

Systematic review: Decentralised health information systems implementation in sub-Saharan Africa

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Globally the health space is being revolutionised by rapid digital transformation to support care activities, promote healthier lifestyles and ensure informed decision making to improve service delivery. However, many health systems in sub-Saharan Africa are yet to realise the full potential of health information systems (HIS) as a digital transformation initiative. The objective of this article is to establish how the sociotechnical challenges in Africa's health systems can be addressed by recommending a fitting approach to implement HIS relevant to the context of the continent. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) technique was applied to search, identify and filter articles over a 10-year period by applying inclusion and exclusion criteria accordingly. Only 42 articles satisfied the objective of this article. The emergent themes include contextual factors, coordination and collaboration, data complexity, organisation structure, accountability and stakeholders' perspectives. The results indicated that less attention has been given to how the implementation approach could impact the output of health systems. In conclusion, the authors argue that a decentralised approach to the implementation of HIS is more appropriate for Africa's health systems. The premise of the authors' argument is informed by the tiered structure of health systems, varying levels of infrastructural development and use of large volumes of health-related data for resources allocation at the national level. Future studies should investigate the processes for formulation and evaluation of health policies to actively redress the administrative issues associated with the current functional HIS in each African country.

Transdisciplinarity Contribution: The paper contributes to the practical implications of implementing HIS in sub-Saharan African health systems by highlighting the contextual realities and data governance complexities that support a decentralised approach towards ensuring resilience and health security.

Keywords: health information systems; decentralised approach; IT implementation; centralised approach; sub-Saharan Africa; health systems.

Introduction

The World Health Organization (WHO) describes a health care system as encompassing all the activities that promote and maintain a wholesome state of well-being by preventing and treating disease outbreaks.¹ Also, a health care system may reflect a country's economic, cultural and political situation.² In other words, health care systems consist of stakeholders with specific roles, characteristics, needs and other variables that may exist in an overlapping, multilayered and organised administrative structures.^{3,4} The primary stakeholders of health care systems include the population, the government and private individuals or organisations.

The organised structure could be regional, local, national or international, with variables that include health indicators, financial expenditure, skilled workforce, enabling infrastructure and technological innovations.⁵ The complexities and dynamics of health care systems suggest the impracticability of a 'one-size-fits-all' implementation approach of health initiatives, especially in the African context. This article discusses about opportunities for success and challenges that pose a threat to the implementation of health care information systems (HISs).

In Africa, health care systems are usually subdivided into private and public sectors, which are regulated by the government.^{2,6} While the private health care system is funded by individuals and insurance companies, the public health care system is primarily government funded. Services in the public health care systems are offered in three tiers: primary health care includes community clinic and home-based care, secondary and tertiary level hospitals.⁷ The goal of a stratified public health care system is to subsidise the cost of health care access for the general populace and simplify the administrative process and governance complexities.⁸ With health care sectors that

operate two parallel health care systems that differ in terms of resources and funding, this is further exacerbated by a rise in population growth that depends on public health care services, disease prevalence and shortage in skilled human capital.¹⁹ In addition, issues of inadequate data management and communication at different levels of health care systems result in delays and uninformed decision making.

To redress the impact of resource constraints, especially in managing health-related information, HISs have been adopted in most health care systems.^{6,10} It is argued that HISs present an opportunity that can automate the coordination and delivery of quality care and administrative services. Health care information uses technology to support the work activities of doctors, nurses and hospital managers by enabling collection, retrieval, exchange and use of large volumes of health-related information for decision making.¹¹ For instance, technology application in health systems may include hospital information systems such as electronic health records (EHRs) to facilitate localised care within hospitals and mobile health to facilitate remote care. The benefits of HIS have simplified the nature of clinical work activities and referrals, reduced human errors and created an avenue for adequate resource allocation and public health monitoring. Yet HISs remain inhibited by critical challenges of its implementation approach.

