

Developing Integrated National Health Information Systems in Malawi: Challenges and South-South Collaboration

1. ABSTRACT

The paper describes and discusses the development of a new integrated health information system in Malawi. This development has benefited from collaboration with other African countries such as Sierra Leone and Tanzania through the sharing of best practices and open source software. Rather than a total integration of all vertical programs in “one go”, integration can be done in an iterative manner based on the commonality of the different programs. Based on some initial successes, the process may continue and gain strength through the building of momentum as various actors see that integration is possible and useful. Organisational politics and differences, rather than technical issues, are the reason why integration of information systems are complicated and often fails. . The incremental integration approach presented in this paper was enabled by what we label the data warehouse approach, as the data warehouse was used to manage an increasing number of data sets as more vertical health programs joined the process and included their data. Three institutions started the integration process in Malawi: the Health Management Information System (HMIS) and Expanded Programme on Immunization (EPI) Unit and HIV/AIDS Department. We explore how human agency is crucial in IS development and how a linear approach to integration may fail despite a promising start.

2. Keywords:

Integration, Health Information Systems, HMIS, Data warehouse

3. INTRODUCTION

Most African countries are plagued by poor health systems and poor health status. The World Health Organisation (WHO) claims that improvement of health systems, health status and the achievement of the Millennium Development Goals (MDG) will rely upon well-functioning Health Information Systems (HIS) (WHO 2007). Three of the eight MDGs set by the United Nation (UN) to be achieved by 2015 are directly health related. These are targeting maternal and child health and killer diseases, such as HIV/AIDS, Malaria and Tuberculosis. A major problem, however, is that HIS in many countries are of poor quality, as they are often fragmented between different health programs, donors and agencies with little or no coordination between them (Braa et al, 2007). In a bid to improve and strengthen HIS in developing countries, the Health Metrics Network (HMN) was established in 2005 under the WHO (HMN, 2008). The central part of the HMN strategy is to work for integration of

different data sources and sub-system through what we here label as data warehouse approach. According to the HMN strategy, countries should develop a country data warehouse, or data repository, for aggregate data and indicators to be shared across a Ministry of Health (MoH), health programs and agencies. In this article we present the case of Malawi where the HMN data warehouse approach to strengthen the country HIS (called Health Management Information System (HMIS) in Malawi) is adapted and used to curb fragmentation of health information systems within the MoH.

The Context of Fragmented Health System

The health system in Malawi, as well as in other African countries, is dominated by more or less strong and resource rich health programs. Each of the health program deal with a particular disease, such as HIV/AIDS, Malaria, Tuberculosis (already three different programs organised as separate entities). They also deal with areas of the health services, such as the Extended Program on Immunisation (EPI) responsible for vaccination; Reproductive and Child Health (RCH) responsible for the health services addressing pregnant women, deliveries and new born, infants and children; Family Planning program; and so forth. Each of these health programs will have funding from external donors who will require reports on how their funds are used. As a consequence of such demands for data and reports (combined with the fact that the official reporting system is not able to provide such data), each vertical health program will establish their own reporting and information system. This leads to a situation where there is no coordination of information resources and no shared data standards. Given this situation, an iterative approach to integration was followed rather than having total integration of data and reports from the different vertical health programs. Starting with the official information system of the Ministry of Health (MoH), the HMIS, one vertical program at a time was included into the data warehouse. Integration was done taking into consideration the needs of each health program integrated and the commonality of the different programs. The aim was to create “win-win” situations. By working together each program would get a better system than they had before. By being able to demonstrate some initial success; showing that the integration actually worked, the integration project gained momentum and is attracting increasing interest from stakeholders. A key lesson from the process is, not surprisingly, that the obstacles to integration are typically not technical, but organisational, political and social in nature. As Latour expressed, integration of systems fail not because of technical reasons alone, but due to a combination of other more complex issues such as institutional, political, and social (Latour, 1996), particularly in cases where technology develops independently from social contexts.

This paper describes a situation where there was a failed first attempt to get all vertical programs of the Malawi health care system to use a big integrated health management information system. The reasons for its failure and the architecture of the failed system are also explained. The paper then describes the proposed iterative and data warehouse approach that addressed the problem. It also illustrate that human agency is a very crucial factor to the success of integration. Further, it demonstrates that

integration if not implemented in a flexible manner, can cause fragmentation. The paper recommends integration done in an iterative and incremental manner with consensus from involved stakeholders.

