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Adoption of Health Information Systems in integrated Primary Healthcare in Developing Countries

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Background and Purpose: Several healthcare organizations in developing countries have implemented health information systems (HIS) due to their remarkable information processing power that has lately transformed the way Healthcare practitioners manage health information. However, even with several health information systems in use, Healthcare practitioners still lack processed patient information to enhance primary healthcare (PHC). To advance understanding of the current role played by health information systems in integrated primary healthcare in developing countries, this paper analyses the current HIS in developing countries and their ability to support integrated primary healthcare.
Methods: The paper relies upon related literature of HIS implementations and primary healthcare.
Results: Derived insight is that prominently used health information systems are health management systems that support healthcare secondary roles more than primary healthcare roles.
Conclusions: The paper concludes by suggesting proactive implementation of comprehensive and interoperable health information systems that support both primary and secondary healthcare roles.

Keywords: Health information systems, Primary healthcare

1 Introduction

Healthcare organizations are increasingly adopting healthcare information technologies due to their potential in promoting quality healthcare [1-5]. In order to promote quality healthcare and make informed health care decisions access to accurate and timely health information is important. Incidentally health information systems have shown great information processing power by transforming the way healthcare organizations manage health information [6, 7]. Consequently, health information system implementation has become the subject of continuing interest among the medical community, health leaders and developing countries.

In addition, a number of authors including [8-10] have highlighted Information Communication Technologies role in improving the healthcare system particularly in developing countries. In recent years, developing countries have implemented various HIS at various administrative levels for monitoring public health through known health indicators [11]. A number of them are health management information systems with limited evidence of patient care information systems [12]. Though there is limited evidence of patient care HIS in developing countries [13] they still offer great possibilities of patient care continuity through implementation of electronic health records systems. The case of HIV/AIDS patient records systems in most developing countries, clearly illustrates this [12, 14, 15].

Existing health information systems' research suggests that healthcare systems ought to promote continuous flow of data to aid better decisions [16] and be interconnected in order to achieve quality integrated primary healthcare (PHC) [2, 16]. Given the importance of primary healthcare (PHC) World Health Organization (WHO) calls upon its member-states to strengthen their healthcare systems through primary healthcare principles [17], in order to meet the primary role of healthcare organizations. According

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to [18] the primary role of a healthcare unit is to offer PHC with the support of other secondary roles. Primary care roles are the ones concerned with patient care activities while secondary care roles are the management and support activities to PHC [18]. There are several interpretations of PHC but this study will follow Kringos and Starfield [17, 19] interpretation of PHC about the primary care process as consisting of access, continuity, integration and comprehensiveness of care. To achieve such comprehensive integrated primary healthcare available HIS ought to be integrated and interoperable in order to coordinate both primary and secondary care roles [18] across the continuum of care.

With great PHC expectations from HIS and its increased adoption in developing countries it is very important to analyse current HIS initiatives [20, 21] and their role in PHC. Analysing HIS implementations particularly in developing countries is vital because, as noted by [22] improved public health improves people's living conditions. It's against this background, that this paper addresses the following research question: To what extent do the current health information system enhance primary healthcare? By analysing the current state of health information systems (HIS) in developing countries and their ability to support integrated primary healthcare for improved public health. Such analysis is important as the present HIS are categorised as standalone and non-interoperable systems since they do not easily exchange information [23, 24]. In the healthcare setting patients are able to visit any healthcare unit of choice, and therefore their patient medical history is dispersed across different healthcare units [16] which makes it difficult to trace and share patient medical records within and between healthcare units [9, 23].

This lack of coordination among healthcare partners delays decision making at the point of care due to missing information [15], and further impedes patient care continuity. Expediently, Information Communication and technologies are renowned for their potential in scaling up healthcare initiatives [25, 26]. They have for example restructured the way healthcare organizations manage patients and hospital information [6, 7]. Nevertheless even with health information system implementations, tracing and sharing a patient medical record is still hard. So in light of this, this paper analyses the predominantly used health information systems for primary healthcare delivery in developing countries.

The remainder of the paper is structured as follows: section two presents a brief description of the study approach, followed by a discussion of the literature review in section three. The presentation, analysis and discussion of the results are discussed in sections four and five. The final section outlines the paper's main conclusion and recommendations for future research.

2 Study Approach

The study relies mainly on a literature review to analyse the role of information systems in integrated primary healthcare in developing countries. The steps of the review were: definition of key search terms, search for studies, establish inclusion and exclusion criteria to guide selection of papers, screening of papers and analysis. The following key words guided the search for primary studies: "Health Information Systems", "Health Information Systems in Developing Countries", and "Primary Healthcare".