Health care information systems implementation

One of the lessons learnt from the emergence of and experiences from the coronavirus disease 2019 (COVID-19) pandemic is that the health care systems in Africa need to be revamped. Public health systems in Africa are already plagued by multiple recurring challenges, and as a result of this, the potential benefits that HIS present have not been fully realised.⁶ Existing literature shows that majority of the HISs developed in Africa are either hospital or clinic-based and implemented independently at a certain tier of the public health system without being in line with a specific architecture approach: centralised or decentralised. For example, in most African health care systems, EHRs are developed to manage context-specific health-related information.¹² While some of the HISs are developed for use in specific hospitals or clinics, patients' records can still be tracked at the national level of the public health system.¹³

The unsuccessful implementation of EHRs is usually associated with infrastructural, social and regulatory factors.¹⁴ Achieng and Ruhode¹⁵ suggested that besides understanding and addressing these factors, identification and characterisation of the underlying generative mechanisms with causal effects that produce current implementation outcomes is crucial. In terms of infrastructure, erratic electricity supply means that the technology can go offline at any time, which may eventually lead to damage. Initial costs of hardware and software serve as deterrents to the implementation of HISs. In addition, Internet connectivity plays a major role in the implementation of HIS. As of 2021, the Internet connectivity among African countries is

estimated at 79% because of the penetration of mobile telecommunication.¹⁶ However, sub-Saharan Africa's digital divide is estimated to be over 40% in terms of areas with less than adequate Internet connectivity to enable and guarantee the use of information and communication technologies (ICTs). Taken these dynamics into consideration, a decentralised HIS might be ideal to avoid single-point failures and their unintended consequences.^{17,18}

There are existing peer-reviewed studies that have discussed centralised and decentralised approaches to HIS implementation.^{19,20,21} However, there is a limited body of literature that emphasises the opportunities of a decentralised HIS architecture, especially in Africa.²² This article provides a perspective on the merits and demerits of decentralised and centralised HISs and takes a position on the suitable approach for the African context.

Aim and objectives

This article seeks to explore the impact of the current status of HISs in Africa's health care systems in terms of the availability, accessibility and use of health-related information to support quality and safe service delivery in African health care systems. This study seeks to contribute a proposed conceptual framework for decentralised HIS implementation in the African context.

Literature review

The primary goal of a health care system is to improve health outcomes through the provision of quality health care services. Globally, health care systems usually have distributed structures consisting of health care facilities such as hospitals, clinics and community health centres that provide different types of care services to the populace.³ Within these health care facilities, HISs have been implemented to facilitate the management of health-related data and information. However, there is a persistent challenge of lack of interoperability between implemented health care technologies that impede the sharing and exchange of health-related data.²³ Given the peculiarities of the African context in terms of infrastructural development and Internet connectivity, it becomes imperative to consider the adoption of a HIS implementation approach that would enable the realisation of quality service delivery in its health systems.

Interoperability issues with implementation of health care information systems in sub-Saharan Africa

The lack of interoperability can be attributed to the use of different software vendors to develop and implement the HIS in individual health care facilities.²⁴ The authors argued that lack of interoperability often creates another challenge of lack of uniformity in the health records generated and stored by the individual health care facilities. For example, records (digital and paper) generated by health care facilities might not be accessible or comprehensible to other stakeholders such as patients, other health care practitioners and medical

insurers. The implication is that the generated health data may diminish in value when it comes to informed decision and policymaking. Besides the lack of interoperability between existing HIS, there is also the constant threat of privacy and security issues in health-related information management and sharing.²⁵

The suggestion for an adequate approach to implementing HISs in Africa is closely associated with understanding and addressing the recurrent issues that result from lack of interoperability. This could be in the forms of accessing, monitoring or analysing of health data²³ for decision or policymaking purposes. De La Cruz et al.²⁶ suggested that the development and implementation of HISs should begin with analysing the context, designing a detailed structure and behaviour of the system to meet its intended purpose. The authors refer to this as a 'system architecture' that is characterised by the system's functionality, components, attributes and its interrelations.²⁶

The system architecture of HIS is usually informed by e-health strategies, normative standard frameworks and related health policies.^{27,28} In the health care systems of many African countries, e-health architecture has been adopted to facilitate the management and sharing of health-related data generated from health ICTs. For example, the health care systems in Ethiopia, South Africa, Ghana and Kenya have incorporated HIS enterprise architecture into their national e-health strategy, as reported by ministries and departments of health, respectively. Subsequently, this informs the implementation of health technology initiatives in the countries' health systems and the quality of health care services delivery.