4. THEORETICAL CONCEPTS

5. *Integration*

If the word integration nowadays refers to a utilitarian goal of greater efficiency, effectiveness and competitiveness in an organization, the term could mean different things to different people (Wainright and Waring, 2004, p 329). Nevertheless in the IS literature the concept of integration has evolved over time from the narrowly technical perspective to a complex socio-technical one. The desire to integrate the different systems in order to have better information and better control has often resulted in greater risks and less control. Following the Beck's theory of Reflexive modernization, Hanseth et al. have shown through the process of integration of information systems in hospitals in Norway that the project eventually led to more fragmentation and less control (Hanseth et al., 2006). The number and role of side effects increased with increased integration (Hanseth and Ciborra, 2007). Hence with integration, complexity also increases.

In order to have a more comprehensive view of integration, we will adapt a framework developed by Carlile (2004) to share and assess knowledge across boundaries in organizations. The framework includes three progressively complex borders; syntactic, semantic and pragmatic. It also use three corresponding progressively complex processes; transfer, translation and transformation. Communication, sharing and agreeing across these increasingly complex borders are about developing an adequate common lexicon, or standards, at the syntactic border, shared meaning at the semantic border and aligning interests at the pragmatic, or political or organizational border. The proposed framework has a forth element which is the iterative cycling through the levels in order to step by step develop common understanding and alignment of interests. This framework describes an ongoing and iterative process where one attempt may not suffice and stresses the need for continuous adjustment or re-adjustment. It considers that the environment in which integration takes place is complex and unstable.

6. *Learning as Doing*

Learning is an issue of sustaining the interconnected practices, through which an organization 'knows what it knows and thus becomes effective and valuable' (Wenger 1998). Learning also is relevant to daily actions, technical, and organizational systems we design (ibid.). This learning approach is well in line with the action research approach followed. This will be outlined in the methods section. While participatory design is a process where researchers and developers engage in active interaction with users of the system, incremental re-designing and improvement of the system is also in line with the learning as doing approach. Learning by doing refers to the capability of those actually doing the work

to improve their productivity by regularly repeating the same type of action through practice. In the iterative approach, developers get a chance to improve on the processes they did before.

7. Role of Human Agency in IS Development

Humans shape the way technologies can be used within organizations (Markus and Robey, 1988). This has caused researchers such as Orlikowski and Barley (2001) to promote research that recognises the role of human agency in organizations within the context of system development.

8. METHODS

The authors have been actively involved in all phases of the system design and development project described in this paper, following an action research approach. Action research in this context aims at generating new knowledge through participation in the process of system development and to feed back this new knowledge to the process. Feedback is through a cyclic approach of (adjusting) design and planning, development, implementation, use and evaluation, and then adjustment before the next cycle (adapted after e.g. Susman, Evered, 1978). All authors are involved in project in Malawi as well as in the wider Health Information System program (HISP) network which started in South Africa during the 90's (Braa et al. 2004, Braa, Hedberg, 2002). The free and open source District Health Information Software version 2 (DHIS2) has been used as a data warehouse in the actual development of the harmonized data sets (www.DHIS2.org). An earlier version of the DHIS, version 1.3, was adopted from South Africa already in 2002 and has been in use since then. The DHIS meta data structure and design principles are therefore relatively well known in Malawi, which have been important in getting staff from the Ministry of Health involved. The web technologies used in the “new” DHIS2, however, have been relatively unknown making it necessary to get external support on some aspects of the technology. One of the authors with extensive knowledge of the DHIS2 through a similar project in Sierra Leone (Kossi et al, 2008), has therefore been participating in the actual system development process for about a year, with about 3 months in-country. Collaboration across countries as facilitated by the HISP network is therefore a strong methodological “undercurrent” important for the research reported in this paper.

