 1) an integrated smart reader and cloud service malaria rapid diagnostic tests (RDTs) that captures and transmits a broad range of data to the cloud via local cell networks being used Ghana, Kenya and Tanzania (57); 2) digital ultrasound that uses mHealth/telemedicine solutions in Tanzania; 3) the mobile-based two-way communication of mHero used in DRC, Guinea, Kenya, Liberia, Mali, Sierra Leon, Uganda (58, 59).

4) Countries with relatively similar socioeconomic development, infrastructure and culture (including language) could be possibilities to collaborate in the scale-up of eHealth solutions

5) Existence of similar telecommunication operators in different countries of Africa could be an opportunity for them to collaborate in the scale-up of similar solutions. Example Vodafone is operating in Ghana, South Africa and Egypt; Airtel operating in Burkina Faso, Chad, Republic of the Congo, Democratic Republic of the Congo, Ghana, Kenya, Nigeria and Uganda; Orange in Botswana, Cameroon, Egypt, Equatorial Guinea, Ivory Coast, Kenya, Madagascar, Mali, Niger, Senegal, Uganda and Togo; and MTN operating in 21 African countries (60).

6) Governments can also collaborate through ministries and institutions working on development and implementation of eHealth solutions. One of the possible collaborations among countries can be through exchange of students for study and internship. For example, scholarship and student exchange can be undertaken for Master of Public Health in Health Informatics at University of Gondar (UoG) – Ethiopia, PhD in Public Health Informatic at UoG – Ethiopia (61) and Master of Science in Digital Technologies for Healthcare at Tunisia (62). This could help the graduates to devise eHealth solutions that can be scaled-up to solve their common health related challenges.

Identifying relevant partners and eHealth solutions from different countries that can complement each other and bring them all together would be challenging (48). However, there are suggestions for countries to establish partnership in the use or share of eHealth solutions. For the successful partnership in the use of eHealth platforms, collaborating countries shall have an agreement on the strategies, long-term commitment, and development of a sense of ownership (48, 63). Nevertheless, intergovernmental information sharing using a shared digital platform can be affected by multiple factors. These include 1) collaborative conditions (i.e., initiation and maintenance of partnership, number and varieties of institutions involved); 2) value network

factors (i.e., roles of each partner, transactions of eHealth solution activities); 3) deliverability of high-quality health information/knowledge/skill; 4) local cultural, legal and political wills; and 5) level of data integration and interoperability factors (7, 49).

For the countries to establish partnership regarding eHealth platform of BETTEReHEALTH, the process of intergovernmental partnership can be applied (48, 63) [Figure 1].
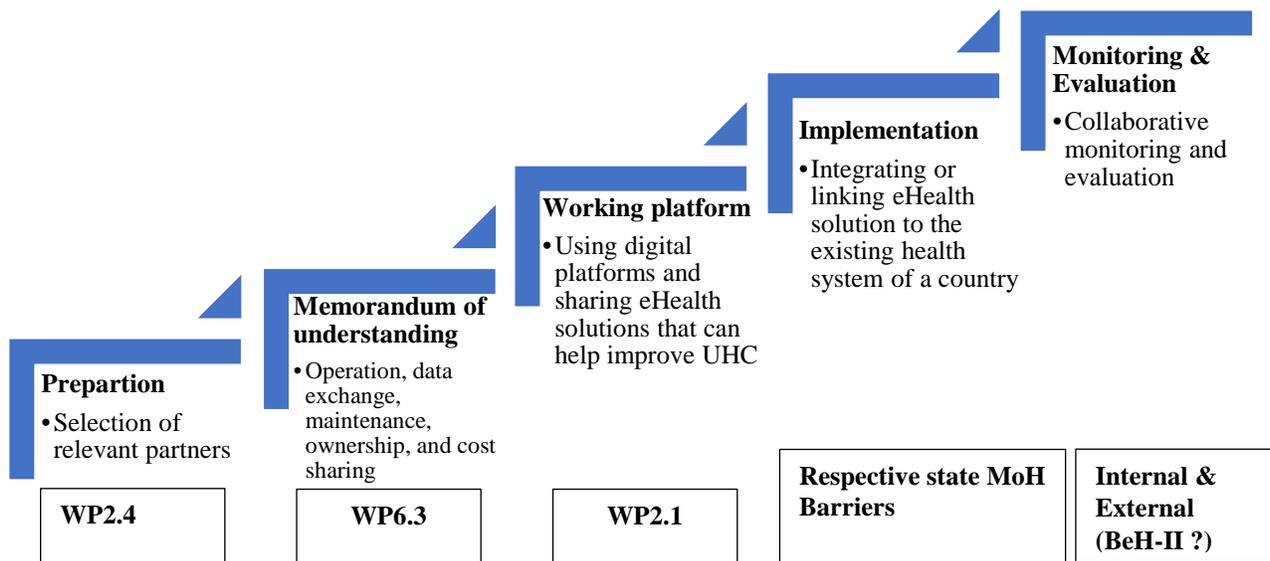

Figure 1: Process of intergovernmental collaboration and its relationship with work packages-Adapted from (48, 63).

The process of effective intergovernmental collaboration in the use of digital platform can have phases of:

1. **Preparation:** This could include the selection of relevant partner institutions from collaborating countries. WP2.4 of the BETTEReHEALTH EU Horizon 2020 project report that focused on the existing strategic partnerships on eHealth deployment in LLMICs and regions in Africa could be used as support to identify partners.

2. **Memorandum of understanding:** Collaborating countries can have memorandum of understanding of operation, data exchange, maintenance, ownership, scalability, capacity

building and stakeholder engagement. The regional hub workshops and the BETTEReHEALTH project international workshops could be important stages where countries can discuss and agree on possible collaborations.

3. **Working digital platform:** The BETTEReHEALTH digital platform registries include eHealth solutions and policies (WP2.1) developed in different countries and shared through the platform that creates an opportunity for countries to access and select correct solutions that contribute to improve UHC.

4. **Implementation:** Countries could adapt and integrate or link shared eHealth solutions related to remote diagnosis and management of diseases to the existing health system in such a way that improve UHC

5. **Monitoring and evaluation:** Collaborating countries could undertake monitoring and evaluation regarding the effectiveness of the collaboration and digital platform of verities of eHealth solutions in terms of contribution to the UHC improvement.

Using the established collaboration, countries can scale-up eHealth solutions shared on the BETTEReHEALTH digital platform or other eHealth digital registries (like Digital Health Atlas of WHO), for which scale up strategy is discussed in the following section.

4.3. Scale-up of eHealth solutions

Purpose of eHealth solutions scale-up

The contribution of eHealth solutions in strengthening health system and achieving UHC in is significant. However, since most of the solutions are pilot-based and donor-funded, they are rarely scaled-up at the national level (64, 65). According to WHO, scalability refers to making new technologies available to a larger number of people more quickly and equitably (66). Scalability can also be defined as "*Deliberate efforts to increase the impact of innovations successfully tested in pilot or experimental projects so as to benefit more people and to foster policy and program development on a lasting basis.*" On its broadest sense scalability refers to the entire process that begins with the design and testing of an innovation and then progresses to its expansion to other areas or groups of people. In the narrowest sense, it refers only to the process of expansion or replication excluding the design and testing of the innovation (67).

