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Developing a national e-health strategy for DR Congo: a preliminary analysis of business needs, existing information systems and solutions

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Background and purpose: In order to reclaim its leadership and to better align existing and future ICT implementations in the health domain with the strategic options defined by the National Plan for Health Development, the Ministry of Health (MoH) of the DRC initiated early 2014 the development of a national e-health enterprise architecture. During the preliminary phase of the architecture development cycle, an initial analysis of human resources, business processes, hardware, software, communication and networking infrastructure related to health information management, had to be established.

Methods: A first part of the study consisted of a detailed analysis of regulatory documents and strategic plans related to the Congolese health system and health informatics development. In a second part, field visits and semi-structured interviews were organized with a representative sample of relevant health structures throughout the country

Results: The study demonstrates the large number of business needs that must be addressed by e-health initiatives. It also documents the donor driven unequal distribution of hardware equipment over health administration components and health facilities. Internet connectivity remains problematic and few health oriented business applications found their way to the Congolese health system. Paper based instruments remain predominant in DRC's health administration. The study also identified a series of problems introduced by the uncoordinated development of health ICT in DRC such as the lack of standardization, data security risks, poor data quality, inadequate ICT infrastructures, an unregulated e-health sector and insufficient human capacity.

Conclusions: The results confirm the precarious situation of the Congolese health information system but they also expose a number of bright spots that provide hope for the future: a political will to reclaim MoH leadership in the health information management domain, the readiness to develop e-health education and training programs and the opportunity to capitalize the experiences from early successes with DHIS2 and a number of hospital information management systems.

Keywords: eHealth enterprise architecture, TOGAF, Health information systems, Democratic Republic of the Congo

1 Introduction

The Ministry of Health of the Democratic Republic of the Congo (MoH) has developed in 2006 a Health System Strengthening Strategy [2], which was reviewed in 2010. This strategic plan was further translated by the MoH and its technical and financial partners into a series of objectives and results in the National Plan for Health Development 2011-2015 [1]. Amongst the objectives were the reinforcement of the National Health Information System and the restoration of the MoH leadership in the field of health information management. Therefore, a number of interventions have been put in place:

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- A Program for Reinforcement of the National Health Information System, focusing on regulation, coordination between national and provincial levels and development of better solutions for structured health information gathering.
- A Program for Health Information Quality Improvement, including human resource capacity building, production of improved health information collection tools, private sector integration and development of data collection procedure reengineering.
- A Program for Improved Health Information Utilization, targeting the implementation of central and provincial health data warehouses with practical information dashboards and the promotion of research based on routinely collected health data.
- A Program for the Strengthening of MoH Communication, covering health information dissemination, the development of a website for the MoH and the implementation of a national electronic communication network for the health sector.
- A Program for the Health Information System Reform, aiming at the progressive replacement of the actual indicator oriented data collection mechanisms with solutions based on secondary use of data from patient-centric registration systems (electronic health record, billing systems, vertical health programs...)

In spite of the efforts put in the implementation of these programs, many issues remain today which prevent an efficient and effective health information management at the MoH:

- The MoH still has no leadership in the health information management domain giving way to a disorderly implementation of many donor-led ICT solutions that don't effectively address other than the donor's objectives.
- Software solutions often remain limited to basic office applications and few departments have implemented appropriate business solutions addressing their functional needs.
- The lack of means for electronic communication compromises the transmission of data from peripheral health structures to national data warehouses
- There is almost no harmonization of solutions between directorates and national, provincial and district levels of the MoH, hindering data merging and centralization.

In order to reclaim its leadership and to better align existing and future ICT implementations in the health domain with the strategic options defined by the National Plan for Health Development in DRC [1], the MoH initiated early 2014, with financial backup of the Belgian Technical Cooperation, the development of a national e-health enterprise architecture. The Open Group Architecture Framework (TOGAF) [11] was chosen as the reference methodology for developing this architecture. During the preliminary phase of the architecture development cycle, an initial analysis of human resources, business processes, hardware, software, communication and networking infrastructure related to health information management, had to be established. This study describes the objectives, methods and findings of this preliminary analysis.

2 Materials and methods

The main objective of the preliminary analysis was to provide a reliable estimation of the existing human and material resources and issues related to health information management in RDC. This study was part of the preliminary phase of a complete e-health enterprise architecture development cycle according to the TOGAF methodology, and therefore its output had to address a number of expectations defined by TOGAF. Summarized, the analysis focused on providing answers to the following questions:

- What are the MoH business needs in terms of health information management?
- Which health information management applications have already been implemented in the field and to what extent do they address specific business needs?
- What data is being collected today by the MoH and what is the quality of it?
- Which technologies (software, hardware, and networking) are being used today in the health domain in DRC?
- What are the important health information management problems today in DRC?