The research behind this paper has also used document analysis, participatory approach involving data collection from national data standard workshop and task force meetings (which all the authors took part) and participation in the design of the iterative approach. One author was involved in the processes that led to the implementation of the initial HMIS system and the monitoring and evaluation processes. One of the authors participated in the 2007 annual sector wide approach (SWAp) performance review. The author works with the Central Monitoring and Evaluation Division (CMED), a department responsible for HMIS. In this case the author used the “researcher as employee” (Easterby-Smith, Thorpe, and Lowe, 1991) method. This helped to experience the processes surrounding HMIS integration at first hand. Three authors are members of the task force and are directly involved in the

design of the data warehouse approach. To come up with a good situation analysis, five papers and a thesis were reviewed. The papers and the thesis were part of the results of studies conducted by the authors.

In addition, other literatures (and HMIS bulletins) were reviewed to have a clear understanding of the context in which the iterative approach was taking place. These included the 2007 annual assessment for HMIS performance and the 2008 landscape survey of the health information systems in Malawi reports. To ensure that the needs of the vertical programs are met, members from the vertical programs are directly involved in the process of designing the system. This is being done using a prototype system. The integration is to be done in an iterative manner starting with expanded programme on immunization (EPI) and HIV/AIDS systems.

9. THE CASE OF MALAWI

The Initial Integrated HMIS System

To address the problems of duplication in data collection and reporting within the Malawi health sector, an integrated, comprehensive and decentralised Health Management Information System (HMIS) where data from all vertical health programs would be reported through was established. The design of HMIS was guided by the principles of integration of all routine health information systems with consensus and buy-in from different stakeholders (Chaulagai et al., 2005). All vertical programs were integrated into the HMIS based on the identification of a minimum essential data and indicator set. This meant that the most important data from across the various vertical health programs was “extracted” and included in the HMIS.

The approach of minimum data and indicator sets; reducing the number of data variables collected and focus only on the essential information, had been successfully followed in South Africa from 1998 and onwards (Braa, Hedberg, 2002). The DHIS v1 database application developed as part of the data set development and standardisation approach in South Africa was used and implemented in Malawi. The DHIS v1 was designed for flexibility in terms of user participation and prototyping in the development of the system, for example developing meta data structures. This included the definition data variables, indicators, evaluation rules, and the organisational hierarchy of clinics, hospital, and districts from where data is reported.

The plan was that the HMIS, the official system of the Ministry of Health, should become, if not the sole source of information from the health sector, at least the dominant and most reliable source, as it would cover the essential information from all sectors. However, a few years after the implementation in 2002 it became clear that the minimum data sets approach had caused more fragmentation instead of solving the problem. The 2007 annual sector wide approach (SWAp) performance review and the 2008 landscape survey of the health information systems in Malawi revealed a number of shortcomings

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implementation challenges related to poor data quality. As a result, the vertical programs continued to use their own reporting information systems and therefore remained fragmented. The data elements and indicators generated from HMIS were not sufficient for their program needs. The national HMIS was not addressing all the information requirements of the vertical programmes as it was only reporting on few agreed data elements. Furthermore, the design and implementation strategy used did not meet the needs of different vertical programs i.e. vertical programs required reports on a monthly basis whereas HMIS reports on a quarterly basis (Galimoto, 2007). While the EPI program collected their data directly at the source at the peripheral clinics, the HMIS collected their data from the larger health centres which included aggregate data from the clinics. This led to differences in actual data reported through the two systems. There were also differences in terms of organizational arrangements between HMIS and different vertical programs; some programs have reporting hierarchies beyond national level, for example to Global Funds, WHO, and the various donor agencies, requiring more data and indicators as well. Figure 1 illustrates a situation where most data required by programs is not included in HMIS and this necessitates the vertical programs to continue using their own information systems. This has resulted in duplication of efforts, inconsistent reports from vertical programmes at national level, and caused problems in combining fragmented data sets for integrated analysis.

The Data Warehouse Approach

Once the problematic areas in the initial HMIS implementation were identified a number of strategies have been proposed. The Ministry of health together with its stakeholders expressed the need to resolve the problems by implementing an integrated data management system at district and national levels. In November 2008, a data standards task force for the National Data Standards workshop recommended an iterative data warehouse approach to address, among others, the issue of integrating all relevant sub-systems within the overall country health management information system. This approach would not only improve data flows in terms of capturing and reporting of routine data from health programmes with any collection frequency (be it weekly, monthly, quarterly or annually), but would also serve as a national data repository, with ability to store and retrieve data as well as facilitating the merging of data from different sources into a combined database.