To realise standardisation and interoperability of health data, an issue most health care systems in Africa struggle with, Higman et al.²⁹ argued that an appropriate e-health architecture must be adopted to achieve interoperability in HISs. The architecture and approach to HIS development and implementation are largely influenced by the structure and nature of a country's health care system,³⁰ which is tiered in the African context. Literature further shows that health care systems that have a top-down approach to management and governance are more likely to implement centralised HISs. In contrast, health care systems that adopt the bottom-up approach are more likely to adopt a decentralised architecture for the implementation of HISs.^{30,31,32}

Centralised versus decentralised approaches to health care information system implementation

In the centralised 'top-down' architecture approach, a primary HIS is implemented and used in the information management of health-related data nationally.³³ The approach has an advantage of central availability and management of health-related data to generate reports for national health-related data analysis in the event of disease surveillance. However, there are problems associated with this approach that cannot be simply ignored, because of the sensitivity of health data and monitoring of allocated resources.

Firstly, the inability of a central HIS to support the peculiar needs and requirements of local health care facilities.³⁰ Furthermore, Zaided et al.³³ argued that access and use of health data from a central repository system that contains data from multiple health care facilities across a health care system can be challenging in terms of data context, data volume, data accuracy and data codification. The implications are that large data become complex to manage, causing delays because of a lack of uniformity in infrastructure and cost overruns because of high costs required to maintain and scale a centralised HIS to sustain uninterrupted service delivery.

A bigger challenge associated with a centralised HIS is security and privacy of health-related data.^{24,25,34} Patil and Seshadri³⁴ argued that centralised HISs that are nationally accessible are more likely vulnerable to security breaches. This is exacerbated by inadequate security measures in health care systems where nationally accessible health care data can be viewed and retrieved by several stakeholders.²⁴ Security breaches and misuse of health-related data are associated with heavy medicolegal consequences for the health care practitioners, institutions and even the government, where health records are leaked and used without unequivocal consents from the patients or owners of health information.

In the decentralised 'bottom-up' approach, HIS are often implemented at regional levels or in individual health care facilities. Transfer of authority to individual health care facilities or regional government health organisation means that all health-related information would be stored and maintained locally.³³ Hence, it becomes easier to monitor allocated resources for accountability purposes and manage the complexities that may result from managing large volumes of health-related data to aid decision making. In addition, a decentralised HIS affords the opportunities for customisation to fit the dynamic health-related and information needs and the infrastructure requirements for each individual health care facility providing different types of care services.

Dwivedi et al.³⁵ argued that the decentralised approach of HIS implementation militates against bottlenecks in the flow of health information and ensures robustness and scalability of the systems. Mudaly et al.³⁰ claimed that without the element of central coordination, the decentralised approach of HIS allows for uniformity in standards. As such, the decentralised architecture approach has the advantage of decreased duplication and increased consistency of health-related data. Also, the decentralised approach militates against security risks associated with a centralised architecture approach, because health-related information remains at the source rather than being duplicated in a centralised repository.³³

Enabling technologies to establish decentralised health care information systems in sub-Saharan Africa

Enabling technologies ensure that any security risks or breach to a decentralised HIS are localised and can be

addressed without disruption to the continuous transmission, sharing and storage of health-related information. Examples of enabling technologies that can be used to implement a decentralised HIS in the health systems of sub-Saharan Africa include blockchain technologies, satellite technologies, cloud computing and the Internet of Things (IoT). For instance, blockchain technologies have demonstrated the value and benefits obtainable in securing the transmission of health-related data in decentralised information systems. Cloud computing systems enable secured remote access to health-related information, reduce the costs to establish multiple infrastructures across several health institutions and mitigate any forms of implementation incompatibilities in HISs.³⁶ Furthermore, IoT can be used to monitor and collect health care indicators at different levels of a health system and automate the transmission of health-related data within an internetworked system to a cloud database.^{37,38} In essence, the decentralised architecture approach to implementing HISs gives consideration to the disparities in infrastructural development, prevents the disarray associated with single-point failures and enables hospital management and regional health bodies to be accountable to the localities they serve.

The two prominent approaches of HIS implementation have been discussed to highlight their advantages and disadvantages, particularly how they support health care systems to manage and analyse data for decision making. Subsequently, the authors attempt to establish which of the architectures between centralised and decentralised approach to HIS implementation is suitable for the African contexts and its peculiarities by conducting a systematic literature review (SLR) of existing studies on African health systems and their efforts to implement HISs.

Method

To ensure that the search and retrieval process was unbiased and accurate, this article used a SLR. Systematic literature review as an approach and procedure for undertaking literature reviews was proposed in the information systems field. A systematic literature review's most noticeable distinct feature is a protocol that prescribes how researchers should identify, select, assess and synthesise evidence from literature sources.³⁹ Okoli and Schabram⁴⁰ established that adhering to prescribed protocols provides a 'standardised method' for literature reviews that are transparent, objective, unbiased, replicable and rigorous.

