ABSTRACT

Healthcare system interoperability remains a major challenge for most upcoming economies. In Botswana, just like most developing countries, the health information landscape is marred by discrete islands of information posing significant barriers to the effective sharing of information between healthcare participants. This becomes even more challenging when trying to understand and accurately report on what is really happening, to support population health surveillance, and to guide policy, service planning, innovation, and clinical and operational decision-making. There is a clear need to move away from the reliance on manual data collection to an environment where healthcare stakeholders can reliably and securely access and share health information in real time across geographic and health sector boundaries. Information and Communication Technologies (ICTs) for health (i.e. eHealth) have the ability to dramatically increase access to, and availability of life-enriching information and services. The Government of Botswana fully understands and appreciates the developmental importance of ICTs. Accordingly, the Botswana Ministry of Health is leveraging ICTs to attain a single health record for every Botswanan which will enable the planning, management, and delivery of timely health services. Botswana has been experiencing an influx of well-intentioned health information system implementations in various health facilities which duplicated functionalities and were not interoperable, leading to fragmentation and potential misinformation. This has led to health systems interoperability being a major component of Botswana’s eHealth strategy. This paper therefore seeks to outline global and local endeavours towards the attainment of interoperable eHealth solutions and suggest a possible eHealth interoperability framework direction for developing economies such as in Botswana.

KEY WORDS

Interoperability, Botswana, eHealth, mobile telemedicine, electronic health record

1. Introduction

Modern healthcare promotes teamwork and communication through the use of health information technology (HIT) tools and services. HITs that facilitate a secure, efficient and effective sharing and use of health information when and where needed is an important contributor to improving health outcomes, quality of care and lowering of healthcare costs [1]. In order to achieve this, there is need to expand focus beyond institutional care delivery and health care providers, to a broad view of person-centric health [1]. This paper discusses the eHealth interoperability landscape in Botswana in relation to global trends towards attaining interoperable eHealth solutions.

2. Literature Review

Literature has revealed that attaining interoperable HITs continues to be a challenge especially for developing economies [2]. The challenges specific to low and middle income countries include problems that are a manifestation of the economic and geopolitical constraints: transportation and geographical barriers; limited clinical workforce; infrastructural challenges for health delivery; poor monitoring and evaluation systems, and inadequate support for health professionals among
patients’ access to much needed specialist care services. Specialist medical doctors, thereby posing a barrier to trucks. Healthcare in Botswana is characterised by few or health facility enclosed in a moving vehicle, mostly.“

In addition, the HIT landscape is characterised by non-interoperable health information systems. This situation becomes of paramount importance to developing countries which bear a disproportionate global burden of disease, yet have the least ability to afford opportunity costs such as electronic records, and money to spend on exploration and continued development of unsuccessful initiatives. Literature further suggests that in order to attain interoperable healthcare systems, first there is need for a framework to guide the alignment of all eHealth solutions with the main EMR system.

2.1. Botswana’s eHealth Landscape

The Botswana government spends considerable revenue on healthcare provision constituting 15% of GDP, despite the outcomes not being commensurate with the level of spending. As a result, the Botswana MoH is looking at eHealth as a sustainable way to deliver cost savings, better patient outcomes, and greater accessibility to healthcare for all. Healthcare in Botswana is delivered through a decentralised mode with primary healthcare being the pillar of the delivery system. Botswana has an extensive network of health facilities which are clustered in 27 health districts. Healthcare facilities in Botswana comprise of 3 national referral hospitals, 15 district hospitals, 17 primary hospitals, 290 clinics, 349 health posts, and 900 mobile stops. A mobile stop is a clinic or health facility enclosed in a moving vehicle, mostly trucks. Healthcare in Botswana is characterised by few specialist medical doctors, thereby posing a barrier to patients’ access to much needed specialist care services. In addition, the HIT landscape is characterised by non-integrated health systems, and low bandwidth connectivity as a result of the traditional landline IT infrastructure.