The major digital databases and journals that were used were: Springer, IEEE Xplore, and ACM Digital Library, and MIS Quarterly and IJMI. Searches on Google scholar were also used to identify references matching the selected search terms. The primary search was based on keyword searches then the secondary search was based on relevant citations and references from the primary search and other identified keywords like "District Health Information Systems" and "information systems interoperability".

Three broad sets of inclusion criteria were applied: 1) studies on health information systems use within developing countries, 2) studies with a focus on primary health care, and research on interoperability issues in information systems. Articles included in the study ranged from 1990-2016.

The paper analysis excluded articles that did not meet the selection criteria, overall 128 articles were identified, 49 were excluded and 62 were considered for the analysis. The process of analysis involved collecting and summarizing the results of the papers that had been selected as relevant studies in relation to the scope of the study.

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3 Results

This section presents findings from the literature reviewed and has been categorised under the key main search items.

3.1 Understanding Integrated Primary Healthcare

The fundamental role of a hospital is to deliver quality primary healthcare to patients, all the other secondary roles are in support of this core primary role [18]. World Health Organization (WHO) has recently [17] called on its member states to strengthen their healthcare systems through primary healthcare principles. Primary healthcare plays a central role in healthcare organizations by contributing to the overall health systems' performance [17, 27-29]. Kringos and Starfield [17, 19] refer to primary healthcare as a complex and multidimensional system divided into structure, process and outcome. The primary care structure consists of: governance, economic conditions, and workforce development, while the primary care process consists of: access, continuity, integration and comprehensiveness of care. Following this, the stated outcome of a primary care system consists of: quality of care, efficiency care, and equity in health. Haggerty [30] grouped care continuity- a core principle of primary care under: informational, management and relationship, whereby each of these links elements in a care pathway to achieve overall patient care continuity. Schang [31] agree with [30] that care coordination entails both information and managerial coordination. Whereas information coordination ensures that information is recorded and used by subsequent care providers, managerial coordination ensures longitudinal follow-ups across providers. This kind of coordination leads to what [17] calls integrated primary healthcare.

According to [17] "integrated primary healthcare" can be achieved through a collaboration between secondary care and primary care. In such a plan the patient receives one coordinated and coherent medical record which can be facilitated by pre-arranged protocols or a team that works very closely [32]. Following this, [18] proposes the creation of synergy between the primary and secondary hospital roles through the use of information systems as shown in Figure 1. Several authors agree to this proposition and recommend implementation of comprehensive or integrated HIS that can meet both primary and secondary care needs for improved quality healthcare [33-35] and integrated primary healthcare.

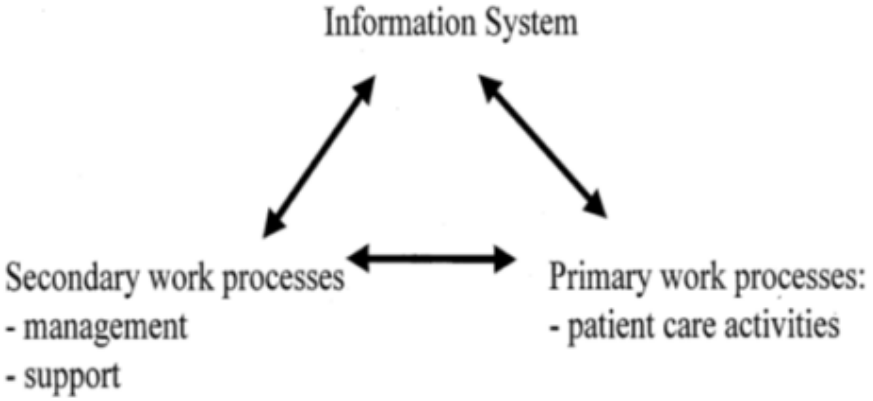

Figure 1. Striving for Synergy through the use of information systems (Source: [18], p. 152)

Figure 1 shows that synergy and harmonization of secondary and primary work processes can be aided by information systems. Secondary roles include managerial, administrative, and support work tasks that typically collaborate with primary work processes. Primary work processes involve all patient care related activities that are essential for the delivery of quality healthcare to patients.