Therefore, SLRs as an approach aim to advance policy formation and practice by providing the best evidence available from literature. Boell and Cecez-Kecmanovic³⁹ posited that SLRs are adopted to provide answers to specific questions. For example, the question that guided this study is, 'What approach is best suited for the implementation of HIS in the health care systems of sub-Saharan Africa?' The findings extracted from the existing studies identified through SLR would help the authors to recommend and argue for a best-suited choice between a centralised or decentralised architecture to the implementation of HISs in Africa.

Search criteria and identification of sources

To source documents for this article, the authors queried Google Scholar and Scopus databases, which offer an extensive array of relevant peer-reviewed journal articles and other documents covering HIS adoption, implementation and use. The authors conducted multiple iterations of searches to identify the relevant publications within a time frame of 10 years (2012–2021). The time frame for the search was between July and September 2021. The authors applied the preferred reporting items for systematic reviews and meta-analyses (PRISMA)⁴¹ in establishing the search procedure in Figure 1.

Using PRISMA approach, a combination of keywords was used to query the two scholarly databases: (1) healthcare OR HIS implementation *and* Africa, (2) decentralised healthcare *or* HIS. A supplementary search was performed using a combination of search keywords: (1) centralised and (2) decentralised HIS architecture. To delineate the search, articles cited in the retrieved articles were also considered but limited by relevance and timeline, dated from 2012 to 2021. These search results yielded 886 peer-reviewed academic journal articles, conference proceedings, book chapters and books.

Exclusion and inclusion criteria

The results generated from the two database queries were screened and filtered by thoroughly reading through the titles and abstracts. The filtering involved screening of document abstracts to identify relevant articles based on the following inclusion criteria: (1) all publications were written in English; (2) studies addressed HIS implementation in Africa; (3) studies focused on decentralisation of HISs in Africa; (4) studies that had empirical design (qualitative, quantitative or mixed methods); and (5) studies that highlighted the advantages and disadvantages of centralised and decentralised approaches of HIS implementation.

On applying the exclusion criteria, the authors discarded: (1) articles written in other languages; (2) articles that do not focus on HIS adoption, implementation and use with particular focus on Africa; and (3) books or book chapters

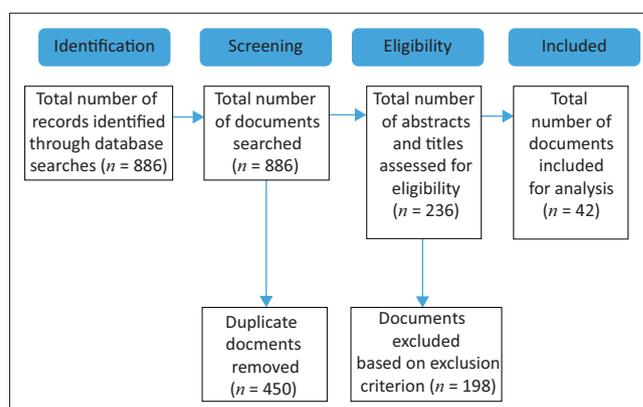


FIGURE 1: The preferred reporting items for systematic reviews and meta-analyses steps applied to identify included articles.

that were not openly accessible. Subsequently, the included 42 documents were imported into Mendeley, a reference software programme designed to easily extract search results and manage reference citations. Figure 1 presents the article selection process. The final articles were consolidated and analysed to identify findings that illustrate the merits and demerits of decentralised implementation of HISs given the contextual peculiarities of the African context and the health care systems within the continent.

Ethical considerations

This article followed all ethical standards of research without direct contact with human or animal subjects.

Results and analysis

A total of 886 articles were identified in the review based on the keywords used in the search. A total of 531 articles were identified from Google Scholar, while 355 were retrieved from Scopus. After removing 450 duplicates, 236 unique titles and abstracts remained. Using the exclusion criteria, 198 articles were excluded after screening their titles and abstracts. The authors read through the remaining 236 articles, and in the end, 42 publications were included in the synthesis. Given the aim and objectives of the article and based on the summary of the studies ($n = 42$) included in the analysis, three interest areas were formed and categorised as follows: (1) overview of health systems ($n = 18$),^{1,2} (2) challenges with the current HIS implementation approaches in Africa ($n = 10$)^{6,14,30} and (3) centralised and decentralised approach to HIS implementation ($n = 14$).^{22,29}

In analysing the purposes for which HISs are implemented, the researchers first determined the status quo of public health care systems in Africa.^{4,9} One of the objectives of the article was to highlight the characteristics of health care systems in Africa and their challenges. By identifying the challenges, the authors were able to associate the results of the study with the need or opportunity for the intentional adoption of a decentralised approach to HIS implementation. Health care systems are described in terms of their structure and purpose, based on public and private services. Public health care systems are characterised by great disparities in funding provision, understaffing and maldistribution of resources, and as such they are viewed as operating under resource constraints.^{2,4,42} As a result of these inadequacies, a majority of the population who rely on public health care systems have access to relatively poor-quality health care services.