Through its Ministry of Health (MoH), the Government of Botswana recognises the importance of investing in interoperable health information systems. The move is motivated by an influx of disjointed eHealth solutions for every emerging health challenge. Furthermore, the high penetration rate of mobile technology in Botswana has also led to an increase in mobile telemedicine solutions piloted over the recent past, leading to the adoption and scale-up of a national mobile telemedicine solution known as Kgonafalo. Pilot studies for Kgonafalo were conducted over a period of 4 years and utilised mobile devices such as smartphones to administer remote healthcare to patients living in rural communities across Botswana. The study’s findings were crucial in its adoption and national scale-up processes. In addition to the Kgonafalo mobile telemedicine solution, numerous other mobile telemedicine solutions have been piloted and proved to have the capability to improve health outcomes in their respective medical specialties. Despite the unquestionable benefits of mobile and non-mobile telemedicine solutions piloted in Botswana over the years, they still remain non-interoperable with the national electronic health record (NEHR), also known as the Integrated Patient Management System (IPMS).

Botswana’s public health system consists of two (2) major patient level electronic medical records suites, the IPMS and the patient information management system (PIMS). The IPMS, is one of the many systems that uses the government data network (GDN) backbone and is currently implemented at 43 health facilities (25 Hospitals and 18 clinics). The IPMS is considered the gold standard of all electronic medical records (EMRs) in Botswana. Its growing control of the North American hospital information system market speaks to how cutting edge and feature rich the IPMS system is. The MoH intends to have rolled out IPMS to the remaining hospitals and clinics with maternity services by the end of the year 2016. IPMS covers 85% of Botswana’s EMR market share, while the remainder of the EMR sector is split among several small scale applications for running clinic facilities.

3. Definition of Interoperability

The Institute of Electrical and Electronics Engineers (IEEE) defines interoperability as “the ability of two or more systems to exchange information and to use the information that has been exchanged” [8]. Technically, interoperability deals with connecting systems and services through interfaces and protocols, using appropriate software engineering techniques and methodologies. Interoperability involves many other aspects that have to be considered such as legislation, agreements between exchanging parties, governance, shared workflows, standardised data elements, semantic and syntactic choices, applications, technical infrastructure, safety, and privacy issues. It is when all these aspects are addressed and all stakeholders are engaged and in agreement that interoperability implementation could be successful.
An eHealth Interoperability Framework (IF) therefore refers to a set of standards, protocols, procedures, and policies developed to help different stakeholders improve the interoperability of the eHealth solutions that they design, implement, use and evaluate.

### 3.1 Benefits of Interoperable eHealth Solutions

The core value proposition for clinicians remains - access to content with minimal disruption in workflow. Clinical interoperability is perceived as an essential prerequisite for high quality healthcare. [9] According to the European Union (EU) perspectives on interoperability, the benefits of interoperable eHealth solutions are numerous [10]. For example, an image from a hospital can be exchanged and used by various professionals and structures without the need to repeat tests; interoperable eHealth solutions constitute a single digital market for healthcare, opening up competition and reducing costs for developers. In this sense, cooperation is vital: “a thorough and wide collaboration allows sharing costs and reduces future reinvestments to upgrade systems.” [10] In order to benefit from interoperable eHealth solutions, there is need for a framework to guide all interoperability efforts of such systems. An interoperability framework would benefit not only the Ministries of Health but could also serve as a motivation to system developers in knowing that their software solutions are aligned with the required national standards. This could lead to the rapid creation of larger but interoperable healthcare systems with improved quality of healthcare data and reports to guide policy and clinical processes.

### 3.2 Global eHealth Interoperability Landscape

Although it remains a universal goal, there is little consensus on how to attain interoperable eHealth solutions. Some developed countries have made progress towards attaining interoperable healthcare systems. The European Union (EU) published the 2012-2020 action plan in which they seek to develop common standards to enhance interoperable healthcare systems among member states [10]. The EU is in support of many other projects aimed to achieving eHealth interoperability across member states. One such project is the "epSOS", short for European patient Smart Open Services. The epSOS project avails a digital patient summary including the patient’s medical status to assist in providing broader care necessary in an emergency situation. epSOS has several modules including the ePrescription module for digital drug prescriptions enabling patients to pick medications in a participating pharmacy internationally [10]. The Australian government’s experience has shown that inadequate ability to interoperate across human-to-human, human-to-system, and system-to-system dimensions could cause significant costs to society, financial and human related [11]. Australia's national eHealth strategy recommends the implementation of a world class eHealth capability in Australia to support an environment where consumers, care providers, and healthcare managers can reliably and securely access and share health information in real time across geographic and health sector boundaries [11]. The strategy also influenced the development of an eHealth interoperability framework for Australia. Prior to developing and adopting the eHealth interoperability framework, the Australian government adhered to some guiding principles to facilitate consistency of the national eHealth architecture approaches and also to support building and operating of consistent and interoperable eHealth systems.