A first part of the study consisted of a detailed analysis of a number of regulatory documents [9, 10] and strategic plans related to the Congolese health system implementation [1, 2, 3, 4, 5] and health informatics development [6, 7, 8].

In a second part, field visits and semi-structured interviews were organized with a representative sample of relevant structures of the MoH throughout the country. For the sake of completeness and standardization, a study-specific interview guide [12] has been developed and was systematically used by the interviewers.

A study of regulatory documents and strategic plans took place in May and June 2014. After that, a first series of field visits and interviews have been organized with 39 relevant MoH and -related structures in the Kinshasa region:

- The secretariat-general and all 13 MoH directorates
- Major health programs (hiv/aids, tuberculosis, mental health, universal health coverage, vaccinations, national health accounts)
- Donor agencies and technical partners (Belgian Technical Cooperation, European Union, World Health Organization)
- Health facilities (University Teaching Hospital of Kinshasa, Ngaliema Reference Hospital, Reference hospitals of Kisantu and Monkole)
- Educational institutions (University of Kinshasa, School of Public Health, ISTM Kinshasa, ISIPA Kinshasa, CEDESURK)
- Telecom operators and ISPs (Airtel, Orange Telecom, Vodacom)
- Other organizations (National Center for Pharmacovigilance, MoH IT-professionals council, Prime Minister's Office)

In the period from July-September 2014, the e-health architecture development staff also visited 5 other provinces. In total a sample of 5 provincial health offices (45%), 55 health zone administrations (11%) and 69 hospitals (13%) have been analyzed by the study, representing an overall coverage of more than 10% of the MoH structures.

Province	Provincial health office	Health district administrations	Health zone administrations	Hospitals	Educational institutions	Research organizations
Bas Congo	1		5	6		
Katanga	1	4	12	14	2	
Northern Kivu	1		10	13		1
West Kasai	1		18	20	2	
Oriental Province	1		10	12	2	

Table 1. Field visits organized in 5 provinces outside Kinshasa

After an introduction on the purpose of the interview, representatives of each structure have first been questioned about the mission, the mandate and the vision of their organization, the objectives, the functions and the roles fulfilled and the way the work is organized. After that, a detailed analysis was made of health information management related human resources, ICT solutions and non-ICT (paper based) instruments at their disposal and existing procedures for exchanging health information with other (MoH or non-MoH) organizations. Finally, an analysis was performed of health information management problems, expected benefits, potential threats and the perceived importance of health ICT for each component of the organization.

3 Results

3.1 Business needs

The most important business needs that were identified in our study have been brought together in a list of 10 business chapters:

- Human resource management constitutes a major challenge for RDC's health sector. Unique health worker identification will be a first mandatory step towards developing individual work contract

management (covering public servants as well as locally contracted workers), salary and payment management, career management, qualifications and competence management, leave management and disciplinary record management.