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3.2 HIS Implementations in Developing Countries

Several studies including [8-10] have highlighted the role of information communication technologies in developing countries. A study by Namakula [36] that particularly looked at HIS capabilities towards improving healthcare services delivery in developing countries revealed the following capabilities among others; records keeping and faster retrieval, enhanced communication, informed decision making and improved chronic disease management among others. According to World Health Organization (WHO) African countries in 2008 declared to strengthen their health information systems for improved quality healthcare delivery [37]. Developing countries have indeed implemented health information systems mostly to support administrative roles [12, 38]. Most implemented health information systems are normally used to collect and provide information on routine health indicators to higher level health administrators [37, 38] reported in aggregate statistics [11]. They are management health information systems and are therefore, capable of administrative secondary care roles [12, 20, 38]. According [21] to DHIS is an example of such systems that meet secondary care roles.

Over 46 developing countries have implemented the District Health Management System (DHIS) [39-41]. Which is a web-based management information system for handling aggregated data used for national health monitoring and planning [42] meeting secondary roles. However among the implemented HIS there is limited evidence of patient care systems [12]. In most countries either there are no patient care information systems or the existing ones are not interoperable with other health information systems [12, 23]. At times the health information systems in place do not hold complete patient records [40], for example the prominent DHIS in developing countries has capabilities of tracking a patient by use of the DHIS tracker [43, 44] but cannot provide a single coherent patient record.

A study by [12] that covered 10 development countries namely: Angola, Botswana, Ethiopia, Ghana, Kenya, Nigeria, Tanzania, Uganda, Zambia and Zimbabwe, shows that there is evidence of Health Management Information Systems (HMIS) implementations. However, there is lower evidence of implementation of patient care information systems that promote patient care continuity. Other studies by [12, 14] have found that most HIS implementations in developing countries are program specific initiatives by donor agents thus not offering comprehensive care to a patient and are therefore unsustainable.

A comprehensive study [20] on HIS implementations in developing countries investigated three particular successful examples at different managerial levels. The first one, SIGA Saude in Sao Paulo, Brazil was an enterprise resource planning system with electronic medical records to manage patient information flow. The second is, Health Information Management System (HMIS) in India a web-based system that collects health indicators for monitoring, planning and evaluation of national health status. The third one was SmartCare Electronic Health Record System in Zambia that provides a portable patient health record. The SmartCare program provides a complete electronic patient health record and assures the patient of continued, confidential, and high-quality care by providing timely information to caregivers at the point of service.

By and large there is great potential of health information systems in transforming healthcare delivery in developing countries [12, 14]. Most countries have implemented HMIS [12] which are used to collect routine data on health indicators [20] thus meeting secondary roles, though with limited evidence of patient care systems [12]. For example in Uganda HMIS tools have been programmed into the DHIS to enable harmonization of data collected through HMIS registers to be entered directly into the DHIS [45].

Though HIS implementations have been highly adopted in developing countries there are however faced with diverse challenges. According to [46] information system implementation in most developmental sectors is not as difficult as in the healthcare sector. Particularly, information system implementation in healthcare is a complex socio-technical network [18, 24, 47, 48]. With challenges including: duality of the socio-technological networks [49], existence of cultural barriers (especially reluctance to change from paper based practices) [5, 50, 51], lack of HIS standardization and interoperability [5, 20, 23, 34, 52, 53] and regulation, HIS-organizational mis-alignment [1, 48, 54], digital divide challenges particular to developing countries [52, 55, 56], and HIS implementation failures [18, 27, 47, 54, 57].

3.3 District Health Information Systems' Overview

Several countries in developing countries have greatly employed the use of DHIS, which now covers over 46 countries [21, 41]. DHIS was introduced in 1994 by a global network known as the Health Information

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Systems Program (HISP) and was first implemented in South Africa [20]. DHIS is a web-based and open-source tool for collection, validation, analysis, and presentation of aggregated statistical data, tailored to integrate state health information management activities [42].

Most countries have employed the use of DHIS as a management system to monitor their operations and improve integration [14, 37]. It allows data entry at district level, data analysis at state level [39] and it empowers users to manage their health services locally [14]. Countries that have been affected by the HIV/AIDS pandemic have greatly employed the use of DHIS to improve surveillance for better prevention and treatment of HIV/AIDS [58]. DHIS has been successfully used to manage ART for HIV/AIDS patients for example in Addis Ababa [14]. DHIS can facilitate state data integration and creation of reports that support decision making [37, 40]. DHIS can also be interfaced with other electronic HIS [35] for example in Addis Ababa: the relevant patient-related data elements from the electronic record systems for HIV/AIDS patients are aggregated monthly and imported into DHIS [14]. There are on-going efforts to integrate DHIS with Open Medical Record System (OpenMRS) to facilitate reporting of aggregated data from the local OpenMRS directly into DHIS [35] for administrative purposes though not for patient information flow.