The Australian eHealth interoperability framework utilises a set of eHealth concepts, structured according to five architecture viewpoints and three design abstractions as influenced by Health Level 7 (HL7) Service-Aware Interoperability Framework (SAIF) [11]. The framework structure is represented as a partially completed matrix with cells of the matrix being populated with specification artefacts representing different stakeholder concerns. The five viewpoints reflect the concerns of the different stakeholder groups involved in the architecture development process, beginning with strategic planners and clinical / subject matter expert roles (enterprise viewpoint), via information / solution / system architects and developers (information / computational / engineering viewpoints) to testes and system integrators (technology viewpoint). The three rows (design abstractions) provide an additional level of refinement. These refinements are views of the system from different sub-groups of stakeholders and are expressed in terms of conceptual, logical and implementable perspectives or design abstractions. The information viewpoint represents different interests of stakeholders on the information used and exchanged. The group of stakeholders can be subdivided into three:

- Those interested in the conceptual view of information, such as clinicians and other subject matter experts, with their preferred ways of representing information, such as conceptual maps.
- Those interested in the logical view of information, in terms of information models and terminology binding, such as clinical information modellers, clinical terminologists and information architects who use more formal representation approaches such as UML
Those interested in the implementable perspective, such as developers who use a specific set of data types and terminologies to develop implementable solutions.

In the US, a report on Health IT and Patient Safety mentions interoperability as a key factor contributing to patient safety along with usability and clinical workflows [12]. The US government through its Department of Health and Human Services (DHHS) embarked on a ten-year vision to advance the connectivity of electronic health information and interoperability of health information technology which is consistent with its mission to protect the health of all Americans and provide essential human services [12]. This work has become particularly urgent with the need to address the national priority of better and more affordable health care, leading to better population health.

The South African (SA) eHealth landscape is somewhat similar to Botswana, comprising of fragmented healthcare information systems which are inoperable [13]. Similarly, the SA MoH acknowledges the lack of interoperability between heterogeneous systems as a key obstacle to realising the potential benefits of eHealth. Contrary to Botswana, the SA government has developed the Health Normative Standards Framework (HNSF) which focuses specifically on semantic, syntactic and organisational interoperability. The HNSF was developed with reference to the World Health Organisation (WHO/ITU) National eHealth Strategy Toolkit. In developing the HNSF, considerations were made of the complexity of eHealth standards. Hence a set of typical healthcare functions/use cases were utilised as guidance to determine standards that could be applicable to the current South African healthcare context. The results were standards that could work together in a cohesive interoperable stack, something which mitigated the implementation risks associated with the incompatibility of eHealth base standards [13].

4. E-Health Interoperability for Botswana

In 2009, the Botswana government embarked on a systems rationalisation exercise through the MoH. The exercise was aimed at reducing the number of isolated eHealth systems from the initial 37 to the current 12 health information systems. The review process resulted in core and non-core health system categories each having its own sub systems. Core systems comprised of healthcare systems largely contributing to the attainment of the MoH’s strategic objectives. These included systems which are very costly to implement and to rollout nationally. Examples of core systems include the IPMS, PIMS, and District Health Information Systems (DHIS).

These systems were further categorised into those handling patient level data (IPMS) and aggregate level data (e.g., DHIS). Non-core health systems were those mainly developed for a specific need of a Programme or Unit within the MoH. In most cases, non-core systems are customised open source tools, e.g. Open Medical Record System (OpenMRS) customised for the Tuberculosis (TB) Programme. Non-core systems also consist of systems handling patient level data and aggregate level data.

The main EMR system in Botswana (IPMS) has the capability of interfacing with several other health systems. Currently the IPMS supports and extracts patient records from many other EMR systems including PIMS and OpenMRS. Further extension of the IPMS includes interoperability between systems within and outside of the public health system, a move that will see this become a fully functional national EHR and ensure continuity of care. The Botswana MoH further seeks to create a patient portal on IPMS to allow for patients to access their results, providers, and useful information. Besides the IPMS benefiting the healthcare provider and the patient, managers will also have access to readily available statistical information to make informed decisions on staffing, infrastructural, and inventory needs.