Many healthcare innovations that have been piloted or evaluated on a small scale around the world have not been scaled up to benefit more people and to help countries build long-term health policies and programs (66). This limitation of scalability is more prominent in Africa where piloted eHealth solutions are project-based, externally funded and rarely scaled-up. Thus, Africa suffers from the condition called 'pilotitis' – which can be defined as the need to undertake pilot projects which never scaled-up at larger level. Thus, it has been recommended that countries should move from the state of 'pilotitis' to scale-up of eHealth solutions at national level (64, 65). Moreover, in contrast to developed countries, in African countries eHealth initiatives and widespread applications of eHealth solutions are not government driven and not funded by its entities, which could contribute to lack of scalability (12).

Scalability of eHealth solutions can be successful when the solution is seamlessly integrated to and interoperable with the existing healthcare system and HIS; sustainably funded and supported by governments and can be replicated, refined, and improved overtime (20, 68). In relation to lack of supportive policies for development and institutionalization of successfully tested eHealth solutions are frequently neglected. Furthermore, the scalability of health service innovations may be limited by the expertise know-how, or capability of implementing institutions, the characteristics of the environment in which scaling takes place, and the resources available (69).

Scaling-up of eHealth solutions that have been tested with special organizational, financial, and human resources to a wider scale necessitates meticulous planning. The planning should consider the existing fragile public national health systems, such that the new eHealth solution complements rather than burdening the existing national health system (66, 68, 69).

Strategic approaches to scale-up

Successful scalability of eHealth solutions needs strategic approach of assessment – action research – scalability strategy. A multidisciplinary strategic assessment could be undertaken to identify critical service interventions, policy recommendations and research needs. Based on the recommendations from the assessment a pilot service delivery related action research could be undertaken. Finally scalability strategy that can influence health policy, planning and program action could be suggested (66).

ExpandNet scalability conceptual framework is one of the frameworks suggested for eHealth solutions scalability. The framework has five elements including:

1. The innovation that has been proven to be successful on a small scale
2. Resource organization/team - individuals or institutions facilitating wider use of solutions
3. User organization - the potential or actual users of the eHealth solution. The user organization could include healthcare providers/ clients using the solution.
4. The context or environment in which scalability of the solution takes place – these may factors external to the solution (social, cultural, political and governance)
5. Scalability strategies – these are making the right choice regarding
   a. Type of scalability to use that may be replication or expansion, institutionalization/vertical expansion and diversification
   b. Dissemination approach - the process of communicating the innovation and preparing users in its application
   c. Organizational choices – the management method of the process of scalability of eHealth solutions
   d. Costs/resource mobilization – includes mapping and availability of fund for scalability process and sustainability

e. Monitoring and evaluation of the process and outcomes of scalability using pre-defined indicators

The scalability of eHealth solutions promoted by BETTEReHEALTH digital platform considers the strategic choices suggested by the ExpandNet/WHO health service innovation scalability framework (66) [Figure 2].
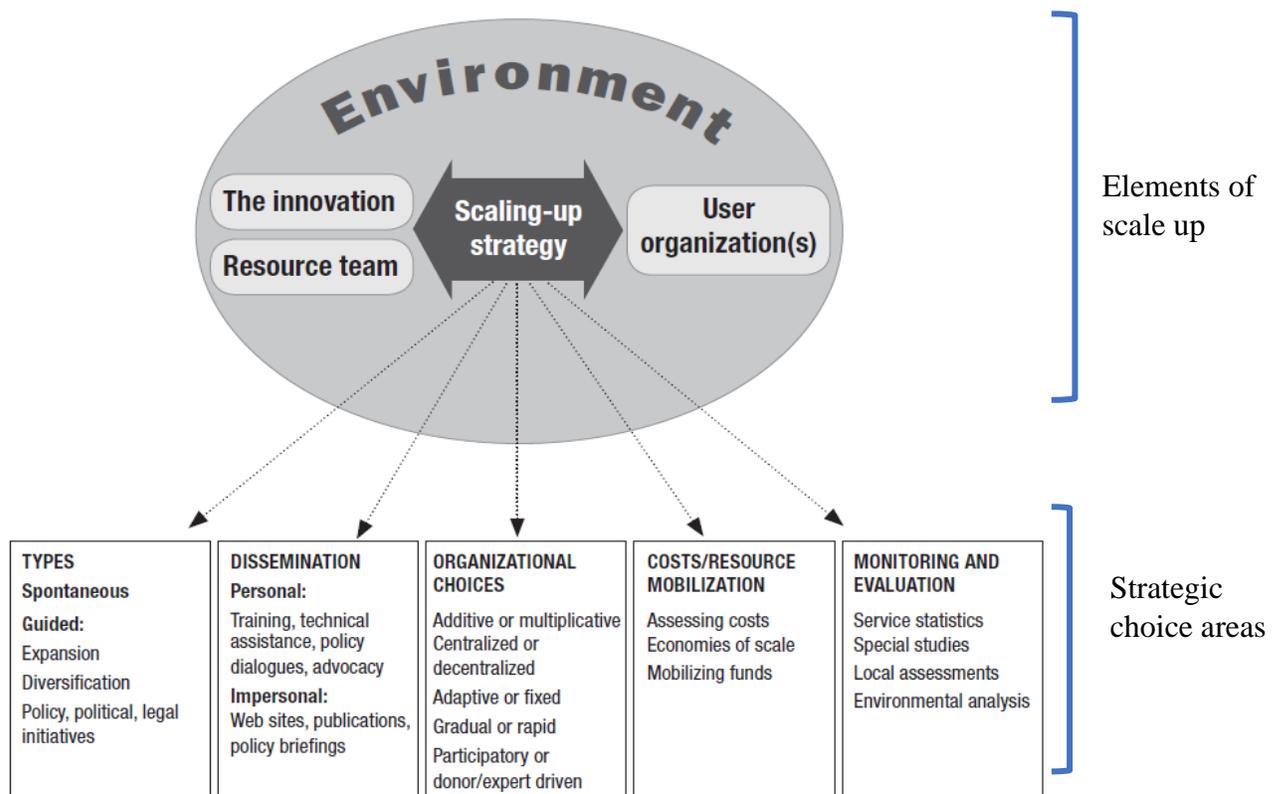

Figure 2: The ExpandNet/WHO framework for scaling up (69)(Page 12)

Many of the successful eHealth solutions on pilot study are underutilized related to lack of scalability. However, the promising outcome of eHealth solution in the UHC achievement inspired African countries to develop varieties of digital health related strategic documents as part of their national health service transformation plan (70-72). Therefore, the BETTEReHEALTH Horizon 2020 project suggested the following strategies of eHealth solutions scale-up in Africa and other LLMICs.

Suggested strategies for scalability of eHealth solutions in Africa

Successful scalability of eHealth solutions requires strategic approaches supported by contextualized scalability strategies (66). Thus, to suggest the contextualized scalability strategies in African and other LLMIC we consulted literature, conducted consultative workshop and collected data from key respondents of the four consortium member countries of Africa. Based on which the following scalability strategies of eHealth solutions are suggested:

1) ***Preparing a rigorous and contextualized plan for scalability*** of the required eHealth solutions. The planning shall include evaluation of the eHealth solution selection, scanning and arranging enabling environment for scale-up, establishing resource team that could be promote the solution for the scalability and identifying the user organization (73). The plan may also include steps that can be followed to develop contextualized scalability strategies, as suggested by the WHO ExpandNet experts (Figure 3).

