

Re-visiting National eHealth Strategies in the IoT and Big Data Era

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Abstract: IoT and big data technologies are redefining a new era of information and communication technology (ICT) applications and innovations in multiple industries including in healthcare. To provide a policy framework that anchors the introduction and integration of health information technologies, a majority of World Health Organisation (WHO) member countries – both advanced and emerging economies – have developed national eHealth strategies over the last decade. However, it is not clear whether these policy frameworks take cognisance of a changing technology landscape set to be dominated by IoT, big data and other fourth industrial revolution technologies. This research examines the scope of key policy issues and the concept of eHealth as interpreted in national eHealth strategies of five countries in sub-Saharan Africa. To harness the potential of IoT and big data analytics in healthcare, the results demonstrate the need to re-examine the applications that define how eHealth is understood as well as a review of the strategic priorities in national eHealth strategies.

Keywords: Internet of Things (IoT), big data, big data analytics, national eHealth strategy, eHealth policy.

1. Introduction

The Internet of Things (IoT) has emerged as the paragon of recent advances in ICT. It is dissimilar from other forms of ICT in the sense that it is not a distinct technology such as software, hardware, telecommunications, mobile computing or the Internet; rather, it is a confluence of multiple technologies and trends. It can be best described as a paradigm or platform that has evolved over time from traditional ICTs and underpinned by developments in radio frequency identification, wireless sensor networks, nanotechnology and Internet technologies [1]. As a basic concept, IoT involves the capability to monitor and control objects – or “things” – via communication networks, typically the Internet. These “things” are uniquely addressable and can interact with each other using the Internet to achieve a goal, and hence the notion of the “internet of things” [2].

There is no agreed definition of IoT. The Internet Society describes it as a scenario where “network connectivity and computing capability extends to objects, sensors, and everyday items not normally considered computers, allowing these devices to generate, exchange, and consume data with minimal human intervention” [3]. Rayes and Salam [4] define the concept as the “network of things, with clear element identification, embedded software intelligence, sensors and ubiquitous connectivity to the Internet”. The later definition highlights four main elements an IoT ecosystem: sensors that capture data, identifiers or addresses (typically IPv4 or IPv6) for communication, software for data

analysis, and Internet technologies for connectivity (mostly wireless techniques such as WiFi and Bluetooth).

The IoT era will be characterised by a proliferation of interconnected devices. It is estimated that by the year 2020 there will be as many as 26 billion IoT devices [4]. The greater numbers of IoT-enabled devices, in turn, is anticipated to contribute to the generation of massive amounts of data, dubbed “big data.” Big data refers to data not capable of being processed by traditional ICT techniques because of its high volume, high velocity, and high variety nature. Big data analytics refers to new techniques that will be used to analyse and generate insights or business intelligence from this type of data [5].

There are varied applications of IoT in sectors such as manufacturing, agriculture, retail, cities, healthcare, and other domains. The application of IoT and big data in healthcare is anticipated to realise new opportunities to improve access and quality of health services while at the same time managing costs. For instance, sensors on medical equipment can be used to remotely monitor patients and make the information available in real time to health workers. This approach can be more cost effective since a higher number of patients can be attended to by a smaller pool of health workers while freeing up hospital capacity to more critically ill patients. Big data analytics will enable better prediction and analysis, based on data from multiple sources, including IoT devices, and thus improve decision making and contribute to an increase in overall quality of healthcare [6].

The use of ICT in healthcare in countries has traditionally been driven by a national strategy or policy. As the ICT landscape evolves, the role of national eHealth strategies becomes even more critical in order to facilitate a well-structured and coordinated approach to the application of cutting-edge health IT technologies. However, in a dynamic technology dispensation set to be dominated by fourth industrial technologies such as IoT and big data, there is a dearth of research that examines the suitability and relevance of current national eHealth policies, especially in the developing nations of Africa.

2. Objectives

National eHealth strategies or policies are the bedrock of eHealth initiatives in a country. By 2016, nearly two-thirds of WHO member states had a national eHealth strategy. A strategy is originally associated with soldiers, denoting the planning, directing, and executing linked to military operations and movements in a war. Later, the term became popular in the business world, referring to approaches, plans, and actions used by an organisation to gain or maintain a competitive advantage in its sector. In healthcare, national eHealth strategies govern and direct the application of health IT, setting out the overall vision, identifying the key priorities, mapping out an action plan, and defining a monitoring and evaluation framework [7].

eHealth is defined as “the use of information and communication technology in health” [8]. It has become an integral component of modern health systems, facilitating timely access to quality health information, enabling shared utilization of human personnel and medical equipment, and overall contributing to better quality of care as well as managing costs. The implementation of health IT typically involves the deployment of ICT tools and infrastructure in health facilities such as software and mobile applications, local and wide area networks, Internet and web technologies and so on. eHealth strategies, on the other hand, form the bridge between health goals and the harnessing of technology to meet a country’s identified health priorities.