Subsequently, HISs have been implemented by virtue of their ability to enhance the management and coordination of health-related data and information and increase health care workers' productivity.^{3,24} Furthermore, the pursuit of integrated health care services has also led to an increase in implementation of HISs for an improved patient experience.

Integrated health care services are viewed as a useful approach to achieving a more patient-centred health care service delivery. However, the challenges and limitations of public health care systems in Africa mean that the implementation of HISs are littered with several problems. The review identified 12 articles that discuss challenges with the current implementation of HISs.^{15,43} The challenges include lack of standardisation, poor interoperability, inadequate coordination and fragmentation of data. In addition, socio-economic and technical factors shaped by broader organisational factors further exacerbate these challenges.

Considering the nature and scope of HISs, their implementations are considered within the context of e-health architectures embedded in most e-health strategies. The review identified 19 articles that fit the criteria of 'centralised and decentralised' and 'HISs' with a central focus on sub-Saharan Africa.^{22,44} The e-health architecture is essential, as it not only informs the activities during implementation but also how health-related data would be collected, processed and stored. Table 1 gives a summary of African countries such as Ghana, Kenya and South Africa that have implemented HISs adopting either a centralised or decentralised approach (or both) and the resulting outcomes.

The methodological limitation of this article is that articles that were not openly accessible could not be included. Hence, this review might not highlight the holistic picture of HIS implementation approaches. In the next section, the authors synthesise the findings extracted from the resulting articles particularly on decentralised HIS implementation in health systems in the African context.

Discussion

This section centres on the concepts of a decentralised HIS and their impact on public health care service delivery. These concepts are used to propose a conceptual framework that could be associated with an adequately functioning decentralised HIS in an African context. The concepts identified are contextual considerations, organisation culture, stakeholders' perspectives, accountability, accessibility, data complexity, coordination and collaboration. The outcomes of the interplay between these concepts can be used to inform the implementation of a decentralised HIS that would meet the dynamic needs and infrastructure requirements for health care systems in Africa especially at the community level.

A review of literature has revealed that a decentralised approach to the implementation of HISs in sub-Saharan Africa's health systems is more viable and would result in more robustness and scalability, interoperability and standardisation of data. All these attributes are more appropriate in the African context, as systems are customised to fit the local needs and requirements of

TABLE 1: A sample of *health care* information systems implementation approach in different regional blocs of sub-Saharan Africa.