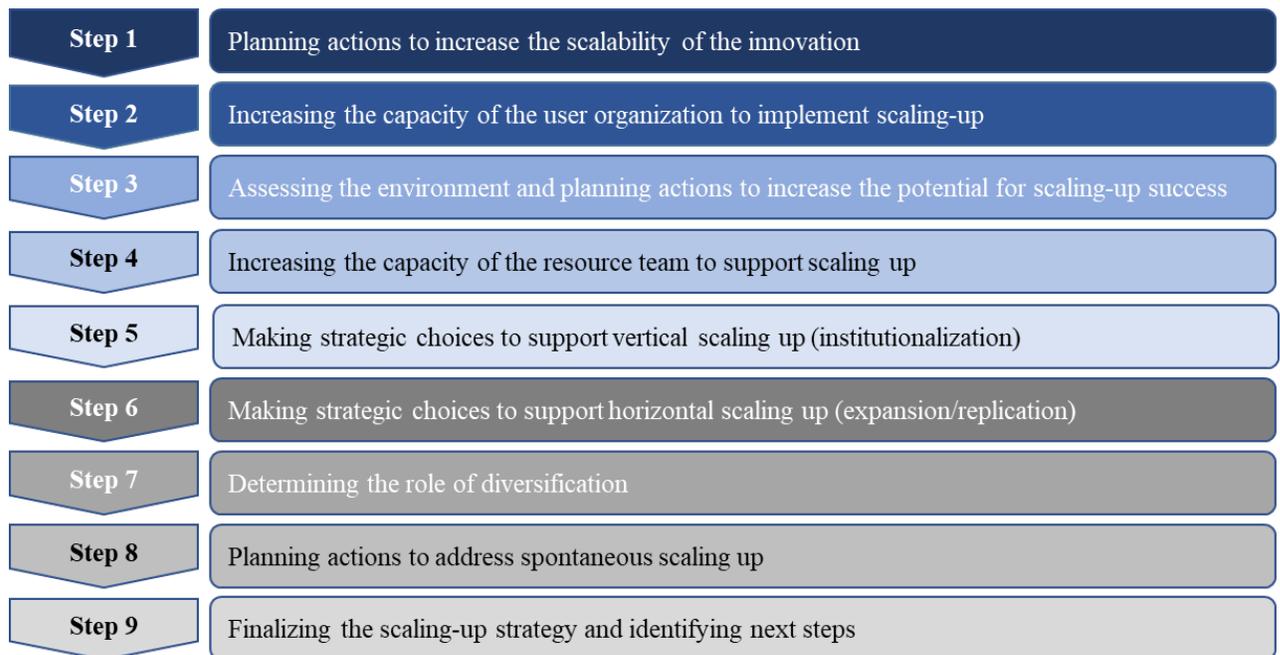| Step 1	Planning actions to increase the scalability of the innovation
Step 2	Increasing the capacity of the user organization to implement scaling-up
Step 3	Assessing the environment and planning actions to increase the potential for scaling-up success
Step 4	Increasing the capacity of the resource team to support scaling up
Step 5	Making strategic choices to support vertical scaling up (institutionalization)
Step 6	Making strategic choices to support horizontal scaling up (expansion/replication)
Step 7	Determining the role of diversification
Step 8	Planning actions to address spontaneous scaling up
Step 9	Finalizing the scaling-up strategy and identifying next steps

Figure 3: Nine-steps of developing scale up strategies

2) ***Selecting correct solutions***

The selection of the solution can be based on credible evidence, relevance to the local health problems, integration/interoperability to the existing HIS, cost and easiness for utilization (66, 73). In the selection of solutions, it is also recommended for African countries to use global

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goods where the solutions can be adaptable and modified to each African country. mHero is one of mobile-based solution used to connect the MOH with the frontline healthcare workers (FHWs) and being implemented in seven African countries. The solution is well integrated to and interoperable with the existing HIS, including District Health Information System 2 (DHIS2) and other solutions (RapidPro and Human resource management system/iHRIS). Moreover, the solution was relevant in solving the challenges of locating FHWs and open health facilities in the management of Ebola outbreak. The solution is now being extended to other services including primary care, maternal and child health, family planning, HIV, malaria, and nutrition (74). The selection of relevant solutions can be made by user organizations that involve the end-users (health care workers / clients) with appropriate contextualization to the local context.

3) *Benchmarking*

Sharing the scalability strategy experience of other regions with similar economic conditions can help to device effective scalability strategies. Scale-up of eHealth solutions at Asian countries could be an experience for African countries to benchmark. The benchmarking can also be made among African countries, where countries with successful history of eHealth solution scale-up share their experiences (12, 75). The affordable SMS mobile-based SMS mHero solution being used in the seven of African countries could be scaled up in other African countries with benchmarking the experience of those countries (59).

4) *Assessing readiness of user organization*

Undertaking maturity assessment for digitalization of health system, healthcare facilities and health professionals (76). The assessment could address digital health infrastructure, human resource capacity, policy and governance, health system, end-users and funding for scalability. Based on the assessment finding appropriate strategic planning shall be prepared by resource team (77). Digital infrastructure can be improved with multiple stakeholders involvement including government entities, development partners and private companies (78). Before the scale-up of mHero countries, software and hardware infrastructure including basic Internet connection, laptops for MOH staff, and servers and backup servers were required. The inadequacy of these infrastructures can be addressed by mobilizing resources through engagement of partners (74).

5) *Capacity building of user organization*

Capacity building activities can be related to development, use and scale-up of eHealth solutions. The following strategies can be applied: establishment of training institutions, availing tailored short-and long-term capacity building trainings, establishing an arena of skill sharing program with developed countries and establishing digital leadership programs. Multiple and varieties of awareness creation activities need to be undertaken to create resilient community ready to use eHealth solutions (12, 74).

6) *Establishing south-to-south collaboration*

South-to-south collaboration among African countries in the scale-up of eHealth solutions could be important (67). For this using existing economic cooperation explained under section 4.3.2 could be an opportunity for the countries to collaborate in the scale-up of eHealth solutions.

7) *Making strategic choices*

The resource team (the team involved in the scale-up process) shall make strategic choices regarding the type/mode of scalability, advocacy/communication of the solution, management of the scale-up process, resource mobilization and monitoring and evaluation mechanism of the scalability process. For these strategic choices, four of the consortium member African countries suggested the following strategic choices

i. *Using contextualized type of scalability*

The preference of type of guided scalability is generally based on the context within which scalability is undertaken, the type of the eHealth solution under consideration and the entity leading the scale-up process. Moreover, the type of scalability could also depend on the actors involved in the scalability process and end-users. Therefore, under the consideration of the above-mentioned conditions, the consortium member countries suggested one or more of the scalability types can be employed.

If the selected solution is to be added to the already existing solution or there is data gap diversification method could be considered. Besides, new features may be added to the existing solutions to exploit their benefits and have comprehensive eHealth system. If the selected solution has been implemented on small scale or have not yet implemented in the country, replication/horizontal scalability with the necessary policy and legal framework is more attractive to increase the spectrum of the solution and improve the contribution of eHealth solution to UHC. The horizontal expansion of solutions to all healthcare services

with the aim of digitalizing all services can improve access in all aspects. Vertical scalability type is crucial regardless of the options we choose because the solutions should align with the national healthcare policy and be integrated into a national HIS. As an example, solutions like DHIS2 and electronic Community Health Information System (eCHIS) scaled-up and institutionalized by MOH of Ethiopia vertically found to be effective, where political support is found to be crucial (79, 80). Similarly, for the scale-up cStock solution, that is used to produce a report and make logistic data visible for decisions helps to improve the supply chain for increasing the availability of medicines for community health workers (CHWs) to run the integrated Community Case Management (iCCM) was institutionalized by MOH of countries (81).