The history and growth of eHealth technologies has been defined by the evolution of the ICT industry. The latest advancements in ICT - notably the emergence of fourth industrial revolution technologies such as IoT, big data, machine learning and artificial intelligence – are, therefore, anticipated to give rise to a new phase of innovative health solutions. But to effectively leverage technology for healthcare, a lot will depend on how stakeholders –

policy makers, health professionals and health IT practitioners – identify the emergent opportunities and how effective the implementation of eHealth strategies or action plans will be. So far, however, there is limited insight as to whether current national eHealth strategies in sub-Saharan Africa and other regions have evolved to reflect the realities of the fourth industrial revolution era. This study, therefore, examines the national eHealth strategies of five African countries, exploring how eHealth is characterized, identifying the key strategic priorities addressed, and evaluating the implications thereof in the IoT and big data era.

3. Methodology

The research approach was guided by a literature review and a thematic analysis of secondary data. The search of academic databases and of websites of government/state agencies was carried out between September 2018 and October 2018. To define a national eHealth strategy, we relied on the WHA 58.28 resolution of 2005 that recommended WHO member states to draw up a “long-term strategic plan for developing and implementing eHealth strategies in various areas of the health sector” [9]. National strategies were included if they were affiliated with a country in sub-Saharan Africa, available in the English language, and publicly accessible. Based on these criteria national health IT strategy documents from the following countries were selected and reviewed:

- Kenya
- Tanzania
- Uganda
- Ghana
- South Africa

Further, these countries were selected because they were among the pioneering African states to introduce eHealth strategies nearly a decade ago, and relative to the region, have fairly well established and ongoing eHealth programmes. Also, with the exception of Uganda, the other four eHealth policies are due for comprehensive review. This work is part of a broader study seeking to contribute towards more progressive national eHealth policies of African countries that promote the use of IoT and big data technologies in healthcare. No primary data was collected and analysed at this stage.

4. Results

The concept of eHealth is clearly defined in the strategy documents and denotes the use of information and communication technologies – software applications, telecommunications infrastructure, computers, mobile phones, and Internet and web technologies – to deliver or access healthcare services and information. This depiction was found consistent with the broad and succinct definition of eHealth as the use of ICT in health by the WHO [8]. In terms of specific eHealth applications, four areas were predominant: electronic health records, mobile health or mHealth, telehealth or telemedicine and eLearning in health. Nevertheless, none of the documents makes reference to IoT or big data-supported applications or health services.

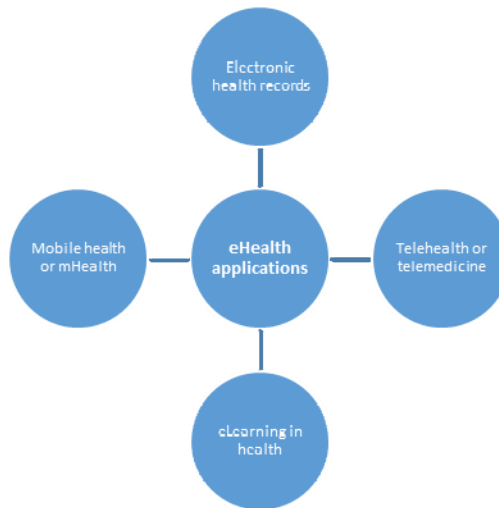


Figure 1: Key eHealth Applications in National eHealth Strategies

The national eHealth strategies are structured around the overall health goals and their main components include: background/introduction (overview of the policy, and its history), situational analysis (context of a country’s health system), strategic model (vision and mission, principles, key objectives and strategic priorities), implementation matrix, and a monitoring and evaluation framework. The eHealth strategic model is a triad of three pillars:

- Strategic priorities – key focus areas for eHealth interventions
- Actions plan – steps to take to exploit eHealth benefits to improve health outcomes
- Foundational components – what to put in place (people, processes, and technology)



Figure 2: The eHealth Strategic Model of National eHealth Strategies

A summary of vision, mission, key objectives and period of the 5 national eHealth strategies are presented in Table 1.

