Health information systems in developing countries: Case of African countries

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Abstract

Background: In developing countries, health information systems (HIS) is experiencing more and more difficult to produce quality data. The lack of reliable health information makes it difficult to develop effective health policies. In order to understand the organization of HIS in African countries, we undertook a literature review.

Methods: Our study was conducted using the PubMed and Scopus bibliographic search engines. Our inclusion criteria were: (i) all articles published between 2005 and 2019, (ii) including in their titles the keywords "health", "information", "systems", "system", "africa", "developing countries", "santé", "pays en développement", "Afrique", (iii) written in English and French, (iv) dealing with organizational and technical issues of HIS in African countries.

Results: Fourteen articles out of 2492 retrieved were included in the study, of which 13 (92.9%) were qualitative. All of them dealt with issues related to HIS in 12 African countries. All 12 countries (100.0%) had opted for a data warehouse approach to improve their HIS. This approach, supported by the DHIS2 application, had provided them with reliable data. However, 11 of the 12 countries (92.0%) were aligned with donor strategies and lacked a national strategy.

Conclusion: This study helped us to understand that the lack of a national health information management strategy will always be a threat to HIS performance in African countries. Ideally, rigorous upstream thinking to strengthen HIS governance should be undertaken by defining and proposing a coherent conceptual framework to analyze and guide the development and integration of digital applications into HIS over the long term.

1. Background

Health information is strongly related to the performance of a health system, in that it
enables it to be effective and efficient [1]. Every year, for example, the World Health Organization (WHO) publishes statistics on the world health situation to measure countries’ member health outcomes. It shows the challenge of health information for any health system to have a well-structured health information system (HIS) that produces, analyses and disseminates reliable and timely information for it to support decision making at all levels of its health pyramid. Therefore, investing in the implementation of HIS, in addition to being an objective, must be a challenge for each health system to hopefully have better monitoring of national indicators and health-related United Nations sustainable development objectives (SDGs).

1.1. Relationship between a health system and a health information system

To better establish the relationship between a health system and a health information system, it was necessary for us to first understand what a health system is as defined by the WHO. According that definition, a health system is defined as "all organizations, individuals and actions whose primary purpose is to promote, restore or maintain health" [2]. To achieve this objective, the health system is based on a conceptual framework with six pillars that are outlined as follows.

Leadership and governance: involves defining national health policies, roles and responsibilities of the actors involved;
Health financing: implies having the necessary funds to finance expenditure related to the health needs of populations by enabling them to benefit from services that effectively deliver services;
Health personnel: implies that the health system must have a quantity and quality of human resources in health to support its performance;
Essential medicines, vaccines and technologies: implies a better functioning of the health system, requires an adequate availability of medical products and technologies;
Service delivery: implies an organization of health service delivery that efficiently corresponds and responds to the temporal spatial health needs of populations;
Health information: implies making available to the health system all the health information necessary to take useful decisions to plan, monitor and evaluate actions undertaken or to be undertaken in order to achieve the health objectives defined in health policies.
The conceptual framework defined by the WHO clearly shows that the organization of the health system must be perceived in a systemic approach by taking into account all its components, including that related to its information system. It is also defined by the WHO as "an organized system that integrates the collection, processing, communication and use of data necessary to improve the effectiveness and efficiency of health services through better management at all levels of health services". This definition highlights the transversal nature of a HIS, in that it integrates the entire structural dimension of a health organization.

From this definitional approach to the health system and the HIS, it is clear that no health system that is intended to be effective can become effective without having a health information system capable of collecting, processing, analyzing and making available reliable and timely information for planning, monitoring and evaluating health actions.

1.2. Problem statement

Although having a HIS is a necessity for any health system, many developing countries still have difficulties at present in having reliable and complete health related data. This issue does not always allow them to achieve the best health results and means that their performance is far from meeting the needs of the population [2]. This literature review aims to provide an overview of the factors that influence the optimal functioning of information systems in such countries.

1.3. Methods of operation

Our work was carried out from February to July 2019 in three stages, (i) searching for relevant articles, (ii) selecting articles, performed by carrying out a complete reading of the articles one after the other according to the publication dates and (iii) proceeding the analysis of all articles in a general synthesis.
1.4. Research strategy

For articles look-up, we used the Scopus and PubMed databases to conduct our bibliographic search. To do so, we searched for relevant articles with titles that included the following keywords: "health", "information", "systems", "system", "africa", "developing countries", "Africa".