Since most of the solutions piloted in Africa are donor-funded, scalability and implementation need to be guided by strong leadership, relevant policies, political support and legal frameworks. The government of African countries should initiate and endorse the scaling up of the innovation in large-scale settings. For sustainability, an eclectic approach of vertical, horizonal or replication scalability types can also be applied as required.

ii. *Promoting the existing eHealth solutions by using appropriate dissemination and advocacy strategies*

The development and scale-up of eHealth solutions in Africa varies among countries. The effectiveness eHealth solutions developed and sometimes scaled-up are not well documented, promoted or advocated for other countries to adopt, customize and use the solutions. Existing eHealth solutions in different African countries can be disseminated, promoted and advocated through different strategies. These include: 1) using traditional methods like regional/continental workshop, conferences and sensitization trainings to showcase eHealth solutions implemented in different countries; 2) scientific publications from evaluation of the implementation of the solutions; 3) using digital platforms like websites (where the technical characteristics of eHealth solution and good toolkits can be presented); 4) policy dialog where countries' delegates discuss and reach on common ground for promotion and advocacy of eHealth solutions from different African countries. However, these dissemination channels need to be used based on the stakeholders involved in the scale-up process.

After the mHero was successfully scaled-up in Liberia, advocacy of the solution was made through meeting conducted among higher officials from three African countries, when Liberia shared its experiences (74).

iii. *The central government entity, i.e., MoH should collaborate with the local authorities for the organization of scale up*

Unlike short-term eHealth solutions implemented for specific health programs or geographic coverage, an integrated eHealth solution scale-up at national level requires the engagement of multiple partners, including the developer or owner of the solution. Such strategy is multiplicative scale-up strategy where multiple partners take part in the scale-up process. This approach has shown a promising outcome in scale-up of DHIS2 and electronic community health information system in African countries (79, 80). On the other hand, in resource limited settings of Africa, solution implemented in digitally well-equipped health facilities or region can be gradually expanded to other facilities or regions, as it was done for mHero (74).

Institutions involved in the proves of scale-up can be composed of relevant public and private institutions. These may include relevant offices of Ministry of Health, academic institutions, Ministry of Finance, regulatory agencies, technical implementation partners (i.e., HISP) Ministry of Social affairs and other relevant organizations. From these institutions, three of the four consortium member countries suggested MOH to take the lead of scalability with a clear national policy and legal guidelines. A respondent from one of the countries reported, "I propose a hybrid approach. The central authority takes the lead to roll up a digital health application then the local entity will take the overall scalability operation". Another respondent stressed the importance of involvement of local authorities in scale-up and implementation of eHealth solutions.

In relation to the strategic choices or decision, respondents of the four consortium member countries presented possibilities of both flexible/adaptive and fixed method of management of the process of scale-up. For the scalability at national level to avoid challenges related to interoperability and standards, it is preferable to adhere to a set minimum requirement that all parties can use, with allowing flexibility at local particularities. However, the

respondent from Tunisia presented the need for flexibility "The scalability process should be adaptive and evolving. Indeed, the process should be flexible to the specific context according to the presented opportunities and constrains".

iv. *Funding and Resource Mobilization for the scale-up and use of eHealth solution*

Scalability of eHealth solutions in a fragile health system and poor digital infrastructure settings of Africa could be costly. Thus, the consortium member countries suggested a cumulative effort of government ministries, private institutions, and external funders. Specific strategies suggested by the countries include:

a. Integration of budget for scalability and sustainable implementation into the national budgetary system

b. Coordinating, mapping and engaging external funders/donors

c. Creating a public-private partnership

d. Devising revenue generation mechanisms at national and local level

e. Reallocation of budget within the healthcare system

f. Looking for solutions available as global goods. For the resource limited setting of LLMICs solutions accessible through global goods or with cheaper investment but with acceptable standards and interoperability could be considered. eHealth solutions available through global goods are successfully scaled-up in LLMICs. DHIS2 is an example of eHealth solution available through global goods and its scalability engaged multiple stakeholders and donors (DHIS2, 2021). The computer-aided detection (CAD) of tuberculosis by digital chest x-ray that has been implemented in Zambia, South Africa and The Gambia is also another example. The technology can reach more people at the remote settings by reducing expenses of transportation and health service-related costs. The developers also claimed that the use of the CAD solution is by far cheaper as compared to costs related to detection made by clinical officers (Nip, 2012, Muyoyeta et al., 2014).

g. Different African regional countries can co-finance for the scale-up of eHealth solutions of mutual interest

v. *Monitoring and evaluation*

MOH of implementing countries could design an M&E framework that would be revised periodically according the HIS maturity level of specific country. It is suggested that M&E entities (including national steering committee, national technical advisory body, or task force) can be established to undertake the M&E activities. These entities shall prepare relevant M&E indicators to track the progress of the scale-up. Moreover, supportive supervision, periodic report and timely feedback can be used.

In the scale-up of the cStock solution, one of the strategies used was establishing technical task force led by MOH and composed of key stakeholders was established. The task force monitors the progress of the scale-up, mobilizes resources, contributes to the development of a five-year transition plan and works on capacity building within MOH for full ownership (81).

Examples of use cases of eHealth solutions scaled in different countries of Africa are given in the annex (Annex IV)

Suggested eHealth solutions scalability framework and future directions in Africa

The achievement of the UHC in resource limited and fragile health system of Africa could be supported by affordable and expanded use of eHealth solutions. However, the use and scale-up of several eHealth solutions developed and tested successfully in Africa are limited and remain underutilized. For leveraging the use and scale-up of those available and emerging eHealth solutions, supportive scalability frameworks are very limited. Olu, et.al., and Barker et.al., are the pioneers to suggest scalability framework contextualized to Africa (34, 82). However, the frameworks could not address the collaboration/partnership of institutions or countries and the strategic choices/decisions required by countries for scaling up of eHealth solutions. Taking these into account, we therefore suggested scalability framework that can better work in the African context. The suggested conceptual framework can contribute an effective scale up of eHealth solutions and their use as tools to achieve SDGs and UHC. The framework can inform public health experts, information communication technologists, policy makers and researchers regarding strategies used to scale eHealth solutions.