Title of article	Author	Context of study	HIS implementation approach	Key findings
Standardising a developing country health information system through proprietary software: Ghana's experience	Effah and Abuosi ⁴⁴	Ghana	Centralised approach using a proprietary software	<ol style="list-style-type: none"> 1. Use of a standard proprietary software across all health care levels enables standardisation of health indicators, data capture and reporting to ensure uniformity. 2. Proprietary software is not flexible and does not enable customisation; hence, the software does not adequately support the varied needs of lower-level hospitals. 3. Centralised HISs are mainly tailored to meet the needs at a national level of a health system. 4. Central HISs do not afford interoperability and integration with other hospital information systems and services. 5. A decentralised reporting structure is associated with delays, inaccuracy and incomplete reporting of health data from some hospitals. 6. A centralised approach to HIS implementation is viewed as a top-down approach and does not include active participations of stakeholders at the lower hospital and community levels.
Health information systems and accountability in Kenya: A structuration theory perspective	Bernardi ⁴⁵	Kenya	Decentralised	<ol style="list-style-type: none"> 1. The District Health Information system (DHIS2) facilitates devolution of power from the national level to the district level. 2. The bottom-up approach of a HIS ensures democratic accountability to meet health service needs when the interests of different stakeholder groups are recognised. 3. The nature of decentralised HIS-mediated socialisation by enabling transparency and access to the use of health-related data, thereby redressing the notion that health data are only useful at the national level of health systems.
Developing decentralised health information systems in developing countries – cases from Sierra Leone and Kenya	Kossi et al. ⁴⁶	Sierra Leone	Decentralised	<ol style="list-style-type: none"> 1. The level of infrastructure development determines HIS architecture. The regions within African countries have varied infrastructure development, which determines the type of technology used and supporting facilitating conditions such as power supply and Internet. 2. Decentralised HIS enables the effective and transparent management of health-related information per region, to prescribe allocation of resources accordingly. 3. Decentralised approach encourages the participation of stakeholders at the community level, which could result in locally championed initiatives.
Utilisation of the district health information software (DHIS) in Botswana: From paper to electronic based system	Seitio-Kgokgwe et al. ⁴⁷	Botswana	Centralised	<ol style="list-style-type: none"> 1. Fragmented data reporting from local and district levels to the national level of a health system can be addressed. 2. Aggregation of administrative processes such as billing and care services are enabled into a single system. 3. Centralised HIS enabled monitoring, feedback and review of national health strategies. 4. Technical challenges such as poor Internet connectivity, periods of maintenance or power outage, inadequate ICT infrastructure will render the centralised HIS inaccessible and unusable.
Understanding the effects of decentralisation on health information system in developing countries: A case of devolution in Kenya	Manya et al. ²²	Kenya	Decentralised	<ol style="list-style-type: none"> 1. Devolution of health system functions has a positive influence on the benefits of HISs. 2. A decentralised HIS can be coordinated at the national level of a health system but requires collaboration of every level. 3. Devolution of HIS results in the need for additional human capacity. 4. Decentralised HIS is perceived to weaken the central control of health systems from supervision and monitoring national health strategies at the district level. 5. Devolution of administrative functions could be useful to curtail ethnic tensions at the central level of health systems. 6. Decentralised HIS leads to increased effective use of health-related data.
Electronic health information systems for public health care in South Africa: A review of current operational systems	Wright et al. ¹³	South Africa	Centralised and decentralised	<ol style="list-style-type: none"> 1. South Africa has several HISs to support patient clinical care service and operational administrative tasks. 2. The centralised HIS is the open-source District Health Information Software (DHIS) to collect routine health data from all primary healthcare facilities. 3. The health indicators in the DHIS tend to focus on operational aggregated data for monitoring and evaluation and less on patient-related data. 4. Inconsistency in data captured on centralised HIS. 5. The decentralised HISs are focused on administrative and patient-related services. 6. Decentralised HISs lack interoperability.

HIS, health care information system; DHIS, District Health Information Software; ICT, information and communication technology.

country-specific health systems and to ensure democratic accountability for the delivery of quality and safe delivery of services.⁴⁵ Figure 2 illustrates that in a health system, stakeholders' perspectives, organisational structure,

coordination and collaboration informs the attributes and functionality of a decentralised HIS such as data complexity and accountability to influence efficient health care service delivery.

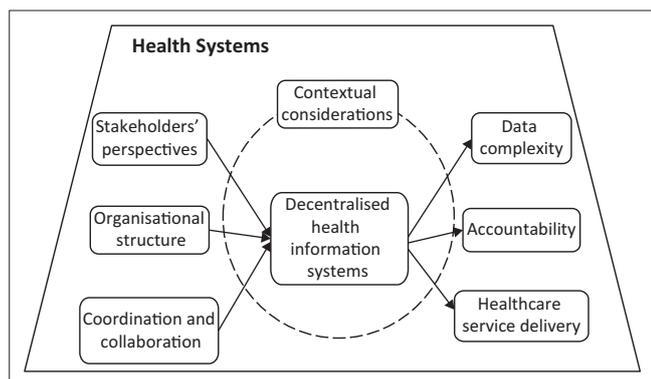


FIGURE 2: A proposed conceptual framework for a decentralised health information systems relevant to African healthcare systems.

Contextual considerations

The review of literature shows that emphasis has been put on HIS implementation failures attributed to technical factors such as software and hardware issues, as opposed to complex and dynamic contextual factors. In the African context, the outcomes of the current implementation approaches attributed to technical factors are well documented across literature. For example, outcomes such as lack of information system customisation to fit local needs and requirements is attributed to varying levels of infrastructure development, disparity in funding opportunities, over-reliance on external vendors and choice of software.⁴⁴ There are broader contextual factors and specific institutional (health care facilities) factors that influence the choice of an HIS implementation. For example, government-mandated e-health initiatives, change driven by a dynamic technology environment and technology initiatives sponsored by external donors may cause contradictions in centralised HIS implementation.