Using the filters present in these two databases, relevant articles have been selected on the basis of the following criteria:

Table 1: Inclusion criteria.

Inclusion criteria:
Original articles written in English or French, peer-reviewed, published between 2005 and 2019; Research to study the factors that influence the performance of HIS in developing countries.

We formulated the bibliographic search equations based on these criteria (Fig. 1 and Fig. 2):

1.5. Selection of relevant articles

Based on the eligible articles for our selection criteria, we carefully reviewed each article title to reject articles whose title, although incorporating some of our keywords, did not correspond to the objective of the literature review.

All selected articles were reviewed. During this review process, we analyzed the various organizational and technical factors that influence the optimal functioning of HIS in DC in terms of strengths and weaknesses. The overall diagram of the selection process is detailed in Figure

2. Results

Based on the keywords selected to constitute the basis of our bibliographic research, we identified a total of 2492 articles: 624 identified in PubMed and 1868 identified in Scopus.

Using our selection criteria (full articles, written in English or French, peer-reviewed and
published between 2005 and 2019) 32 articles were eligible. We then carefully reviewed the titles and abstracts of the 32 articles to double check the selection criteria, which resulted in the selection of 14 articles that corresponded to the objective of our work (Fig. 1).

Faced with public health challenges, such as SDGs, the essential role of information in a health system is increasingly highlighted in all countries [3]. Indeed, reliable and solid health information facilitates, on the one hand, better monitoring of SDGs indicators and, on the other hand, the development of health policies based on established facts.

Unfortunately, many countries still with a health information management which faces factors that do not allow HIS to adequately meet information needs [4].

A systematic review of the 14 resulted scientific articles enabled us to take stock of the state of health information management in some countries in Africa where such an information has been subject of a scientific publication (Fig. 4). These selected articles dealt with issues of evaluation, organization, data quality, improvement or development of integrated information systems or data warehouse (Fig. 5).

Four articles dealing with general HIS issues in Africa [8, 12, 16, 20] and 10 others dealing with HIS-specific issues from 12 countries: South Africa [13, 14], Benin [9], Botswana [14, 15], Ghana [15], Malawi [1, 5, 10], Mozambique [19], Rwanda [19], Sierra Leone [14, 18], Tanzania [19], Zambia [19], Zanzibar [14, 17], Zimbabwe [15]. Although the literature on health information systems in these countries has been limited, the analysis of the literature available to us has allowed to identify the organizational and technical structure of each HIS.

Of the 14 articles selected, 13 (92.9%) were qualitative in nature. All 10 articles dealing with HIS issues from 12 African countries had addressed the topic of health data warehouses, 10/10 (100%).
2.1. Insufficient integration of stakeholders and coordination in the implementation of the HIS

A health system, insofar as it involves several actors to achieve its objectives, should also proceed by involving all these actors in the implementation of a reliable HIS strategy. The review of the literature shows that taking into account the needs of all stakeholders in the health system is the common point between the countries found in the projects to set up HIS in Africa, although these systems have been implemented in different ways. It is by drawing on their national health plans and involving all stakeholders that some countries have identified the needs and defined all the aspects to be taken into account in the design phase of their HIS [5]. Although the development of national HIS strategies has not often been sufficiently highlighted, it has nevertheless been noted in the literature that some countries that have taken into account the needs of all stakeholders have put in place coherent strategies for the integrated management of their HIS [6]. However, it should be noted that these strategies are generally shorten in nature, generally sometime after the project is implemented [7]. Insufficiently asserted coordination with well-defined roles and responsibilities also makes it more difficult to ensure the sustainability of these integrated HIS, making them less and less effective with data of questionable quality. This situation tends to promote the fragmentation of HIS within actors using specific information systems to collect the data they need. This fragmentation of the HIS is sometimes encouraged by some funding organizations that prioritize certain subsystem needs to the detriment of the more global needs of the integrated HIS [8]. Health programs collecting more specific data to meet the objectives of their donor agencies have little involvement in more comprehensive strategies for developing and managing more integrated HIS [9]. This explains the fact that many HIS projects have experienced governance problems as a whole [10]. This is why some countries such as Malawi have optimized the quality of their data by asserting their leadership, including by
implementing a national strategy. We observed that 11 of the 12 countries under study (92%) did not have a national strategy, but rather strategies implemented under a Project. The Malawi is the only one of the countries under review in this review that had a national strategy to which all actors, including donors, must align. This strategy was accompanied by a procedural guide to facilitate the design of a HIS integrating all sub-systems [11]. Despite the implementation of coherent strategies such as national health plans that integrate the development and management of HIS, it is clear that insufficient integration of all stakeholders and coordination of HIS is not conducive to the production of comprehensive data. Indeed, collecting data from multiple non-harmonized tools makes it difficult for managers to fill out various paper or electronic forms at the same time for several programs [12]. The use of statistical surveys to estimate certain necessary indicators is the means used by some countries to circumvent the problem of unreliable data [13].