The constructs of the framework were suggested based on the review relevant literature (12, 68, 73) and discussion output of workshops. As shown in Figure 4 the eHealth solution scalability framework proposed for LLMICs in Africa by the EU Horizon 2020 BETTEReHEALTH project includes a cyclical process comprising of readiness, collaboration, selection of correct solutions, scale-up activities, monitoring and evaluation, evidencing and innovation or adoption of new solutions. The framework suggests determining readiness of countries to implement and scale-up eHealth solutions. Readiness can be determined from six basic perspectives. 1) Health system, 2) Technological ecology – interoperability, infrastructure and the uptake and compatibility of the solution to the end-users; 3) Human resource and capacity – skill level and mix of professions; 4) eHealth policy and standards – availability of relevant supportive policies, standards, guidelines; 5) eHealth governance – political support, leadership capability and commitment, top management involvement; and 6) Finance and funding – sustainable funding for implementation and scale-up. On the other hand, institutions and countries need to establish collaborative partnership to scale-up solutions. To run the scale-up the institution or country interested in the scaling up (user organization) shall create a team composed of researchers, policy makers, professionals, community representative and end-users (example healthcare providers and clients). This team carefully analyze solutions considered for scale-up to make a correct selection. Then, the user organization could undertake strategic decisions or choices in collaboration with the resource team (the origin of solution that promotes its scalability). Once scaled-up monitoring and evaluation shall be undertaken by the user organization and resource team. Moreover, it could also be supported by research evidence which could help to the scaled-up solution or add new solution (Figure 4).
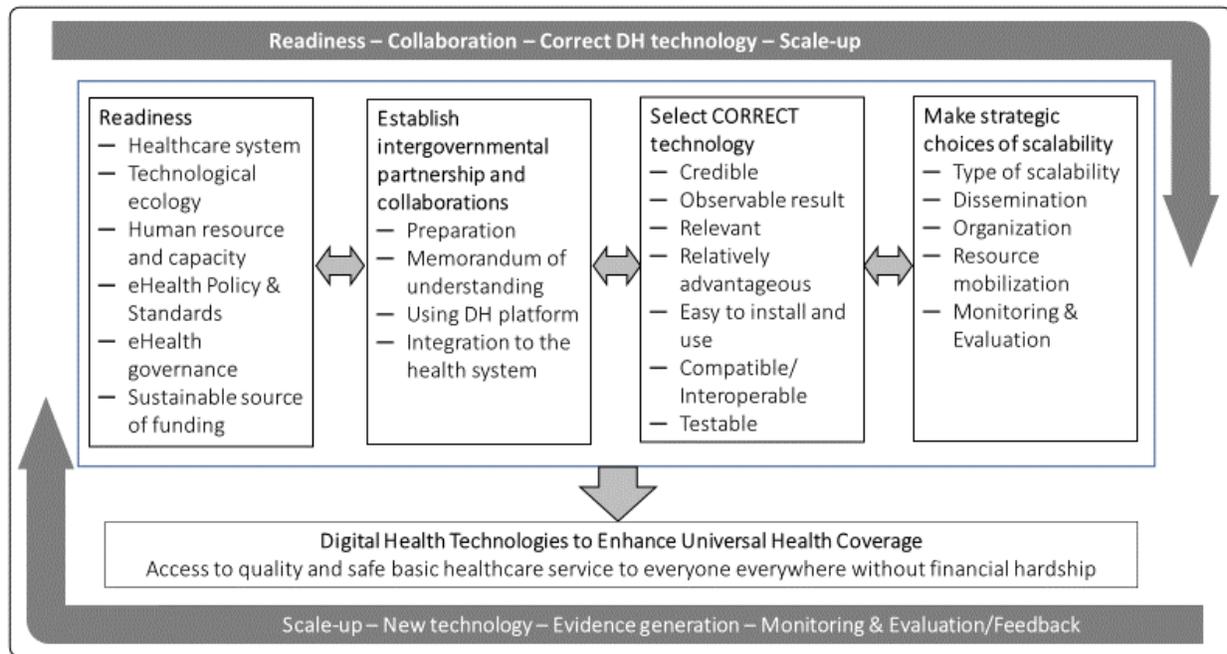
Figure 4: Conceptual framework suggested for scale-up of eHealth solutions to support UHC

5. Conclusion

People living in LLMICs can hardly access the quality and type of healthcare services they need. They are thus, expending much for transportation with higher risk of preventable morbidity and mortality (BUNDI et al., 2020). To alleviate these challenges and improve UHC, countries are introducing varieties of eHealth solutions. However, most of these initiatives are fragmented, the solutions are not integrated to the existing national HIS and not scaled-up strategically at the national level or beyond (Adebesin et al., 2013). eHealth solutions contribution to the attainment of UHC at individual, facility and system level could be realized with the availability of adequate ICT infrastructure, user-friendly and well-accepted solutions, skilled ICT professionals, supportive policies and allocation of adequate budget (83).

Despite significant obstacles to implementing eHealth solutions in LLMICs, evidence suggests that several factors drive the need for eHealth solutions in achieving overarching health goals such as UHC. Nonlinear technological growth and supportive conditions such as upcoming telecommunication privatization and growing interest in technology-assisted client care are among these enabling forces. Hence, because of its contribution to reducing errors in data mining,

knowledge discovery, and ensuring a future resilient health-care system, eHealth has become and continues to be a valuable resource for achieving UHC.

African countries can establish South-to-South collaborative partnership to scale-up and use relevant eHealth solutions that help to tackle cross-border health problems and improve UHC, efficient use of scarce health investments and share experiences.

Scaling-up of eHealth solutions can be an evolving and cyclical process of making scalability enablers ready, collaborating among countries, selecting correct solutions, making strategic choices and use strategic monitoring and evaluation techniques supported by research evidence. Considering these enabling factors and activities we suggested a scalability conceptual framework and strategies contextualized to Africa that can inform public health experts, information communication technologists, policy makers and researchers regarding strategies used to scale eHealth solutions.

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Annexes

Annex I: Literature on Barriers in eHealth implementation

Author, Year, Title,	Country and area of Application	Method	Participant	Outcome/main findings	Implication of finding to adverse barriers
Micheal etal, 2019 Assessing core, e-learning, clinical and technology readiness to integrate telemedicine at public health facilities in Uganda: a health facility-based survey Vincent	Uganda Telemedicine	Cross-sectional with mixed method of data collection	Medical doctors, other HCP and patients	While the majority of HP (70%) were aware and utilized telemedicine (41%), a substantial portion of HW (over 40%) were not, and patients reported barrier to its use. The study also identified a technological readiness gap throughout different levels of Ugandan HF.	Technological and human capacity barrier
Fassil Shiferaw & Maria Zolfo The role of information communication technology (ICT) towards universal health coverage: the first steps of a telemedicine	Ethiopia Universal Health Coverage using **Telemedicine**	Descriptive case study of the first Ethiopian telemedicine project, run between 2004 and 2006, and it analyses the	Ten sites in Ethiopia were selected to participate in this pilot between 2004 and 2006 and twenty physicians, two per site,	► Considering Telemedicine as it's a premature phase of development in Ethiopia sub-Saharan African countries, and e-health solution remains difficult to talk objectively about measurable impact of its use, even though it has demonstrated practical applicability beyond reasonable doubts. Lack of financial and administrative support at grass root level cause failures, and ►Lack of content development was stated as challenge	Technological factors, e-government readiness, enabling policies, multisectoral involvement and capacity building processes are major barriers. In addition to that the implementation of telemedicine lacks considering

project in Ethiopia, (2012)		reasons for its non-successful adoption and implementation.		Generally technological factors, e**-government readiness**, lack of enabling policies, budget shortage, multisectoral collaborative involvement and capacity building processes are considered as major barriers for effective Telemedicine implementation and use in Ethiopia.	the local context. Moreover; not taking into account the local language, and lack content development to use telemedicine at the grass roots level are barriers.
Mercy Mpinganjira, 2013 E-government project failure in Africa: Lessons for reducing risk	South Africa e-Governance in South African Revenue Services	a review of the E-filing program-based analysis of secondary sources of information relating to the service and direct observation		►As service providers some of the e-Governance characteristics are critical factors that can help to ensure e-government project success. i.e Project support and commitment from top management, requires large financial investments to cover costs such as those associated with hardware, software and training of staff. ►Technological infrastructure especially in the areas of **Telecommunications**, **Networks and sustainable Electricity power,** the fact remains that most common challenges in African countries. ►lack of leadership and commitment at both political and administrative levels is critical to the success of E-government initiatives. Having in place a project implementation team with clear deliverables, having reliable technical infrastructure, ensuring that users views and situation are taken into consideration in project implementation were identified as major finding to reduce the risk of ICT based service delivery.	e-Governance in-service provider entity is barrier. Lack of clear deliverables from implementers, lack of reliable technical infrastructure, and budget related barriers are indicated in ICT related service provision areas and lack of strong project evaluation and monitoring system in place are major barriers. Human resource related barriers lack of support and commitment from top management,