Table 1: Summary of Key Aims of the National eHealth Strategies

Country/Key component	Vision	Mission	Key objectives	Period
Kenya[10]	Develop efficient, accessible, equitable... health care services supported by ICT	Promote and deliver efficient healthcare services	<ul style="list-style-type: none"> • Support informed policy, investment and research decisions • Improve the quality, safety, and efficiency of clinical services • Enable the Kenyan health sector to effectively operate as an interconnected system • Create linkages between health research and information technologies 	2011 – 2017
Uganda[11]	Effective use of ICT for better health outcomes of the Ugandan	Transform the health of the people of Uganda by promoting	<ul style="list-style-type: none"> • Harness eHealth to facilitate the transformation of the Uganda health system • Make patient care safer and more effective • Ensure equitable access to quality health services for all 	2017 - 2021

	population	effective utilization of information and communication technology	<ul style="list-style-type: none"> • Contribute to ‘health literacy’ for all citizens • Safeguard data security of patient information • Efficient use of healthcare resources • Promote eHealth research and development 	
Tanzania [12]	To enable high quality, efficient, and sustainable health system for all citizens	Transform Tanzania health system by leveraging ICT to improve health	<ul style="list-style-type: none"> • Enable efficient use of healthcare resources • Enable health sector to operate more effectively • Make patient care safe • Support communication and information sharing 	2012 - 2018
Ghana [13]	Delivery of quality, affordable and modern health services in an equitable manner	Harness the potential of ICT to improve the health status of people living in Ghana	<ul style="list-style-type: none"> • Improve access to information in support of safe, efficient and effective health care delivery • Provide access to information to enable individuals to make informed health choices • Improve reporting of data, health activities, and health outcome information • Provide standards on interoperability and data security • Establish effective eHealth governance structures 	2010 – 2015
South Africa [14]	Enable a long and healthy life for all South Africans	Establish eHealth as an integral part of the transformation and improvement of healthcare services in South Africa	<ul style="list-style-type: none"> • Support the medium-term priorities of the public health sector • Pave the way for future public health sector eHealth requirements • Lay the requisite foundations for the future integration and coordination of all eHealth initiatives in the country 	2012 – 2017

After a review and analysis of the national policy documents, policy issues were identified and summarised under 7 key strategic priorities. These were:

(a) Leadership, governance and regulation

A participatory approach, involving state and non-state actors, was adopted in the formulation of the national eHealth strategies. With multiple stakeholders across different domains, eHealth implementation is complex and its success is invariably fraught with numerous challenges. Strong leadership - political, executive and clinical – is, therefore, required to drive change. Proper regulation of the sector and governance of the eHealth function also form important considerations towards the realization of policy objectives.

(b) Stakeholder engagement and funding

Introduction of eHealth applications such as teleradiography and mHealth not only involves and impacts multiple groups but it also requires proper funding to ensure success and sustainability of the projects. Hence, collaboration and investment are important elements to the growth and long-term progress of eHealth initiatives. Overall, the effective engagement of stakeholders is essential because it helps to “mobile support, identify opportunities, highlight priorities, manage and mitigate risk” [14].

(c) Standards and interoperability

Standards introduce common rules and procedures that optimize the degree of order within a setting. A notable challenge to eHealth adoption has been the lack of standards and guidelines specific to the setting or environment of use. Interoperability, in contrast, denotes the capability of health information systems to communicate and exchange data accurately and reliably with other information systems. For example, a standards and interoperability issue common to the 5 countries are electronic health records systems using

different data format, complicating data sharing and collaboration among healthcare providers. Policy guidelines are introduced to promote consistency and integrity of data across various systems through various measures such as the development of a unique national patient ID. Other actions include guidelines on software and hardware acquisition, clinical coding and security of electronic data.

(d) eHealth foundations

eHealth maturity is progressive and thus the introduction of advanced forms eHealth applications is often hinged on the successful rollout of more basic technologies. The national eHealth strategies acknowledge this approach and address fundamental eHealth programmes such as ongoing improvement of network infrastructure and connectivity, registration of health facilities and providers, and the continued rollout of basic national electronic health records.

(e) Capacity building and training

The eHealth workforce comprises both health and ICT professionals. Do these professionals have the skills and competencies to design, develop and implement eHealth applications? Does a country have a critical mass who can leverage ICT for clinical work and other health programmes? These constitute some of the pertinent questions on workforce capacity and training addressed by the eHealth policy documents. For example, the South African strategy seeks to establish a standardised eHealth competency framework for health workers and health IT practitioners, with a focus on requisite skills, knowledge and training for each professional category.

(f) Technology tools and applications

The adoption and diffusion of health IT is anchored by the introduction of various technology tools and applications. Applications mentioned in the strategies include electronic health records, mHealth, telemedicine, appointment scheduling systems, clinical pharmacy systems and decision support systems. Tools refer to software and hardware devices as well as connectivity infrastructures such as those used in mHealth and teleradiography.