In 2007, the WHO as well as other partners working to improve HIS established mechanisms to align their support with national strategies, policies and procedures developed by partner countries [14]. In this perspective, some countries have undertaken to evaluate their HIS in the first instance and to develop national plans and policies in the second instance, with which all initiatives should be aligned with the identification and harmonization of indicators as one of the first requirements of this approach [15, 16].

2.2. Organization of technical and infrastructural support for the implementation of HIS

To enable the country to achieve better health outcomes, several funding agencies had advocated the integration of data into Data Warehouses. This recommendation to materialize requires the commitment of all actors to the planning and strategies
implemented by the countries. In this regard, some mechanisms to align international efforts with national systems have been set up, including the International Health Partnership (IHP+) and the Partnership for Statistics for Development in the 21st Century (PARIS21). Some initiatives, in line with this logic, have been undertaken with the District Health Information System (DHIS) software, among others, in South Africa, Sierra Leone, Zanzibar and Botswana [14].

In South Africa, the approach had been to validate a standard model on which to build a data warehouse (DW) based on the DHIS software. This DW operates in parallel with other existing subsystems. It is notified at all levels of the health pyramid and the subsystems, regardless of their specific needs. At the level of three other countries, the approach was to integrate all subsystems into a single DW. In Botswana for instance, it was intended to integrate all the paper forms of the subsystems into the DHIS software without any prior standardization, resulting in data overlap and duplication. Zanzibar and Sierra Leone, for their part, opted for a consensual sorting (with all stakeholders) of data from the different sources before their integration into a unique DW. Although using the same approach in standardizing the data to be pre-integrated, the recording of data in warehouses was different in the two countries. In Zanzibar, paper forms were used to collect data from health facilities and made available to health districts, which were then filled in the DW. To overcome the errors which may occur with a manual process associated with the use of paper forms, the Zanzibar Ministry of Health had undertaken a project to use the OpenMRS clinical management software at the health facility level for processing and recording data in the DHIS warehouse. However, this OpenMRS-based project is experiencing difficulties in its implementation due to limited technical capacity [17].

Sierra Leone has had an approach that takes into account the context of unequal distribution of technical infrastructures in the country. The adapted and validated digital
DHIS solution served as a repository for the national HIS at all levels of the health system. The adaptation of DHIS was done in such a way that in areas with a digital infrastructure, this repository exchanged data with a hospital information system (HIS), such as OpenMRS where the SDX-HD standard facilitates this data exchange. The DHIS solution also provides the ability to enter data from paper or mobile phones. It is therefore a model that allows data to be recorded at all levels and aggregated in one place [18]. This evolutionary approach, based on a collaborative architecture, has enabled Sierra Leone health system to have increasingly accurate health data that is accepted by several organizations that use it.

Five other countries (Ghana, Mozambique, Rwanda, Tanzania, Zambia and Mozambique) which received support from the International Health Partnership had used the DHIS software to implement their HIS. In Zambia, Rwanda and Tanzania for instance, the software had been adapted by standardizing and computerizing the various registers to collect data on care delivery from the health facilities. While Ghana and Mozambique have adapted the software from the standardized tools collected, in order to record aggregated data at the facilities, district and regional levels [19]. For the majority of cases, initiatives to implement integrated HIS in the different targeted developing countries have been technically supported by the use of the DHIS solution. This digital solution, with open source code, has enabled several projects, even with various approaches, to digitize data management and analysis from the health district to the central level [20]. At the structural level, DHIS was either filled in from the paper supports that allowed the collection of care services, or by using an Extract, Transform & Load (ETL) application that extracts data from the given HIS to transform them and loaded them into a central DW.

2.2.1. Presentation of the common platform used in the HIS projects in Africa: DHIS

DHIS is an open source software platform for the integration, analysis and dissemination
of routine health data developed by the Health Information Systems Program (HISP) with the support of the Department of Computer Science at the University of Oslo in Norway.