- Operational management of material resources is a second chapter that must be developed; it not only covers a physical inventory of the health system's assets, but also the careful planning of maintenance and quality control and inspection operations.
- Financial resources are poorly managed in today's public health system in RDC. There is a lack of normalized accounting plans, nomenclatures for provided health services, and coding systems for donors, gifts, loans etc. No information system for budget planning has been put in place. Follow-up of public tenders is a predominantly manual procedure as well as the management of tender guarantees and insurances. Finally, there is a huge need for implementing a solution for standardized general and analytic accounting at all levels of RDC's public health system.
- Regulation and normalization are essential tasks of the many directorates at the central level of RDC's Ministry of Public Health. Unfortunately, newly created normative documents do often not fully take into account existing legislation due to a lack of legislative consolidation. The creation of a consolidated health legislation (*Code de la Santé*) using appropriate ICT tools has been identified as a priority for the MoH.
- Paper based health information management in RDC's public health facilities is outdated and hardly functional. The introduction of integrated health facility information systems covering hospitals, health centers and community health workers is a must. Such systems must include modules for individual electronic medical record management, financial transactions management, pharmacy, lab and medical imaging management, paper based health record filing, preventive medicine and statistical reporting. Integration of basic solutions for tele-consultation and tele-expertise must help to cope with the chronic lack of clinical expertise in rural RDC.
- The lack of health-ICT qualifications with RDC's healthcare workforce will require the development of large scale health informatics training programs at academic (post-graduate and undergraduate), non-academic higher education and community levels.
- The use of ICT-tools for health-related research must be stimulated and developed. Existing research initiatives must be inventoried as well as published papers and work in progress.
- National aggregate health data collection and production of health indicators suffers from poor quality source data due to the massive use of redundant paper based data collection instruments, which are not integrated with care-oriented data registration procedures. Data collection for national reporting is therefore perceived by many users as pure administrative overhead. Public health data collection development should therefore focus on integration with existing business processes of care oriented data registration (e.g. secondary use of individual health record data extracted from EMR systems).
- Planning of public health sector activities and spending is poorly organized. Few well-functioning experimental solutions exist at the central level of the MoH, but their content is poorly disseminated to the lower levels of the health system. The use of ICT-solutions for health system planning should focus on execution and monitoring of activities identified in the National Plan for Health Development (PNDS), human resource planning, material resource management, financial resource planning, harmonization of donor and NGO interventions and inter-sector or inter-ministry coordination.
- A last business chapter identified the important need for electronic communication solutions in RDC's health sector. The daily transfer of all kinds of business data between the more than 120.000 public health workers constitutes a huge challenge for a country that suffers from unreliable power- and network infrastructures. Still, the need for solutions that enable the production of letters and structured office documents, the rapid exchange of information between health workers and third parties, the archiving of huge amounts of information, the publication of information of public interest and the implementation of workflow logic, must be properly addressed.

3.2 Hardware

The study showed that computer hardware has most often been supplied to the MoH within the scope of donor-driven intervention programs. There is no organization-wide management of computer equipment and therefore distribution of hardware over the different MoH directorates, provincial or zone administrations and hospitals is very heterogeneous: some structures which are supported by several donors are very well equipped, others remain without any computer hardware at all.

Generally speaking, hardware specifications are quite standard: desktop PCs with Windows XP and Windows 7 operating systems, of which a large number have limited functionality due to computer virus infections (there is no budget available for keeping antivirus software databases up to date and most of the PCs have no access to internet for performing updates anyway). PCs are almost systematically accompanied by an uninterruptible power supply (UPS), but due to the lack of battery maintenance, the protection offered by these UPSs is minimal.

Most of the executive staff make use of laptop computers which in about half of the cases are their personal privately owned equipment.

Many of the MoH structures own one or more printers. Most of them are individual printers that are not being shared in a network. Toner and ink cartridge supply is very problematic due to unavailability of toner cartridges on the Congolese market or absence of a budget for that kind of operational costs.

Files and documents are commonly transferred from one computer to another using USB memory sticks, which constitute an infamous source of virus infections.

3.3 Networks

At the central level (Kinshasa region), most of the MoH structures have a local network (wired or Wi-Fi) at their disposal. Sometimes, these networks are connected to the internet thanks to donor funding, which unfortunately is always limited in time (and sometimes also in data volume). Internet bandwidth offered by local ISPs in Kinshasa is poor and unstable. Although optical fiber connectivity has recently become available in Kinshasa and Lubumbashi, excessive government taxation has prevented the expected price drops or improved availability of high-bandwidth internet in Kinshasa.

Installation of internet connections is uncoordinated, resulting in some structures accumulating several (poorly performing) parallel connections on the same site: 7 different wired internet connections have been identified at the site of the secretariat-general, without taking into account the dozens of individual 3G-USB modems offered by some donor programs. Remarkably, in spite of the generally unreliable internet connectivity, most MoH structures at the central level state that an internet connection has become indispensable for their activities.

Outside the capital and larger cities such as Lubumbashi, Mbuji-Mayi, Kananga, Goma or Kisangani, the situation is completely different. Wired internet connections are almost systematically unavailable and performance of 2G and 3G wireless data networks is extremely poor. Donor agencies (such as DFID, EU or Global Fund) are increasingly equipping MoH structures with VSAT connections, which have the advantage of providing stable and reliable bandwidth. Unfortunately, they come with high operational costs, causing the internet connection being unavailable part of the time due to inappropriate use (downloading of movies or audio) which can consume all of the monthly foreseen VSAT credit in only a few days. Thuraya phones and modems have been forwarded as a possible solution for the Central African region but we haven't seen one during our numerous field visits in DRC.

3.4 Software

Almost all of the end user computers run Microsoft Windows operating systems (XP, version 7 and 8) completed with Microsoft Office applications, with the exception of laptop computers in the University Teaching Hospitals of Kinshasa, Lubumbashi, Kisangani and Bukavu, which are running Ubuntu. Debian and Ubuntu operating systems also seem to be increasingly popular on MoH servers.