Considering the peculiarity of challenges that are associated with health systems in Africa and their negative effects on data quality and health information flow, the use of decentralised HISs is advocated to enable uniformity in standards of capturing and storage of health data.³⁰ A decentralised HIS ensures robustness and scalability of information systems to fit the needs of the local health care facilities.³⁵ Yet another contextual factor to consider is the lack of national health information management strategy, which is attributed to inadequate performance of HIS in many health care systems in Africa.⁶ This impedes on the realisation of improved quality health outcomes.

Contextual complexities such as industrial strike actions by health care practitioners that plague public health care systems in Africa further emphasise the need for decentralised HISs.²² Such actions not only have negative implications for the delivery of quality health care services⁴ but also on reliable and timely generation, storage and distribution of health-related data across a health system. A decentralised HIS ensures that management of health-related information remains at individual facilities, and challenges can be locally

addressed without disruption of information management at other health care facilities.

Organisational structure

Organisational structure in health care differs from other sectors because of the scope, dynamics and complexities of clinical and administrative activity coordination. The organisational structure defines the functions carried out across a health care system to achieve its objectives, including decisions relating to the acquisition and implementation of health technologies.⁴⁸ Thus, an organisational structure and its respective stakeholders play a vital role in influencing the implementation structure of HIS. It is through these structures that decisions such as planning, budgeting, recruitment of health care practitioners and distribution of infrastructure resources are managed in the tiered health systems.^{8,49} As such, HISs are implemented nationally or provincially or at community health care centres.

The implementation of HISs in the different tier structures very much depends on the scope of the implementation initiative and the purpose of systems.^{6,8} At the highest level of the implementation structure is the ministry of health, which is the central source of e-health policies, standard setting and infrastructure resource distribution. Health information systems implemented at this level are generally used for analysis and reporting of health care-related information. The implementation structure of HISs at provincial and community tiers is mainly focused on clinical care and administrative duties for managing patient records at individual health care facilities.

In addition, HIS at the community level focuses on subject and task-based systems such as electronic medical records. The misalignment between planning, budgeting and maldistribution of resources, persistent in many African public health systems, could potentially be addressed by adopting a decentralised approach to HIS implementation that is fitting for the tiered structures. Considering the purpose of HISs and organisational structures, a decentralised HIS could promote accountability, standardisation of data and accessibility of quality health information.

Stakeholders' involvement

Diversity of stakeholders within a health system adds to the complexities of HIS implementation and use.⁵⁰ As indicated in the previous section, the implementation structure of HIS reflects that of the health system. As such, stakeholders that partake in e-health initiatives come from the tiers and are typically made up of internal and external individuals or groups. Considerations should therefore be given to all types of individuals or groups by characterising the stakeholders, their roles, interests, expectations, perceptions and relations within the health care system and implementation process.⁴⁵ Consequently, individuals or groups in each health care setting where the implementation of HIS occurs can identify the value of making use of a system.

It is important to understand the dynamics of different stakeholders involved in the different stages of HIS, from acceptance to infusion, by identifying their needs within health care settings. These needs should be tailored to fit not only the purpose and objectives for a decentralised HIS but also the peculiar needs of stakeholders. This would result in equitable infrastructure resource allocation and reskilling of health care practitioners.⁸ A fair representation of stakeholders in the implementation of a decentralised HIS is crucial to ensure all interests at local, regional and national levels of health systems are acknowledged. Addressing the needs and dynamics of diverse stakeholder groups in a health care system is complex and challenging in a centralised HIS.²²

Accountability

Accountability is a major issue in many sub-Saharan Africa health care systems and involves the obligation of all stakeholders to accept responsibility. Democratic accountability ensures that data use and resource allocation are transparent.⁴⁵ Hence, it is critical to identify and assess the responsibilities of the stakeholders in the health care systems if accountability is to be adequately addressed. The flexibility of decentralised HISs promotes improved accountability in the functions of health care services since autonomy, authority and responsibilities of planning administrative activities are managed by local or regional health care facilities.²² In addition, a decentralised HIS accounts for financial expenditure and efficiency in health care service delivery of a particular region to improve local communities' health outcomes. As such, a decentralised HIS can enhance accountability, which in turn promotes transparency.⁴⁶