Initially designed and developed for data collection at the level of basic health committees and community information systems in health districts, the platform evolved into a web-based version 2 in 2006 with an adaptation at the national level, hence DHIS2 for version 2. Oriented towards the capture of aggregate data from health programs. The application has a module called "tracker" that can be parameterized to allow data to be recorded in the most granular way possible and facilitate automatic compilation. This module, which is far from playing the role of an electronic patient record, is more oriented towards data specific to certain health programs and almost not towards care services with more complex data.

Table 3

| Organizational Issue | Technical Issue |
|----------------------|-----------------|
| Strengths:           | Strengths:      |
| • Definition and validation of the data to be collected by all stakeholders; | • Possibility to contextualize and adapt DHIS to nationally validated models; |
| • Review and harmonization of data collection tools to avoid data overlap and duplication; | • Consensus approach to a system; |
| • Definition of harmonized national indicators; | • Removal of redundant data and improvement of data quality at the central level; |
| • Validation of a national data warehouse, sometimes cohabiting with existing subsystems; | • Possibility to enter DHIS information from a mobile phone or a paper data collection medium; |
| • Consensual choice of essential indicators by theme; | • Storage and centralization of data in a single database. |
| • Creation of a HIS coordination unit housed at the level of the Ministry of Health in some cases. | Weaknesses:      |
| Weaknesses:          | • Design (of DHIS) taking insufficient account of the needs of data-producing structures because the collection and transmission of aggregated data more helps decision-making at the central level and not the local one; |
| • HIS not sufficiently taken into account in national health policies, making it difficult to ensure the sustainability of HIS at the end of projects; | • Unable to collect primary data in DHIS (individual patient data); |
| • Inadequate institutional management of HIS; | • DHIS does not allow the linking of care data with those of other systems such as health insurance; |
| • Coherent conceptual frameworks insufficiently defined ; | |
| • Dependency on external donors for HIS funding. | |

3. Discussion

3.1. **Main lessons learned**

The implementation of an HIS must take into account the process of data collection, analysis processing and transmission at all levels of the health pyramid and support decision-making. This requires that the development of HIS be supported by sufficient
governance with policies integrating HIS-related aspects, including harmonized indicators, forms (electronic or paper) for integrated data collection, user-friendly databases.

From the conducted literature review, it mainly emerges that governance, a crucial element for an efficient HIS, has not been sufficiently taken into account in most of the projects to set HIS up in DC. The weak involvement of all stakeholders, together with weak leadership expressed by States and insufficient coordination of HIS actors are among the main factors that have often threatened the sustainability of these HIS [10]. This is clearly highlighted by the results of some HIS evaluations conducted using the WHO Health Metrics Network (HMN) framework and the US Agency for International Development (USAID) Performance of Routine Information System Management (PRISM) tool [9, 10]. It appears that in most cases, these HIS implementation projects are supported by external donors, with involvement limited to a simple consensus between actors without a regulatory coordination framework at the country level [19]. Although stakeholders have often been involved in the phase of identifying information needs, harmonizing collection tools, defining data to be collected and indicators, it is unfortunately worth noting that the absence of a framework that is enforceable against all does not always guarantee the establishment of an integrated HIS in the long term [18]. The development of policies and strategies is an asset for the continuation of an integrated HIS after the withdrawal of the external donors, since the implementation of these HIS is based more on the policies of donor agencies, which prioritize their own needs over national needs.

Some countries that have set HIS up projects on the basis of national strategies have sometimes had better data [17]. However, overall, it can be observed that despite these few successes, a number of weaknesses persist, including those related to inadequate policies and insufficient data centralization, resulting in often incomplete data. To maintain this momentum for improving data quality, it is appropriate for the ministries in
charge of health to assert their leadership by developing national information management policies and strategies by defining the roles and responsibilities of the various actors with coordination structures.

The use of information and communication technologies as a support for the HIS to collect, process and disseminate health information is widely observed in DC. The implementation of the context-specific DHIS solution makes it easier than ever to collect and transmit information at the central level to support decision-making [20]. However, it is unfortunate that the non-systemic structure of this IT solution, which takes very little (if any) into account the health related data at the structure level, undermines this category of actors (local structures) who, in addition to producing the data, were to be their first users of these data.