The Botswana government has eHealth as one of the pillars of its national ICT policy (Maitlamo) developed in 2007. The MoH in Botswana has further made commendable efforts by connecting all the main health facilities on the GDN, a move that could make health systems integration achievable. Despite all the notable efforts, eHealth interoperability still remains a challenge.

5. Discussion and Recommendations

Literature suggests different ways to attaining interoperable eHealth solutions. The Australian eHealth interoperability report suggests that a number of general ICT management principles are applicable when considering eHealth interoperability [11]. These include: improving the safety and quality of healthcare; improving the efficiency of healthcare services; compliance with legal, ethical and organisational requirements; maintaining security; ensuring all change is managed; ensuring solutions are fit for purpose; re-using eHealth components; assessing whole-of-life costs; ensuring information quality; ensuring solutions are scalable, maintainable, available, and recoverable [11].
Standards have been identified as key to supporting any type of interoperability work. Without standards there is no interoperability. A standard is defined as an agreed-upon way of doing something that ensures consistency [14]. The benefit of developing IT systems based on agreed standards include alignment, integration, flexibility, reusability, portability and reduced time to market. For eHealth, standards set a baseline for healthcare system development. The introduction of standards, however, often requires a culture change in designing and using the resulting system [14]. The latter should be addressed via change management interventions and is beyond the scope of this paper. However, the existence of standards alone does not create interoperability since standards need to be adopted by all the relevant stakeholders. Hence the benefits of a system that adheres to standards only emerge if there are other systems compatible with the same standard. The adoption of standards also requires a push on the side of the government [14].

The Botswana MoH supports the adoption of relevant eHealth standards. This is embedded in Botswana’s eHealth strategy document. Beyond the adoption of eHealth standards, there is need for low resource settings such as Botswana to develop and adopt a comprehensive eHealth Interoperability Framework (eIF) relevant for the healthcare setting. The developmental process of Botswana’s eIF should build upon already existing interoperability frameworks supporting eHealth. The European eHealth Interoperability Framework (EIF) and the Australian eHealth Interoperability Framework are some benchmarks to consider [11, 15]. These eHealth frameworks serve as operational toolkits for implementers to deploy eHealth systems and also as a reference guide for any eHealth Request for Proposal (RFQ) issued during tendering processes [11, 15]. Common aspects addressed include legal and regulatory issues, policy and resolution of policy conflicts, sharable workflows, defining and coding of information needed to deliver integrated care, observance of eHealth standards, application integration, technical infrastructure, and safety and privacy issues [11, 15]. The above mentioned interoperability concepts apply for low resource settings and could inform, and be the starting point towards, the development of the eHealth interoperability framework for Botswana. Some considerations require examination to customise some of the above concepts for Botswana’s eHealth landscape. For example, it is important to appreciate that Botswana, like many other low resource settings, has a shortage of specialised medical personnel coupled with unreliable IT infrastructure. These factors call for innovative ways to deliver remote care utilising existing platforms such as mobile telecommunication technologies. Botswana has a high penetration rate of mobile technologies coupled with recent advances in mobile telecommunications service provision. An example is the recently introduced fourth generation (4G) connectivity. The scale up of a mobile telemedicine solution in Botswana was partially motivated by these technological advances. The same initiative could be replicated to other low resource settings. As a recommendation, eHealth interoperability frameworks for low resource settings should rigorously address, as a separate aspect, mobile telecommunication tools and services in relation to data capture, handling, import-export, security, and privacy issues, and how they could be utilised to feed into existing EHRs to advise policy and strategic decision making.

6. Conclusion

The need for interoperable eHealth solutions in Botswana cannot be over-emphasised. However, interoperability is not a closed concept for which a line can be drawn. Instead, interoperability is a means to achieving a goal which, in the case of Botswana, is to enable national access to a patient health record. Despite efforts made by the MoH towards attaining interoperability in eHealth, there is still much to be done. The national eHealth strategy is needed to explicitly state the need to have a national framework to guide successful interoperability of all eHealth solutions. An eHealth strategy alone, without guiding policies on how to execute the strategy, will not be sufficient as the strategy will become ineffective. Some developed world countries have designed and implemented eHealth interoperability frameworks suited to their environments. An example is the Australian eHealth interoperability framework. No eHealth interoperability framework has been developed for low resource settings such as Botswana. Lessons could be learnt from developed economies and a framework developed for low resource settings.

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