DHIS has many great capabilities features which when fully explored can greatly improve healthcare delivery. These features include; openness, interoperability, scalability, tracker, customizability, and visualization clearly indicated at the DHIS website [43]. For example the DHIS tracker can be used to record and track a patient medical history [43, 44] which can fully benefit the healthcare organization in promoting patient care continuity and improving primary care. Though DHIS is considered a good system with many capabilities, it still faces challenges particular to developing countries which include: poor infrastructure and internet connections, electricity blackout [59] and lack of frequent training for system users [21, 37, 39, 40] which ought to be addressed.

4 Discussion

This section discusses HIS used in developing countries, their capabilities, and challenges in achieving integrated primary healthcare. According to [17] integrated primary healthcare can be achieved through a synergy of both secondary and primary care roles which can be aided by HIS [18]. In developing countries achieving integrated primary healthcare is still challenging because most of them have strong secondary HIS support but weak primary care support [12]. Most implemented HIS in developing countries are management systems with District Health Information System (DHIS) as the prominently used system since it is implemented in over 46 countries [21, 41], thus it is capable of meeting secondary care roles. However among the implemented HIS there is limited evidence of patient care systems [12] and thus limited systems to meet primary care roles. According to [12, 20, 38] developing countries prioritize: (i) health information systems that support higher administration roles whilst neglecting implementation of patient care information systems. The prominent DHIS is such an example [21] meeting secondary roles not the primary role of patient care continuity [20]. (ii) Implementation of health information systems that are not interoperable to each other [24] and thus cannot aid decision making [16, 23] and continued integrated primary healthcare. Sandiford [60] once noted that improvements in information processing does not automatically guarantee rational decision making. Therefore, to improve primary healthcare installed HIS ought to be comprehensive [33-35] and interoperable [61] with ability to exchange information and use it [62]. Furthermore, HIS implementation challenges ought to be addressed to improve future HIS implementations in regards achieving PHC.

5 Conclusion and Future Studies

This paper has provided an analysis of the propensity of current health information systems towards integrated primary healthcare in developing countries. The practical implication to healthcare professionals is to increase awareness that integrated primary healthcare can be enhanced by implementing comprehensive HIS that are capable of meeting both secondary and primary care roles. The paper proposes an integration of the prominent DHIS with other patient health information systems in order to promote both secondary and primary care roles for improved primary healthcare delivery. For future research, the paper proposes a focus on how health information systems can be further interoperated and integrated into

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comprehensive systems, and how HIS implementation challenges particular to developing countries can be overcome.