(Zach Landis, etal 2015) Barriers to using eHealth data for clinical performance feedback in Malawi: A case study	Malawi the use of EMR data for clinical performance feedback	a qualitative study, observations,	32 healthcare providers and 7 hours observation of system use.	We identified four key barriers to the use of EMR data for clinical performance feedback: provider rotations, disruptions to care processes, user acceptance of eHealth, and performance indicator lifespan. Each of these factors varied across sites and affected the quality of EMR data that could be used for the purpose of generating performance feedback for individual healthcare providers.	four key barriers to the use of EMR data for clinical performance feedback are provider rotations, disruptions to care processes, user acceptance of eHealth, and performance indicator lifespan as common barriers. Moreover; understanding of the clinical setting while design.
Tran Ngoc, etal 2018 Conclusions of the digital health hub of the Transform Africa Summit	Report and synthesized from Transform Africa Summit 2018 in Kigali UHC and SDGs In prevention and control of Non-Communicable Diseases in Africa.	five thematic areas which explored the status digital health in Africa, leadership, innovations, sustainable financing of digital health and its deployment for prevention and control of Non-Communicable Diseases in Africa.	over 200 participants from Ministries of Health (MoHs) and ICT, Private Sector ICT Operators, International Organizations, Civil Society and Academia.	e-health solution strengthening the health system and enable the attainment of universal health coverage. In order to achieve strengthening the health system and achieve universal health coverage the following solution were recommended in Africa. eHealth has to move from Donor-driven pilot projects to more sustainable and longer-term nationally owned program. Strong health system that takes eHealth solution. Availability of an enabling environment including: national digital health strategies, regulatory, coordination, sustainable financing mechanisms and building of the necessary partnerships for e-health solution required. e-health solutions should be people-centered and demand driven so as to support communities especially the hard-to-reach ones to access equitable and good quality health services. The security of public health data is a cross-cutting issue which needs to be comprehensively addressed in Africa.	Donor-driven pilot projects are the cause of barriers and results in unstainable mushroom pilot project. Lack of enabling environment such as Government leadership including national digital health strategies, regulatory, coordination, sustainable financing mechanisms and building of the necessary partnerships for digital health are barriers for eHealth implementation and use. people-centered and demand driven approaches wand.

(Labrique, A. B. and etal 2018). Best practices in scaling digital health in low- and middle-income countries (2018).	Review Distilled from real-life case studies discussed at a Digital Health Dialogue held in Ghana.			Five key focus areas have suggested that enable success i.e unattaining these could be considered as barriers. **Environmental factors** include ensure the involve private partners and eHealth policy and strategies should consider global level collaborative efforts and it has to be in line with the health system polices. In addition, eHealth solutions must offer tangible benefits to address an unmet need, with end-user input from the beginning. Capacity building issues like, providing need-based training and motivate end users to implement a new initiative is required. And the technical barriers such as simplicity, interoperability, enterprise architecture and adaptability have to be addressed in accordance. The infrastructure should consider not only availability but also scalability of the solution.	The limitation in technological infrastructure availability and no considering scalability are barriers. Environmental factors, solutions lack task technology fitness from end users' perspectives, end users' capacity building needs to consider need-based training and motivating end users to use eHealth solution. The technical barriers include simplicity, interoperability, security, enterprise architecture and adaptability are identified in LMICs
(Olushayo Olu1 etal 2019) (WHO Country and regional Office, and International Health System Strengthening Expert Report) How Can Digital Health Technologies Contribute to Sustainable	(Juba, South Sudan, Brazzaville, Republic of Congo, Kigali, Rwanda, Accra, Ghana) Attainment of	This article reviews the key benefits and challenges associated with the application of eHealth for UHC and propose a conceptual framework for its wide scale		Implementation of eHealth solution in Africa is constrained by barriers such as: ✓ Poor coordination of mushrooming pilot projects, ✓ Weak health systems, ✓ Lack of awareness and knowledge about digital health, **Poor infrastructure such as** ✓ Unstable Electricity power source, ✓ Poor internet connectivity (depends on cost and speed) and ✓ Lack of interoperability of the numerous digital health systems.	Besides the Weak health systems imposes its challenges in addressing UHC. Lack of basic infrastructure or poor performance, and **technical** issues such as interoperability scalability was identified as major barriers. Besides, lack of awareness on leading digital solution and lack of coordination and unmanaged user's demand were identified as barriers for eHealth solution implementation and use.

Attainment of Universal Health Coverage in Africa? A Perspective	Universal Health Coverage in Africa	deployment in Africa		Also indicated the benefits of eHealth in attainment of universal health coverage requires the presence of elements such as ✓ Resilient health system, ✓ Communities and access to the social and economic determinants of health.	The report also comprehensive evidence and a conceptual framework is required for successful eHealth solution implementation and use for universal health coverage in Africa.
Kgasi, M. R., & Kalema, B. M. Assessment E-health Readiness for Rural South African Areas. *Journal of Industrial and Intelligent Information*, (2014).	South Africa Area Investigate the determinants of e-health readiness	Quantitative method used	Professionals from Moses Kotane referral hospital and three clinics that were sampled by their radius distance from the referral hospital were used for data collection	Results indicated that **societal readiness construct** was ranked as being the least important compared to other constructs with an explanation power of 7.6% to overall e-health readiness. ►As socio technical factors: ✓ Resistance to change and socio-culture attributes have negative explanation power as compared to other attributes. ►As opposed to barriers the **successful** implementation and use of eHealth solution indicated that: ✓ Organization's planning should show clear understanding of what is expected when they are implementing e-health solution. Another issue to consider is the emergent of the need's assessment as the most important attribute in core readiness category also indicated as enablers.	Limitation in Change management / leadership skills are barriers. And limitation in addressing the socio-cultural attributes including change resistance that comes as a result of eHealth solution implementation were identified as barriers. Moreover; lack of clear understanding to planning and current the future requirement of eHealth solution are major barriers.
(Funmi Adebesina , , Paula Kotzéb , etal) Barriers and Challenges to the Adoption of E-	South Africa e- health standards development and the level	Literature review	NA	The report focusses on e-Health standardization and the report indicated from analysis of the literature revealed that developing countries also face additional challenges when compared to developed countries, including: ►Limited participation in standards development process, lack of involvement of diverse users of	Technical barriers especially limitation in following standardization in developing countries was identified as major barriers.

Health Standards in Africa 2014	of African countries' participation in the development process.			standards in the development process, lack of understanding of the importance of standardization at national level, lack of human resource capacity for standards development, lack of foundational infrastructure, lack of implementation guidelines, The standardization and interoperability issue will have direct effect with eHealth successful implementation and effective use. **And the following are listed as** enabling environment include: ►Leadership, governance, and multi-sector engagement, strategy and Investment: this provides for a responsive strategy and plan for a national e-health environment and aligns funding for e-health with national e-health priorities. ►Workforce: ensures that the necessary e- health knowledge and skills are available through internal expertise, technical cooperation or partnership with the private sector.	
(Jitendra J, etal, 2020) Adoption of enterprise architecture for healthcare in AeHIN member countries	In Asian Health Information Network (AeHIN) member countries eHealth Enterprise Architecture adoption	an EA Adoption Evaluation framework with four principal layers: governance, strategy, EA and performance.	26 participants from 18 healthcare organizations in the Asia- Pacific region representing 11 countries. Organizations included Ministries of Health,	►Stated that Healthcare organizations are undergoing a major transformational shift because of the use of e-health solutions. And lack of adoption of enterprise architecture is one of the barriers for healthcare that hinders from applying standardization, integration and alignment with the business strategy, ► Lack of senior management experience and involvement in EA is a major challenge for the limitation in adoption of EA in these countries.	Lack of technical infrastructure, interoperability, and alignment of business and lack of IT strategies are barriers. All organizations believed that their interoperability and infrastructure would improve after adopting EA. And alignment with the business strategy.