Care coordination and collaboration

To realise the full benefits of decentralised HIS, collaboration and coordination between the health care organisational structures is essential. Coordination and collaboration are products and necessities of tiered health care systems where different specialities are involved in the care delivery process and information sharing is indispensable. The application of IoTs and cloud computing can be used to facilitate remote access, monitoring, sharing and storage of health records during care coordination and collaboration. For example, in the tiered levels of Africa's health systems, a referral system is used to transfer trauma cases between hospitals, depending on the severity and clinical care service required. The enabling technologies guarantee time-efficiency of service delivery in a decentralised HIS. Many et al.²² indicated that without a common interest to adequately coordinate and collaborate between the national and regional governments, a decentralised HIS may result in imminent tensions and inadequate processes to cater for community and universal healthcare.

Data complexity

The goal of health-related data and information is to inform decision making either at a macro or micro level. In a

decentralised HIS, health data is generated, stored and maintained locally.³³ The availability of and accessibility to updated health data assists health care professionals, hospital managers, national decision-makers and sometimes patients to plan and act accordingly.⁶ Many et al.²² argued that when HISs are decentralised, variations in health-related data such as duplications or discrepancies in health indicators can speedily be identified due to relatively lower volumes of information being managed locally or regionally. A decentralised HIS can ensure data quality, security and enhance a culture of effective health information use. Several authors have investigated the possible use of blockchain technologies to design and develop decentralised HISs because of its security measures, distributed network of data sources and capability to operate without a central authority of management.^{23,24,35}

Implications and recommendations

The review of literature reveals that many health systems in Africa adopt a mix of decentralised and centralised approaches to HIS implementation. The authors argue that while a centralised approach to HIS implementation may ensure that the health system of a country is coordinated and monitored from a national level, a decentralised HIS is more appropriate for a tiered health system. Within African countries, there is disparate infrastructural development and Internet connectivity; thus, a decentralised approach is more appropriate to avoid the resulting delays of a single point failure in a continent already characterised by many socio-economic challenges. The devolution of administrative duties associated with a decentralised HIS will guarantee the effective budgeting and management of health-related data such that resource allocation, detection and prevention of public health crises can quickly be managed. Therefore, the authors argue that a decentralised approach to HIS implementation adds more relevance and value to the African context.

Conclusion

This study contributes to the conceptualisation of decentralised HISs as an approach suitable to strengthen health systems in Africa, because of the continent's peculiar characteristics and tiered health care services. A decentralised HIS is ideal for Africa's health care sector because it enables localised management of health indicators, autonomy of administrative roles and duties and government-led decisions that involve resource allocation. A decentralised approach would ensure that the HIS serves local, regional and national health care service needs in a well-coordinated and collaborative manner. Otherwise, the health systems in African countries might not be resilient during a public health crisis such as the coronavirus disease 2019 (COVID-19) pandemic.

It is recommended that a decentralised approach be adopted as a standard to implement HISs. A decentralised HIS would provide a measure for the realisation of accountability at the

different tiers in the public health care systems of sub-Saharan African countries and can be useful to manage expectations required to fund accessibility and availability of health care services from a national perspective. With regard to security measures, adopting a decentralised approach to implementing HISs would mitigate the effects of breaches to patient records and prevent the resulting legal implications. Challenges of data quality and data reporting could be addressed in HISs with a decentralised approach, as live up-to-date information can be exchanged through a bottom-up strategy that caters for the inclusion of all relevant stakeholders.

Based on reflections from this literature study, future studies in the aspects of decentralised HIS can investigate the processes for formulation and evaluation of health policies adopted or developed by the governments of African countries. In practice, the policies would serve as a blueprint for direct stakeholders, including hospital managers, industry vendors and software application developers. In this way, government can regulate technology applications and optimally leverage the benefits of a fully automated and digitised health care system to promote, prevent and manage the persistent burden of diseases in Africa.

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Competing interests

The authors have declared that no competing interest exist.

Authors' contributions

O.O.O. and M.S.A. contributed equally to the conceptualisation and writing of the manuscript. The introduction section was written by O.O.O. while M.S.A. wrote the background and methods section. The results section was jointly written by M.S.A. and O.O.O. The discussion section was written by O.O.O. and the conceptual framework was developed by O.O.O.

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Data availability

Data sharing is not applicable to this article, as no new primary data were created or analysed in this study. The study is a review of openly accessible articles in online journal databases.

Disclaimer

The views expressed in the submitted article are solely of the authors and not an official position of the affiliated institution.

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