References

[1] Chaudhry, B., et al., Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Annals of internal medicine, 2006. 144(10): p. 742-752.
[2] Demirkan, H., A smart healthcare systems framework. It Professional, 2013. 15(5): p. 38-45.
[3] Oliveira, S.V.W., et al., Use and development of health information systems: the experience of an organizational unit responsible for the technological services at a public hospital. JISTEM-Journal of Information Systems and Technology Management, 2011. 8(1): p. 155-178.
[4] Werder, M., Health information technology: A key ingredient of the patient experience. Patient Experience Journal, 2015. 2(1): p. 143-147.
[5] Olaronke, I., et al., Interoperability in Nigeria healthcare system: The ways forward. International Journal of Information Engineering and Electronic Business, 2013. 5(4): p. 16.
[6] Demirci, U., S. Wang, and F. Inci, Editorial for Advanced Health Care Technologies. Advanced Health Care Technologies, 2015. 1: p. 1-2.
[7] Demiris, G., et al., Patient-centered applications: use of information technology to promote disease management and wellness. A white paper by the AMIA knowledge in motion working group. J Am Med Inform Assoc, 2008. 15(1): p. 8-13.
[8] Heeks, R., ICT4D 2.0: The Next Phase of Applying ICT for International Development. . IEEE Computer., 2008. 41(6): p. 26-33.
[9] Lucas, H., Information and communications technology for future health systems in developing countries. Social science & medicine, 2008. 66(10): p. 2122-2132.
[10] Walsham, G. and S. Sahay, Research on information systems in developing countries: Current landscape and future prospects. Information technology for development, 2006. 12(1): p. 7-24.
[11] Anokwa, Y., Delivering Better HIV Care in Sub-Saharan Africa Using Phone-Based Clinical Summaries and Reminders. . (2010).
[12] Foster, R., Review of Developing Country Health Information Systems: A high level review to identify Health Enterprise Architecture assets in ten African countries. Health Enterprise Architecture Project, 2012.
[13] Rexhepi, H., R.-M. Åhlfeldt, and A. Persson. Challenges and opportunities with information system support for healthcare processes–a healthcare practitioner perspective. in 8th IADIS International Conference on Information Systems, Madeira, Portugal, 14-16 March, 2015. 2015.
[14] Braa, J., et al., Developing health information systems in developing countries: the flexible standards strategy. Mis Quarterly, 2007: p. 381-402.
[15] Van Lerberghe, W., The world health report 2008: primary health care: now more than ever. 2008: World Health Organization.
[16] Jeong, J.-S., O. Han, and Y.-Y. You, A Design Characteristics of Smart Healthcare System as the IoT Application. Indian Journal of Science and Technology, 2016. 9(37).
[17] Kringos, D.S., et al., The breadth of primary care: a systematic literature review of its core dimensions. BMC health services research, 2010. 10(1): p. 65.
[18] Berg, M., Implementing information systems in health care organizations: myths and challenges. International journal of medical informatics, 2001. 64(2): p. 143-156.
[19] Starfield, B., Primary care: balancing health needs, services, and technology. 1998: Oxford University Press, USA.
[20] Consulting, V., Health Information Systems in Developing Countries. A Landscape Analysis.
[21] Garg, R., N. Sharma, and A. Garg, OPPORTUNITIES AND CHALLENGES OF HEALTH MANAGEMENT INFORMATION SYSTEM IN STATE PUNJAB.
[22] Sachs, J., The end of poverty: economic possibilities for our time. . European Journal of Dental Education, (2008). 12(1): p. 17-21.
[23] Adebesin, F., et al., A review of interoperability standards in e-Health and imperatives for their adoption in Africa. South African Computer Journal, 2013. 50(1): p. 55-72.
[24] Bygstad, B., O. Hanseth, and D.T. Le. From IT Silos to Integrated Solutions. A Study in E-Health Complexity. in ECIS. 2015.
[25] Blaya, J.A., H.S. Fraser, and B. Holt, E-health technologies show promise in developing countries. Health Affairs, 2010. 29(2): p. 244-251.