	in low-income and middle-income countries			Universities, NGOs and Technical Advisory	► Enterprise architecture (EA) is a conceptual paradigm; healthcare organizations can leverage to address these critical issues systematically. ► key driver for adopting EA in healthcare organizations is to address interoperability issues in the health system to successfully implement and use e-health solution.	Lack of EA knowledge and leadership among senior management is a major barrier that needs to be addressed for a successful EA adoption. The study highlighted that "the need for capacity building in the areas of EA implementation, adoption and evaluation targeted towards the senior management."
(Daniel Luna, and etal) Health Informatics in Developing Countries: Going beyond Pilot Practices to Sustainable Implementations: A Review of the Current Challenges (2014)	A non-systematic review on the Current Challenges	searched using the keywords medical informatics, developing countries, implementation, and challenges in PubMed, LILACS, CINAHL, Scopus, and EMBASE.			The following are some of the barriers identified as common to developing countries in relation to sustainability that includes: ►The lack of adequate infrastructure, and the ways these problems can be bypassed. Addressing the fundamental need to develop nationwide e-Health agendas to achieve sustainable implementations; Ways to overcome public uncertainty with respect to privacy and security; the difficulties shared with developed countries to achieve interoperability; the need for a trained workforce in the health system and existing initiatives for its development; and strategies for achieving regional integration.	Major barriers lack of resource and infrastructure, limitation of Development of health IT agendas, limitation in Overcoming uncertainty, ethics in data security, Lack of use of common interoperability, Lack of a trained workforce, lack of regional integration are identified

Annex II: Guiding questions – eHealth scalability strategic choices

The following guiding questions are prepared based on the strategic choices suggested by WHO ExpandNet. The participants are requested to for forward strategic choices based on the context of their specific country or Africa.

1. Considering the context of your country, what type of scalability do you think more applicable?

    a. replication or expansion – horizontal

    b. political, policy or legal initiatives – vertical

    c. diversification – adding to the exiting solution

    Would you explain the possible reasons for the suggested type of scalability?

2. Dissemination and advocacy

    2.1. What strategies would you suggest for African countries to disseminate eHealth solutions from the country of origin to other?

    2.2. How can countries collaborate and establish partnership in sharing eHealth solutions?

3. Considering the following methods of management of scalability process, please indicate your view considering the context of your country.

    3.1. Which one do you think more relevant for scaling of eHealth solutions in African countries? Additive (scalability implemented by the original sponsor of the innovation, where a single organization is involved) or multiplicative (new partners can join the expansion or promotion of the innovation).

    3.2. How should the process of scalability be directed? Should it be the central authority (e.g., ministry of health) or by local authority (e.g., regional or county health bureaus)?

    3.3. How should the scalability process be managed? Should it adaptive where the scaling-up strategy be flexible to the specific context, according to the opportunities and constraints presented or should it be fixed where it adheres to a set of prescribed guidelines, wherein a uniform package of interventions is introduced in all locations in the same manner?

    3.4. What do you suggest the pace of scale-up of eHealth solutions in Africa (by phase, gradual, time frame)?

3.5. Considering the pace and time frame of scale up, to what extent (in terms where the solution can be introduced) should scalability be undertaken? (national, regional/county level, zonal, specific institution)

3.6. Who should manage the content and implementation of process of the scale-up? Experts/High level professionals or by engagement of relevant stakeholders' indecision making?

4. Cost of scale and resource mobilization

4.1. What sources of fund can be available at your country for expanding the innovation to new geographical sites or population groups; to obtain political support for scaling up and for institutionalization; and (c) for diversifying the innovation through the additional testing of new components of eHealth solutions?

4.2. From sustainability point of view how costs of further expansion and standard practice be integrated to the local and national budgetary system?

5. Considering the African countries context, what monitoring and evaluation strategies of scale-up process of eHealth solutions do you suggest?

Annex III: Discussion Points - Development of scalability conceptual framework

I. Review of literature by lead team
II. Prepare questions that guide the development of the framework, at the inhouse workshop
   Points for discussions – scalability
   a) What need to be considered for scalability of eHealth solutions in Africa? Examples include: type of technology, actors, health system, etc
   b) What variables can be considered?
   c) Categorization of the variables in to related concepts
   d) Show interrelationship
   Points for discussions – scalability
   1. Considerations
      a. Proven technology identification that c
         — Interoperability – the new technology integration/interoperability national system like DHIS2
            ▪ in a way that can improve patient care
            ▪ improve management system
         — usability framework
         — technical
         — clinical/health aspect impact
         — cost effectiveness/affordability
         — time required to operate with the technology
      b. Identification of actors/stakeholders participating in scale-up process
      c. Targets users (community, HCPs, IT professionals, decision makers, policy makers)
         — Wholistic within the healthcare
         — System thinking - institutionalization
         — capacity/skill
         — address vulnerable – like gender, variation in residence, pastoralist/agrarian, disability
         — demand
            • shared across individual, system, national
            • balance with supply
            • creation through education or spontaneous
         — digital literacy, awareness among
      d. human capacity (technical team)
         — availability of trained support team (professionals) with adequate technical support capacity
         — capacity building collaboration with local institutions (universities, research centers) for sustainability of scale-up of technologies
         — PPP (public-private partnership)
         — New graduate professional internship - engaging new graduates to related institutions for internship then helping them to form enterprise to work on the maintenance
      e. Environment/context
         — Innovative in relation to the context
         — Cultural context

    f. eHealth infrastructure
- Telecommunication infrastructure
- Band width
- Devices – server (storage capacity, process capacity), computers, capacity, up to date/modern, quantity
- Gadgets, furniture
- Electric supply – continuous, alternative power supply

    g. Resources
- Resource source of finance
- Resource mobilization mechanism from stakeholders, donors, government
- Efficient management existing resources
- Inefficient channeling of finance
- Duplication of efforts – when different solutions for the same purpose implemented

    h. Legal and policy framework
- data sharing, security
- public health regulations – allow introduction and implementation of eHealth solution – in case of re-enforcement
- supportive digital policies – national and sectorial, eCHIS
- taxation regulation – for example tax free for DH technologies
- supportive legal framework – Ex: telemedicine with medication prescription, technology-based medicine distribution
- procurement policy for purchasing of software applications and devices

    i. Intergovernmental collaboration
- data sharing policy among countries – Ex: patient who treated in Ethiopia accessing data in Sudan
- supportive policies across countries
- supportive diplomatic relationship
- cooperative framework among countries which can be specific to health
- communication standards among countries
  - addressing language difference across countries – Anglophone and Francophone
  - difference in the calendar across

    j. health system
- alignment of eHealth solution with national health system policy
- initiatives to improve healthcare system

    k. monitoring and evaluations
- mechanism of M&E devices
- independent entity that can undertake M&E
- indicators for effectiveness have to be defined
- allocation of budget for M&E

2. Variables
   a. Enabling environment/Readiness
   b. Culture

        c.   Health system
        d.   eHealth policy
        e.   Intergovernmental cooperation
        f.   Stakeholder management policies
        g.   Technology

3. Categorizations: in to 4 concepts
        a.   Readiness
        b.   Collaboration/partnership
        c.   Selection of technology
        d.   Strategic choices
4. Interrelationship between the concepts and with the UHC

III.   Review by the consortium member countries partners and modifications

A. A case of mHero solution

mHero is a mobile phone-based solution originally designed by IntraHealth International and UNICEF during the 2014 Ebola outbreak in West Africa to connect health officials (MOH) with frontline health workers (FHWs) via a two-way SMS message communication to collect and share information helpful for a rapid response to the outbreak. The first use case of the solution used in Liberia during the outbreak helped to locate FHWs and determine which health facilities are open. The solution has been also been supported by an interactive voice response. In addition to the communication the solution helps to provide training for healthcare providers and collect real-time data. Beyond the response to the Ebola outbreak, the solution has been integrated to the Ministry of Health and Social Welfare HIS, DHIS2, that supports varieties of health services, including primary care, maternal and child health, family planning, HIV, malaria, and nutrition. The solution is affordable and user friendly where it can be supported by both smart and non-smart cell phone apparatuses (58, 59, 84, 85).