Although health specific software implementations remain rare, a clear tendency towards web-based business applications is being noted, often based on Linux/Apache, MySQL databases and PHP or Java development:

- The MOH started in 2014 pilot implementations of the DHIS2 data warehouse in Kinshasa and West Kasai as a replacement for the outdated MS Access based GESIS health data collection solution. Further extension of DHIS2 to the Maniema and Equator provinces was scheduled for end 2014 and by the end of 2016 all DRC provinces should be covered. Early DHIS2 deployments in DRC uncovered a list of technical and operational problems, many of them related to poor internet connectivity and unreliable offline data entry. These must be solved before national DHIS2 rollout can be successfully planned.

- iHRIS human resource information system deployment also started end 2014 with the first implementation pilots scheduled for the first quarter of 2015.
- Hospital information system (HIS) implementations remain exceptional (less than 2% of the hospitals), with 3 health university teaching facilities in our study sample running OpenClinic GA, 1 hospital running an alpha edition of BHIMA and 4 hospitals using different locally developed Microsoft Access or SQL Server based applications. The majority of the HIS solutions are concentrated in third level reference health facilities.
- Alfresco document management was installed at the central MoH level but is not yet being used in a production environment
- Joomla and Drupal seemed to be the most popular solutions for dynamic website content development (13 out of 14 sites or 93%)

Epi-Info and SPSS are the leading statistics software solutions at the central level, where CSPro also gained some popularity in remote structures.

General and analytical accounting systems are extremely scarce in the health sector structures of the DRC: Progi-Santé (local development), Account-Pro, Ciel Compta and SAGE are being used by a handful of health facilities while Tompro was recently introduced for project-oriented accounting at the central MoH level.

Software type	Central level	Intermediate & peripheral level
Operating systems	MS Windows (XP, 7, 8) Debian & Ubuntu Linux	MS Windows (XP, 7, 8) Debian Linux
Office applications	MS Office	MS Office Libre Office
Database servers	MySQL MS SQL Server	MySQL MS SQL Server
Statistics software	Epi-Info SPSS Epi-Data	Epi-Info CSPro SPSS STATA Epi-Data
Accounting	Ciel compta Tompro	Progi-santé Ciel compta Account-pro SAGE
HIS	OpenClinic GA OpenERP-Medical PPH	OpenClinic GA Gestion hospitalière BHIMA
Data warehouse	DHIS2	DHIS2 GESIS (exit strategy)
HR management	iHRIS	iHRIS
GIS	Epi-Info Maps Quantum GIS Healthmapper (WHO)	Epi-Info Maps Quantum GIS Healthmapper (WHO)
Planning software	GPSS WISN (WHO) Health Accounts Production Tool MS Project	CDMT
Content management	Joomla Drupal Alfresco	Joomla

Table 2. software systems identified

3.5 Paper based instruments

Only 2 of 11 provinces and some 30 health zones out of 516 are using ICT-tools for reporting health data to the central level, meaning that the vast majority of the MoH structures still rely on paper based instruments for routine data collection. Information is written down in registers by peripheral health center- or hospital staff and sent on a monthly basis to the health zone administration (emergency surveillance information is sometimes reported more quickly using SMS). Health zones then forward compiled health facility data to the provincial level, where eventually provincial reports are sent to the central level in Kinshasa.

A minimum of 32 registers must be kept up to date permanently by each health center. Additionally, donors and health intervention programs claim parallel and redundant reporting from the health facilities and zone administrations they support, which represents an impressive administrative overhead.

Paper based instruments are also predominant in the vast majority (98%) of the hospitals, which all suffer from low quality health information management.

3.6 Health information management problems detected

Over the past 10 years, the existing health sector ICT landscape of the DRC has been growing organically, with the majority of the project-oriented solutions being brought in by donors and health programs. This happened in an uncoordinated way, leading to:

- **Lack of standardization:** health information representation is hardly standardized and very few international classifications or coding systems are taken into account (with the exception of some of the DHIS2 and HIS modules).
- **Data availability risks:** many databases are hosted in donor countries outside DRC, with serious data accessibility risks for the MoH. Also, many MoH agents use personal computer equipment without appropriate backup procedures or anti-virus protection.
- **Data protection risks:** data access rights are not being formally organized according to the role that individual agents fulfil in the health administration; most often people have full access or no access at all to the information.
- **Poor data quality:** multiple reasons explain the poor quality of data collected in the field. There is (1) the lack of intrinsic motivation with MoH staff that don't produce data for their own purpose; (2) the important administrative burden caused by redundant health data collection processes; (3) the fact that many MoH agents don't have the necessary qualifications for producing reliable data; (4) the absence of personal consequences linked to the production of erroneous information; (5) donors often pay for project focused health data and compromise the global and systemic collection of data that is not linked to such financial benefits.
- **Poor data promptness:** the lack of reliable (electronic) communication instruments delays the transmission of health information between different levels of the health system.
- **Lack of data completeness:** data is still being considered a factor of power and the lack of perceived personal interest in information sharing interferes with effective and systematic communication of data in the health sector of the DRC.
- **Defective and insufficient computer equipment:** the vast majority of the MoH structures have no access to appropriate ICT hardware and due to the lack of maintenance procedures, many of the existing equipment has become defective. Computer virus infections also constitute a major problem for the MoH administration.
- **Inadequate ICT infrastructure:** today, access to stable electric power is out of reach for most of the MoH structures outside the larger cities. UPSs have been provided with most of the computers, but their batteries are often defective and don't provide any protection against power failures (in some regions, power failures can last for days, heavily compromising the reliability of electronics in every day's work). Affordable high bandwidth internet is unavailable for most of the MoH components. Donor project-funded internet connectivity is always limited in time and does rarely bring a sustainable solution.
- **Unregulated e-health market:** although e-health solutions are being considered "medical devices" by WHO, no standards or regulations have been put in place for bringing in ICT-tools in DRC's health system. E-Health solutions deployment therefore escapes today from any health authority control.
- **Lack of health applications:** most of the software solutions deployed in the health sector are generic office applications, statistical analysis applications or aggregate data reporting instruments. Very few health application implementations such as hospital-, laboratory-, radiology- or pharmacy information systems have found their way to the DRC's health system.
- **Insufficient human capacity:** human resources constitute a major problem for introducing e-health solutions in DRC: on the one hand, qualified staff who are capable of effectively using ICT-tools in their work environment are missing in most of the MoH structures. On the other hand, there is a plethora of unmotivated and unqualified (often pensionable) staff occupying positions in the MoH administration [13] preventing young and better qualified workers from being recruited. Additionally,

health-ICT related training and education opportunities are not aligned to the needs expressed by the different directorates and health facilities.

- **Organizational problems:** the organizational structure of the MoH reflects in no way the important transversal role of ICT in today's healthcare. The statute of ICT professionals of MoH is far from attractive, demonstrating the fact that they are considered an administrative burden rather than a valuable asset of the organization.
- **Ineffective dissemination of information:** the absence of a reliable communication network also heavily compromises the dissemination of regulations, good practice guidelines and policies from the central MoH level to the peripheral structures.

4 Discussion

This study enabled us to quantitatively and qualitatively estimate the status of health ICT tools deployment in RDC's health sector, based on a representative sample of administrative structures, health facilities, education- and research institutions. The output of the study has been used as a starting point for the further development of an e-Health Enterprise Architecture for DRC's MoH, of which a first draft was presented in Kinshasa on October 20th 2014 [12].

The study results more or less confirm the precarious situation of the Congolese health information system [1, 2, 13, 14], but they also expose a number of bright spots that provide hope for the future [16, 17]:

- There seems to be a political will to reclaim MoH leadership in the health information management domain by enforcing compliance with international consensus and standards for all future e-health initiatives, with the MoH in a regulator/gatekeeper position.
- The human resource deficit in health informatics is huge [13] and many of the country's education institutions will have to collaborate on national and international levels to provide necessary ICT training, undergraduate and postgraduate health informatics programs. The readiness to do so seems to exist on the side of the Congolese universities and the donor community [15, 17].
- Although DHIS2 pilot implementations have been facing numerous practical problems, most of the users involved in these pilots agree that a number of important steps forward have already been realized and none of them wishes to revert to paper based data collection.
- Hospital information management systems implementation has been successful in several hospitals (University Teaching Hospitals of Lubumbashi, Kisangani and Bukavu [15], Reference Hospitals of Kisantu, Monkole and Tshikaji) and provide clear evidence for the feasibility of HIS implementation in DRC [16].

The challenge remains to capitalize the experiences from the success stories and to integrate them in a new coordinated, well adapted and appropriately funded e-health strategy for the country in the next 5 to 10 years.

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Statement on conflicts of interest

None

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