 J Health Inform Afr. 2018;5(2):39-46. DOI: 10.12856/JHIA-2018-v5-i2-204

[26] Otte-Trojel, T., et al., Characteristics of patient portals developed in the context of health information exchanges: early policy effects of incentives in the meaningful use program in the United States. Journal of medical Internet research, 2014. 16(11): p. e258.
[27] Afrooz, G.A., Report of The Regional Committee for the Eastern Mediterranean Fifty-fifth Session Cairo. 2008, WHO.
[28] Rocha, K.B., et al., Assessment of primary care in health surveys: a population perspective. The European Journal of Public Health, 2012. 22(1): p. 14-19.
[29] Starfield, B., L. Shi, and J. Macinko, Contribution of primary care to health systems and health. Milbank quarterly, 2005. 83(3): p. 457-502.
[30] Haggerty, J.L., et al., Continuity of care: a multidisciplinary review. BMJ: British Medical Journal, 2003. 327(7425): p. 1219.
[31] Schang, L., S. Waibel, and S. Thomson, Measuring care coordination: health system and patient perspectives: Report prepared for the Main Association of Austrian Social Security Institutions 2013: London: LSE Health.
[32] Blount, A., Integrated primary care: Organizing the evidence. Families Systems and Health, 2003. 21: p. 121-134.
[33] Aghazadeh, S., A. Aliyev, and M. Ebrahimnezhad, Comprehensive Review of Information Systems, Medical Institutions. International Journal of Computer Theory and Engineering, 2012. 4(6): p. 862.
[34] Berler, A., S. Pavlopoulos, and D. Koutsouris. Design of an interoperability framework in a regional healthcare system. in Engineering in Medicine and Biology Society, 2004. IEMBS'04. 26th Annual International Conference of the IEEE. 2004. IEEE.
[35] Braa, J., et al. Comprehensive yet scalable health information systems for low resource settings: a collaborative effort in Sierra Leone. in AMIA Annu Symp Proc. 2010.
[36] Namakula, S. and G. Kituyi, Examining health information systems success factors in Uganda's Healthcare System. The Journal of Global Health Care Systems, 2014. 4(1).
[37] Seitio-Kgokgwe, O., et al., Development of the national health information systems in Botswana: pitfalls, prospects and lessons. Online journal of public health informatics, 2015. 7(2).
[38] Krickeberg, K., Principles of health information systems in developing countries. Health Information Management Journal, 2007. 36(3): p. 8-20.
[39] Garg, R. and A. Garg, District Health Information System (DHIS2) Software in India. Advances in Computer Science and Information Technology (ACSIT) 2015. 2(10): p. 39-42.
[40] Kihuba, E., et al., Assessing the ability of health information systems in hospitals to support evidence-informed decisions in Kenya. Glob Health Action, 2014. 7: p. 24859.
[41] Muhaise, H. and A.H. Ejiri, Factors Influencing District Health Information Software Version 2 Success–A Case of the Greater Bushenyi Districts, Uganda. American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS), 2016. 26(1): p. 166-176.
[42] DHIS2. District Health Information System. [cited 2016 20-08]; Available from: http://www.openhealthnews.com/resources/district-health-information-system-2-dhis2.
[43] DHIS. DHIS2 Overview. [cited 2016 20/08]; Available from: https://www.dhis2.org/overview
[44] Saugene, Z.B., Customization of Generic Open Source Software for Health Sector in Developing Countries. 2013, University of Oslo, Norway.
[45] Ministry of Health, <Ministry of Health, Health Systems 20/20, and Makerere University School of Public Health. Uganda Health System Assessment 2011. Kampala, Uganda and Bethesda, MD: Health Systems 20/20 project, Abt Associates Inc. . 2012.
[46] Sagiroglu, O. and M. Ozturan, Implementation difficulties of hospital information systems. Information Technology Journal, 2006. 5(5): p. 892-899.
[47] Berg, M., Patient care information systems and health care work: a sociotechnical approach. International journal of medical informatics, 1999. 55(2): p. 87-101.
[48] Winter, A., et al., Strategic information management plans: the basis for systematic information management in hospitals. International Journal of Medical Informatics, 2001. 64(2): p. 99-109.
[49] Berg, M., et al., Guidelines, professionals and the production of objectivity: standardisation and the professionalism of insurance medicine. Sociology of Health & Illness, 2000. 22(6): p. 765-791.
[50] Hindemark, F., E-Health at Outpatient Clinics in Uganda. KTH R Inst Technol Sweden, 2013.
[51] Richard, A., Adoption of clinical information systems in hospitals in Uganda. 2012, GRIN Verlag: Munich.
[52] Adebesin, F., et al., Barriers & challenges to the adoption of E-Health standards in Africa. 2013.
[53] Begoyan, A., An overview of interoperability standards for electronic health records. USA: society for design and process science, 2007.
[54] Bush, M., et al., The alignment of information systems with organizational objectives and strategies in health care. International journal of medical informatics, 2009. 78(7): p. 446-456.

 J Health Inform Afr. 2018;5(2):39-46. DOI: 10.12856/JHIA-2018-v5-i2-204

[55] Anwar, F., A. Shamim, and S. Khan, Barriers in adoption of health information technology in developing societies. Int J Adv Comput Sci Appl, 2011. 2(8): p. 40-5.
[56] Oak, M., A review on barriers to implementing health informatics in developing countries. Journal of Health Informatics in developing countries, 2007. 1(1).
[57] Heeks, R., Information systems and developing countries: Failure, success, and local improvisations. The information society, 2002. 18(2): p. 101-112.
[58] Bwesigye, D., et al., Theoretical Application Assessing Adaptation of District Health Information System (DHIS 2) for HIV/AIDS Surveillance in Uganda. Health Systems and Policy Research, 2015. 2(1): p. 1-7.
[59] Kiberu, V.M., et al., Strengthening district-based health reporting through the district health management information software system: the Ugandan experience. BMC medical informatics and decision making, 2014. 14(1): p. 40.
[60] Sandiford, P., H. Annett, and R. Cibulskis, What can information systems do for primary health care? An international perspective. Social science & medicine, 1992. 34(10): p. 1077-1087.
[61] Njeri, K.C., et al., Adoption of Integrated Healthcare Information System in Nairobi County: Kenyatta National Hospital versus Mater Hospital. 2014.
[62] Radatz, J., A. Geraci, and F. Katki, IEEE standard glossary of software engineering terminology. IEEE Std, 1990. 610121990(121990): p. 3.

 J Health Inform Afr. 2018;5(2):39-46. DOI: 10.12856/JHIA-2018-v5-i2-204