3.2. **Limitations of the study**

Our review, in addition to being less exhaustive in terms of representativeness of the countries whose HIS were analyzed in this study (12 out of 54 African countries), also has a low number of articles retained. Also, out of the 12 countries whose HIS issue were studied, 11 were English-speaking countries. However, the reality of HIS management in English-speaking countries may not be the same as in French-speaking countries, even if the health problem is the same. It is therefore advisable to deepen such an initiative at the level of French-speaking countries and to establish the management of the HIS is the same according to whether one is in an English-speaking or a French-speaking country.

**Conclusion**

The implementation of an efficient and effective information system implies in its design a systemic approach, with the global consideration of the needs of stakeholders at all levels of decision-making, including at the level of the health care structure. Although not sufficiently implemented in practice, because it is done in a consensual way without an
enforceable framework with coordination, it has been observed that most projects initiated in Africa to set up or improve HIS have integrated this systemic approach by taking into account the needs of various actors. The main concern would be that this systemic approach is often not supported by strong leadership from ministries of health. Nevertheless, during the time of a project with a consensus between stakeholders, some countries have managed to obtain quality health data. This leaves an optimism that with a coherent, unifying governance in terms of the management of state health information, best health indicators can be achieved. In this case, IT solutions such as DHIS alone are not enough. It requires that during the development of HIS, rigorous upstream reflections on strengthening HIS governance should be carried out by defining and proposing a coherent conceptual framework that will make it possible to analyze and guide the development and integration of IT solutions into the HIS.

Abbreviations

WHO: World Health Organization
HIS: health information systems
SDGs: sustainable development objectives
DHIS: District Health Information System
USAID: US Agency for International Development
HMN: Health Metrics Network
PRISM: Performance of Routine Information System Management
HISP: Health Information Systems Program
SOGIM: Société Gabonaise d’Informatique Médicale

Declarations

Ethics approval and consent to participate
This study did not incorporate the practical aspects arising from ethical principles, such as man and respect for human dignity.

**Consent for publication**

All authors consent to publication

**Availability of data and material**

Not applicable

**Competing interests**

The authors declare that they have no competing interests

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**Authors' contributions**

APK designed the research project, GD and EBN validated the methodological approach and the research equations. APK proceeded with the bibliographical research, downloading the articles. APK, UJB, EBN and GD carried out the literature review by reading the 14 selected articles and synthesizing them. APK wrote the first draft of the manuscript. GD improved the manuscript in English. All authors participated in the final review of the manuscript, corrected and approved the manuscript for submission.

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Figures

**Figure 1**

Bibliographic research equation on the Scopus database
Figure 2

Bibliographic search equation on the PubMed database

- Articles identified in PubMed (n=624)
- Articles identified in Scopus (n=1,868)

Application of our filter criteria on articles (n=2,492)

Careful reading of titles and articles summaries (n=32)

Articles selected for the study (n=14)

2452 excluded articles

18 excluded articles

Figure 3

PRISMA process diagram

(((health[Title]) OR information[Title]) OR systems[Title]) OR "pays en développement "[Title]) OR Africa[Title]) OR developing countries[Title]
**Figure 4**

Places concerned by the information systems studied in our study

| Articles | General HIS issues in Africa | South Africa | Benin | Botswana | Ghana | Malawi | Mozambique | Rwanda | Sierra Leone | Tanzania | Zambia | Zimbabwe |
|----------|-----------------------------|--------------|-------|----------|-------|--------|-------------|--------|--------------|----------|--------|----------|
| Karuri J et al., 2014 [1] | x | | | | | | | | | | | |
| Chululagai CN et al., 2003 [2] | | | | | | | | | | | | |
| Abou-Zahr C et al., 2005 [3] | | | | | | | | | | | | |
| Glők Abahaziz Y et al., 2016 [4] | | | | | | | | | | | | |
| Alman A et al., 2016 [5] | | | | | | | | | | | | |
| Amoula S et al., 2012 [6] | | | | | | | | | | | | |
| Cline GB et al., 2013 [7] | | | | | | | | | | | | |
| Sebio J et al., 2011 [8] | | | | | | | | | | | | |
| Asil A et al., 2016 [9] | | | | | | | | | | | | |
| Beka J et al., 2015 [10] | | | | | | | | | | | | |
| Mutale W et al., 2013 [11] | | | | | | | | | | | | |
| Ly O et al., 2018 [12] | | | | | | | | | | | | |

**Figure 5**

Themes covered in the 14 articles examined