With the proposed system, each vertical program would pool its data elements into a data warehouse and the common data elements from different systems would only be stored once and used commonly by different programs. In essence, the database would have multiple views based on each program's requirements, and each program will be able to access the database and come up with their own reports. This contrasts the initial "one size fits all" approach where all vertical programs were integrated into the Health Management Information System (HMIS) in Malawi, based on identification of minimum data and indicators sets.

Figure - HMIS and different sources of its data

To operationalize the data warehouse approach the national data taskforce is working through subgroups addressing the data, architecture, and security issues. The data subgroup ensures that data being collected have uniform definitions; each health facility has a unique identifier; and identifies the core data sets. The architecture subgroup is for the designing and implementation of a national data warehouse using the data identified by the data subgroup whilst the security subgroup identifies the identification schemes.

Divergences between the National HMIS and Systems for Vaccination and HIV/AIDS

There are clear divergences between HMIS and programs such as Expanded Programme on Immunization (EPI) and HIV and AIDS reporting structures.

10. EPI Programme vs. HMIS

The data elements on immunization used by HMIS since 2002 only include 5 of the 9 required vaccines in an infant's immunization scheme. However, the EPI require that all 9 vaccines be included in their reporting, in addition to some other specific data elements. Since the defined national core indicators for EPI does not cover all the programmatic data in HMIS, the EPI programme established an additional reporting system to cover those programmatic data that were not covered by the HMIS. Since the EPI had their own funding, they also established a separate structure for reporting their data whereby monthly reports were generated instead of the HMIS quarterly reports.

There was discrepancy between EPI data reported through HMIS and that reported through EPI programme. While HMIS received data from all reporting health facilities, the EPI programme was receiving data directly from the both the reporting health facilities and outreach clinics. However, according to the HMIS procedures, outreach clinics should report to the catchment health facility in which they belong. As the peripheral (outreach) clinic would have already reported their immunization data to the EPI programme, it became a tendency that not all of them reported to their respective catchment health facility. This contributed to the variations between the figures reported by HMIS and those reported by EPI Programme. The result was that EPI data reported by EPI Programme was more complete and of better quality than the EPI data reported through HMIS. This resulted in the general sentiments expressed by the users that the data quality was better in the vertical program reporting structures than in the HMIS.

11. HIV/AIDS Programme vs. HMIS

The data set for the HIV/AIDS programme on the other hand, is different from the one used by HMIS and other programs such as EPI. The HIV and AIDS data is based on cohorts of patients defined as from which quarter and year they started the treatment. The DHIS v1 software version used for HMIS

at that time could not handle cohort based data. This resulted in the HIV/AIDS program having its own database and reporting tools. Today, the HIV/AIDS programme has more data elements than the entire HMIS reporting form whereas HMIS has very few indicators related to HIV/AIDS. Further, the HIV/AIDS programme has more sources of funding than the other programs, hence more resources. The unit responsible for the HIV/AIDS programme has a certain legitimacy that makes them strong and important in the ecosystem due to the urgency of the programme in addition to the sizeable resources they have.

12. Data warehouse approach to HMIS Integration

Since 2002, the Ministry of Health (MoH) had opted for an integrated HMIS to provide an effective monitoring and evaluation (M&E) tool for better health in Malawi. Although the initial attempt implemented in 2002 did not yield the expected result, the Central Monitoring and Evaluation Division (CMED) with recommendations from data standards task force based on the HIS assessment conducted in 2009, decided to give another try to such a process by following the data warehouse approach. While adhering to the Health Metrics Network (HMN) framework and following the roadmap after the assessment conducted in 2009, CMED, with the approbation of the M&E Technical Working Group (TWG) decided to pilot a more comprehensive integrated HIS through an incremental development of the data warehouse approach. This new strategy consists of integrating the current HMIS managed by CMED with the systems in use at HIV/AIDS and EPI programs.

The aim is to start with these three actors and once the process will yield result more vertical programs systems will be brought on board and integrated into the data warehouse iteratively. Choice of the two initial programs to be integrated into HMIS was made based on a number of factors: i) EPI unit and CMED were already collaborating in terms of the data collected, resulting into CMED getting final figures for EPI data in HMIS from the EPI programme; ii) HIV/AIDS is one of the programmes which has more legitimacy and clout and having this programme first can make the integrated system more attractive for others.