(g) Monitoring and evaluation

The average implementation period for the national eHealth strategies is 6 years. During this period, it is imperative to monitor and evaluate the performance of the eHealth action plan. Periodic reviews, typically within 2 to 3 years, are advocated and are a standard best practice with regard to national eHealth policies. The goal of monitoring and evaluation is to check whether the objectives are being realised as well as to provide input for future planning. Except for the case of Uganda, the other four national strategies are due for complete review since their time period has elapsed.

5. Discussion

National health IT policies can be catalysts or enablers to practical implementation of technology in healthcare. Typically, an effective strategy is one that is linked to the larger vision of a country's health system. With respect to the reviewed policy documents, their origins, design and development processes were seen to be largely anchored and guided by the respective country's health needs and priorities. This approach is proper and consistent with health policy best practice in other regions [15].

Broadly, the characterization of eHealth in the national eHealth strategies explored by the study was found to be delineated by traditional ICT technologies such as computers, mobile phone, Web and Internet technologies, so possibly explaining the prevalence

applications such as electronic health records and mHealth in the five countries. None of the policies, however, made reference to IoT or big data applications. Scott and Mars [16] posit that eHealth can be “anything” about technology that you want it to be. Whilst arguable that the statement is largely true, the danger therein is that the “anything” about technology can be a fading or outdated notion about technology. IoT and big data are not just new technologies; they represent a new paradigm that will potentially revolutionise integration and automation in health systems. Considering the pivotal role of policy in guiding technology introduction, how the notion of eHealth is theorised or interpreted in national eHealth strategies becomes of significance. Therefore in addition to electronic health records, mobile health, telehealth, and eLearning for health, eHealth in the modern era ought to also include a broader scope of digital technologies such as health big data analytics and IoT-enabled smart devices [17].

Altogether, the focus areas or strategic implementation areas of the national strategies discussed tended to overlook the recent and impending shifts in the ICT landscape, notably on IoT and big data. This corresponds to findings of recent studies that assert that IoT-enabled healthcare services have by and large not been addressed by existing eHealth policies [18], [19]. Possible amendments to policy issues that have implications on IoT and big data technologies are as follows:

- Leadership, governance and regulation – The use of big data analytics in healthcare raises unique concerns on privacy, confidentiality and general security of electronic data and health services not common to other industries such as retail or manufacturing [18]. Health IT practitioners and other stakeholders should ensure that legislative and regulatory instruments address the specific security concerns of the industry. Moreover, the said laws should also cover new forms of wireless transmission and storage used by smart medical devices and other IoT-enabled medical gadgets.
- Stakeholder engagement and funding – Health stakeholders comprise state and non-state actors as well as international partners. The contribution and interactions among these players are influential in the introduction of health IT technologies. Stakeholders should be engaged to identify unique opportunities and priorities that exist in the use of IoT and big data analytics in the context of their countries. The nature of such forums would also identify potential challenges, risks, and formulate measures through which such issues could be mitigated.
- Standards and interoperability – A number of wireless standards have emerged for IoT devices [4]. National health IT strategies should adopt common standards for IoT-enabled medical gadgets and equipment to guarantee interoperability as well as accurate capture and transfer of data.
- eHealth foundations – Health information systems are foundational to the implementation of big data analytics since such applications rely on digital data. Further, smart devices and sensors in healthcare depend on existing broadband and last mile connectivity infrastructure. As a consequence, the progress on investment in infrastructure and pioneering eHealth applications such as electronic health records will have a bearing on the likelihood of success in the uptake of IoT-based health services.
- Capacity building and training – Capacity building programmes ensure that a country has a critical mass who can leverage technologies for clinical work. Strategies must be keen on initiatives that incorporate training on how to harness IoT/big data in the healthcare sector.

6. Conclusions

This study argued that, in the emergent IoT/big data era, national eHealth strategies of five African countries surveyed need reform on two fronts; first, in expanding the scope of

digital technologies that define the interpretation of eHealth and secondly, in re-evaluating the focus of key policy priorities. We proposed that an eHealth characterization that goes beyond pioneering eHealth applications such as electronic health records and mHealth to include concepts such as health big data analytics, IoT-based digital implants, medical smart devices, is a better approach. Lastly, recommendations were made on how key policy issues – such as governance and regulation, stakeholder engagement, standard and interoperability, eHealth foundations, and capacity building - could be realigned to take into consideration developments in the IoT and big data domains.

In closing, IoT and big data technologies will offer new and possibly more effective opportunities to tackle the most pressing issues facing modern health systems in Africa and other developing regions. To this end, well-defined health IT strategies at the national level will be critical. In a dispensation to be largely defined by fourth industrial revolution technologies, such as IoT and big data analytics, a befitting strategy would be one that embraces a reformist vision about eHealth and refocuses the strategic priorities to acknowledge the evolving technology settings.

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