The right solution

Since the solution uses an open source-code and open standards for health information data exchange its adaptability and scale-up at national level in the resource limited settings of Africa. Moreover the accessibility and flexibility of the solution has got the attention of MOH of respective countries to scale-up at national level (41, 74, 81).

Creating a forum for countries to share their experiences

After the mHero was successfully scaled-up in Liberia, officials from the three countries met through iHRIS and mHero trainings. In 2016 the MOH of Sierra Leone piloted the solution.

Resource mapping and funding

The scale-up of the solution in Liberia, Sierra Leone, and Guinea was funded by USAID through the Ebola Grand Challenge Innovation Grant through the Global Health Bureau. Whereas the scale-up was undertaken by MOH and IntraHealth in Mali and by MOH in Senegal.

Type of scalability

Vertical scale-up method: The solution has been adopted, led and institutionalized by ministries of health of Guinea, Liberia, Mali, Senegal, Sierra Leone and Tanzania (9, 59).

CORRECT technology

Interoperability –It has been well integrated and can communicate, use and exchange data with 1) RapidPro (UNICEF) an SMS platform that allows users to create SMS messages in a "workflow" through a website; 2) Human resource management system (iHRIS) developed by IntraHealth used to track and manage health workforce data and 3) DHIS2.

Clear role of resource team and user organization:

The major stakeholder for scalability of the mHero was MOH (of Liberia, Sierra Leone, and Guinea), which identified and prioritized application areas and target health cadres. Partners (IntraHealth and UNICEF) aligns the solution with the national policies and standards; engage in the capacity building of implementers at MOH and collaborate to strategically integrate to the existing HIS.

Strategies used for the successful scale-up the mHero includes:

1) Ministry of health leadership and ownership: The MOH has taken the lead in scale-up by identifying the national policies and standards and integrating the solution to the existing HIS.

2) Awareness-raising with health workers: Awareness creation activities are required to inform health workers that message sent by mHero is form MOH and their response is used for decision making by officials.

3) Infrastructure: Adequate software and hardware including basic Internet connection, laptops for ministry staff, and servers and backup servers are required functionality of mHero. The inadequacy of these infrastructures can be addressed by mobilizing resources through engagement of partners.

4) Implementation capacity: Ongoing capacity-building for mHero team members and users through ongoing training and mentorship was provided by IntraHealth. For sustainable capacity building activities and overcome turn-over an organizational development approach could be important.

5) Engaging other external partners: Many donors and implementing organizations were involved in the scale-up of mHero (58, 81, 84, 86).

B. CSTOCK Supply Chains for Community Case Management: Using mobile technology to increase community access to life-saving medicines in Malawi.

The cTock is RapidSMS-based reporting and resupply system solution designed by JSI in collaboration with Malawi's MoH. It is used to produce a report and make logistic data visible for decisions. The timely decision helps to improve the supply chain for increasing the availability of medicines for community health workers (CHWs) to run the integrated Community Case Management (iCCM). The community supply chain management could be successful with the collaborative contribution of cStock, user-friendly dashboard and district product availability teams (DPATs). The cStock system processes the stock data sent by CHWs and automatically calculates resupply quantities and transmits a request via SMS to supervisors at health facilities. The feedback, which could be the readiness of the order or stockout is then communicated to the CHWs. The web-based user-friendly dashboard helps the district and central level managers to provide real-time logistic data for coordination, planning, and decision making. District product availability teams (DPATs) that include district management, health center (HC) staff, and CHWs support the cStock, monitor community supply chain performance, and addresses supply chain challenges by the logistic data provided by the cStock.

Scale-up strategies

The scale-up process of the solution was run over two years (2013-2014) by four primary strategies.

1) Ministry of Health endorsement: Since the community supply chain performance showed improvement with the use of cStock on the pilot, Malawi's MOH endorsed the full package of the cStock system.

2) Continued engagement and coordination with partners: For ownership, sustainability and continued utilization of the cStock, the MOH has been leading the scale-up process. Local partners and external funding partners were coordinated centrally by the MOH to prevent duplication of effort and reach all districts of the country.

3) Creation of task force: A task force led by MOH and composed of key stakeholders was established. The task force monitors the progress of the scale-up, mobilizes resources, contributes to the development of a five-year transition plan and works on capacity building within MOH for full ownership.

4) Development of the National Product Availability Team (NPAT): The NPAT was established by the MOH to manage the system by reviewing data on performance and to provide leadership and support as needed to make sure that all districts can use the system effectively (81).

The cStock solution is embedded within DHIS2 and being used for all commodities managed by nomadic, hard-to-reach, and migratory communities of Kenya (81).

C. A case of AfyaPro

AfyaPro is a smart technology which uses mobile App and call center for remote management of chronic conditions including cardiac conditions, hypertension, and diabetes. It has been integrated to the hospitals HMIS/EMR effectively. The solution has portals for patients, call center operators and health professionals. The solution can be used for risk assessment of complications, eLearning, eConsulting, personal health record, self-management and reminders. This all services are executed without the physical presence of patients at health facilities. On the other hand, AfyaPro supports health facilities full control of administration process and patient records. It also helps to communicate and exchange data with other satellite health facilities. The solution has been scaled-up and in use in Indonesia, Ghana, Kenya, Tanzania and soon in South Africa (87).

D. A case of e-voucher

The e-voucher, vaccination management eHealth solution is being used by around 22 African countries, including Angola, Botswana, Eswatini, Ethiopia, Gabon, Ghana, Ivory Coast, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. The solution is Cloud service system that can be used online and offline. The solution can be used to track the beneficiary's enrolment, identification (face recognition, PIN or other), new vaccine registration, past vaccination records using an Integrated Circuit (IC) card given to the beneficiaries. The solution can also be used to purchase different sanitization items. Moreover, using the solution the health authorities at the MoH can monitor and analyze vaccine transaction records and sales undertaken. The solution can be used by individual clients, health facilities and health managers (including ministry of health). However, since the solution is commercial and uses Cloud services the solution could be expensive for LLMICs (88).

E. A case of mHealth Assessment Platform for Children 2–60 Months of Age

MEDSINC is a web-browser based mobile health (mHealth) platform used by frontline health workers (FLWs) at point-of-care (POC) to assess severity, triage, treatment and follow-up recommendations for children 2 to 60 months. The solution incorporates the WHO's Integrated Management of Childhood Illnesses (IMCI) and Integrated Community Case Management (iCCM) protocols and guidelines as well as additional evidenced-based medicine. The MEDSINC platform significantly increased pediatric health-care capacity with regard to undertaking accurate assessment, triage of children and facilitation of early life-saving therapeutic interventions (89).

Having the above presented use case as an example, African countries could plan for scale-up of relevant eHealth solutions to enhance UHC and also reach the hard-to-reach communities.