Initially, an agreement from the three initial actors (EPI Unit, CMED, and HIV/AIDS Unit) was sought. A fruitful negotiation resulted in the three initial actors going for an integrated system and a team comprising of representatives of CMED, HIV/AIDS Unit, EPI Unit and (Health Information System Programme) HISP was set up and assigned to develop the technical system as well as addressing some non technical issues. The team has a manager, information technology (IT) specialists, M&E specialists; some members of the team double as both technicians and managers. Together, the M&E and IT staff designed the technical system. The role of the M&E staff is mainly to help the technicians in understanding the phenomenon.

To ensure good progress the system is demonstrated regularly to the whole team to make sure that the requirements are met and get feedback. Some technical constraints highlighted during feedback session

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raised political issues. For example, the issue of solve or removing overlapping forms and how to address the overlapping data elements from different programs. Although a consensus was built on solving this issue it is openly admitted by at least CMED and HIV/AIDS Unit that there is a need for harmonisation of reporting tools and indicators among the three actors. Although the HIV/AIDS programme has admitted that it will get more benefit from the new system, it wants the integrated data warehouse to implement all functionalities of its existing system in the initial phase. Obviously some of their requirements conflict with the interest of other actors. A continuous feedback and feed forward process of developing the integrated system is undertaken to make sure that system meet the demands of all actors.

The joint development of the system is also an opportunity to allow the understanding and the mastering of the system by the users (especially M&E at this stage) but also to develop local capacity in terms of development of such a system. The local team has been learning by doing with the support of an expert on DHIS2 and health data “harmonisation” from HISP, who has participated in the development of a similar system in Sierra Leone and the Gambia. In June 2010, the Malawian team had attended DHIS2 implementers’ workshop in Tanzania and had met and shared experience with other implementers from Tanzania, Mozambique and Norway. The system has raised a convincing degree that led the managers of the three systems to allow the piloting in five districts before a countrywide roll out.

Prior to the development of an integrated HIS, the MoH had started the process of HIS strengthening with an assessment workshop in May 2009 using the Health Metrics Network (HMN) framework. Stakeholders who attended the assessment workshop assessed the current HIS in a consensus manner. A strategic planning workshop followed in February 2010. From the assessment results, strategic objectives and interventions were defined to address the identified and prioritised problems in order to reach a commonly agreed vision of the HIS in 2020. Both the assessment and strategic planning workshop outcomes serve as input towards the development and implementation of an integrated health information system.

The process follows the HMN roadmap which comprises three phases – assessment, strategic planning and implementation. These three phases are not a linear process but iterative. The implementation should be assessed, the plan revised accordingly and re-implemented based on the change in requirements. The different committees and groups mentioned above are meant to address political and technical issues continuously and are cadre for renegotiating and adapting to the changes happening in the ecosystem.

On the technical dimension, the current HMIS is using DHIS v.2 software. This current software is flexible enough to adapt to local requirements and further changes. In addition, it accommodates the cohort structure used by programmes such as HIV/AIDS.

13. DISCUSSION AND CONCLUSION

From the findings, the divergences between HMIS and vertical programs such as EPI and HIV/AIDS illustrate a situation where there was a failed attempt to get all vertical programs of the Malawi health care system to use a “big” rigid integrated health management information system. From the findings, human agency comes out as a crucial factor in the process and success of integration.

14. *Human Agency and Integration of Vertical Programs*

Having integrated systems from different vertical programs into HMIS in the initial attempt, data was supposed to flow from HMIS to EPI and HIV/AIDS Units. However, this arrangement was not successful as HMIS failed to meet some requirements of the vertical programs. This led to a situation as suggested by Hanseth et al. (2006) where the desire to integrate the different systems in order to have better information and control resulted in less control and more fragmentation. The number and role of side effects increased with increased integration (Hanseth and Ciborra, 2007). Vertical programs continued using their own systems and some developed new systems to meet their requirements. Coordination and collaboration between vertical program coordinators and HMIS personnel was none existent in most cases leading to figures being reported by vertical programs varying from the ones reported by HMIS.

CMED initiated rapport and resorted to using data from EPI and HIV/AIDS programmes once it was noted that there was a shortfall in the immunization and HIV/AIDS data collected through the HMIS. This eased the problem of variations in immunization and HIV/AIDS figures reported by the programmes and HMIS and marked the beginning of a relationship where ideas on how to best improve data collection instruments for HMIS. This was proof of how humans are capable of shaping the way systems are designed and implemented and the way technology can be used within an organization as suggested by Markus and Robey (1988). As suggested by Orlikowski and Barley (2001) promoting research that recognises the role of human agency in organizations within the context of system development is very crucial to the success of systems integration. The human interactions and efforts between CMED and EPI and HIV/AIDS Units provided an opportunity for stakeholders to come up with a more feasible and flexible way of integrating the vertical programs systems into HMIS.

15. HMIS Integration Process

The findings stress the thesis that the concept of integration has evolved over time from the narrowly technical perspective to a complex socio-technical one. In the initial HMIS, although technically the system was functional and information was being produced for the different programs, some issues that needed to be solved emerged such as the frequency of reporting and number of indicators required by specific programs which resulted in HMIS risking losing confidence from participating programs and having less control over the programs. This increased complexity and number of side effects (Hanseth and Ciborra, 2007). The first integration attempt that was meant to encompass all the vertical

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programmes information needs did not yield expected results despite an initial agreement or consensus on the need to have such integrated system. Instead of having one integrated system, more systems sprouted. In turn this leads to variations in the reported data from HMIS and the different programs.

Through the experiences of interacting with the initial integrated HMIS, shortfalls were noted which necessitated re-designing of the integration process to use the iterative approach. The practices which the HMIS implementers and users went through helped them to know the shortfalls and improve the way things are done in order to become effective and valuable. They went through learning by doing (Wenger 1998).

In the new integration approach and following Carlile's integrative framework;

- i) a common data dictionary has been developed among the three actors and duplication avoided in order to allow efficient data sharing (transfer),
- ii) inconsistencies, duplication or different way of managing data such cohorts was addressed to come out with standardized definition and meaning (translation) and
- iii) since the organisation units or facilities all involved actors are collecting data from are not the same (private, different level of the hierarchy) and collection frequencies are different, the entire system has slightly changed to include private facilities, zones as new administrative units and the frequency of EPI and HMIS data has been set to monthly instead of quarterly for the first and quarterly for the second (transformation).

These processes are iterative and not linear since the feedback and feed forward processes raise often new issues that have to be negotiated. However, all the actors know that this is only a first step there will be a need to negotiate and agree on a standardized data dictionary among all the HIS stakeholders.

Challenges Related to Human Capacity and Infrastructure

There are many challenges related to development of the new integrated system in Malawi as related to human and institutional capacity in information systems and database design, health information systems and open source software technologies, in particular Java based technologies. The capacity and network of developers, implementers and institutions being built around the DHIS2 platform and therefore has a certain threshold. In order to address these obstacles and enable people and institutions to learn, educational programs and international South-South-North collaboration on capacity building and research have proven to be important. While the project has been based in the Ministry of Health, developers and researchers have been recruited from the University of Malawi as they are engaged in a collaboration with the University of Oslo for the development of their Masters of Public Health (at the College of Medicine) and Informatics (with the Department of Informatics) respectively. Students and staff from these two departments have been participating in the project over several years. Furthermore, staff from the university and the Ministry of Health are enrolled in the PhD program in Oslo, within which framework, collaboration with West Africa and Tanzania have been enabled. The project has

benefited significantly from this international cross-fertilisation and adaption of best practices and solutions from other African countries.

16. Conclusion

The task of developing integrated and well functioning health information systems is important in improving health systems and status, in Malawi as well as in other African countries. The task is challenging in terms of human and institutional capacity. Collaboration with other African countries in adopting and adapting best practices and not having to all the time re-invent the wheel has been important in the development of the so far successful information systems development project in Malawi. The findings indicate that integration of fragmented information system being owned by different health programs can be more effective if the process is continuous and iterative and not using a linear approach. The integration process should continue based on the successful implementation of the initial integrated systems. The importance of human agency and learning by doing has also been stressed in this paper.

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