

Comparing Strategies to Integrate Health Information Systems Following a Data Warehouse Approach in Four Countries

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Abstract: This paper presents four country cases of standardizing and integrating health data which are all following what is here termed a data warehouse approach; data from across different health programs are organized in one database framework – or data warehouse. In all countries, fragmentation of health information in different partly overlapping sub-systems run by different vertical health programs represented a major problem, which was addressed by what here is labelled a district data warehouse approach. The district forms the basic managerial level which needs are addressed by the data warehouse. Data captured and managed at the district are then replicated up the hierarchy of the health services and at the national level. While South Africa developed a new integrated system in addition to the existing fragmented sub-systems, Zanzibar, Sierra Leone and Botswana all followed slightly different approaches; more or less incremental in the approach to standardizing health data, and more or less strict in whether to include “all” data, and whether to solve all inconsistencies between the various data sets included early on. The four cases demonstrate that integration is as much, and maybe more, about aligning organisational-political actors as it is about technical solutions. The technical solutions are however important in aligning these actors and in enabling integration. We argue that “attractors”, technical solutions or standards that achieve a certain level of success and enable the building of momentum, are important in aligning the various political actors.

Keywords: Integration, standardization, health information systems, data warehouse

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1. INTRODUCTION

Effective Health Information Systems (HIS) are seen as key instruments for countries to achieve the health related Millennium Development Goals. There is relative consensus among researchers and global agencies such as the Health Metrics Network (HMN) that key problems with the current HIS in many, if not most, developing countries are related to 1) fragmentation among a multitude of donor and disease specific health program driven vertical systems (HIV/AIDS, Immunisation, Mother & Child Health, Tuberculosis, etc), (Chilundo and Aanestad, 2004), leading to 2) lack of shared standards (overlaps, gaps and inconsistent definitions of data in the various data reporting formats) (Kossi et al, 2008), 3) poor human capacity, and poor technical infrastructure in terms of e.g. power and Internet. These problems are leading to poor data quality, no overview of data and information across sub-sectors, and negligible use of data by decision makers and health care providers.

A central part of the HMN technical strategy to overcome the problems of fragmentation and lack of data standards is the establishing of data warehouses, or data repositories, for the storage of essential data and indicators from multiple data sources. This data repository will then provide shared access to shared information across the various health programs and user groups (<http://www.who.int/healthmetrics/>). In this article we describe and discuss different varieties of such a “data warehouse approach” as they are applied in four countries. Botswana, Zanzibar and Sierra Leone represent relatively recent developments (since 2005/07), whereas in South Africa the process has been ongoing since 1998. While in Botswana, Zanzibar and Sierra Leone, they have followed various strategies to include all data routinely collected from the health services by different health programs in one data warehouse system, in South Africa they started out with a minimum essential data set strategy (i.e. only a sub-set of data reported), which has gradually evolved to include more data through a longitudinal standardisation process.

We use a very loose definition of data warehouse: “A data warehouse is a repository storing integrated information for efficient querying and analysis. Information is extracted from heterogeneous sources as it is generated ... This makes it much easier and more efficient to run queries over data that originally came from different sources” (Stanford University 1998)

The 2nd edition of the HMN technical framework uses the term “data repository”, whereas they used “data warehouse” in earlier versions. This is done because they want to omit confusion in a developing country setting, because, in many cases, the term data warehouse is understood as something more sophisticated than what is seen as naturally fitting into a poorly developed infrastructural setting. A description of a data warehouse in a “Western” setting, will for example typically include methods to automatically

“extract, transform and load” (ETL) essential data from a computer based “transaction system” to the data warehouse. What then, when the transaction system, as is the case in most developing country contexts, are paper based? Our rationale for still using the term data warehouse is that we would like to translate it to a developing country context. If, for example, the transaction systems are paper based, as is the case with most patient record handling systems in Africa, the data in the data warehouse will be captured from paper forms. When transaction systems are gradually computerized, then the loading of the data to the data warehouse will be increasingly automated. For the foreseeable future, therefore, the transaction systems from which the data warehouse in developing countries gets the data will be both paper-based and computerized.

Integration as demonstrated in the four cases, however, is not primarily a technical process, but rather a political one. In all cases the overarching problem of fragmentation was caused by different organizational actors working independently. Providing a technical solution to integrate two different systems is relatively easy, but the politics of negotiating this among the actors involved is key to attain any use, and hence sustainability.

This article will proceed as follows. First we present the methods applied. Then we present relevant literature on the issues of integration and standardization in developing countries, before presenting the four cases, the discussion and finally the conclusion.

2. METHODOLOGY

This article draws on case material from direct involvement and experiences in the development and assessment of health information systems in South Africa, Zanzibar, Sierra Leone and Botswana. The authors are all involved in the one or more of the four countries, as well in the broader network of the Health Information Systems Programme (HISP) (Braa et al. 2004; see also www.hisp.info). HISP started in South Africa in the 90's as a conscious effort to adapt and apply central features of the Scandinavian action research tradition in IS development, such as user participation, evolutionary approaches and prototyping, to the context of Africa (Braa, Hedberg, 2002). Action research aims at generating new knowledge through taking part in the full cycle of design, development, implementation, use, and evaluation and analysis together with all involved parties before the interventions are adjusted accordingly, and the cycle starts all over again (Susman, Evered, 1978). In each of the four countries the authors have been engaged in repeated prototyping cycles of the DHIS software including revision of data sets (i.e. what data to collect and process) and exploration of ways to access, present and analyse the information in the system.

The research and lessons in South Africa, where HISP was initiated in 1994, forms the basis for the research and interventions in the three other countries. The overall HIS development approach first developed in South Africa, including the focus on the local district level, data standardisation based on essential information needs, and local use of own data, has been tried adapted to the other country contexts. As the context differs considerably between the countries, a major research challenge has been to ensure a

framework for cross country comparative and collaborative learning and intervention. The methodological approach to address this cross country challenge is based on a “network of action” strategy (Braa et al. 2004), where, first, a mutual beneficial “win-win” collaboration is sought between action projects, which then is fostered through the circulation of people, best practices and lessons, and software and other (needed) materials. The PhD program at the University of Oslo includes 15-20 African students and facilitates comparative action research within and between countries and thus enables the needed “circulation of people” and sharing of experience. Four of the authors of this article are part of this program and are each involved in one or two of the four countries. Shared development and application of the DHIS software, which is used in all four countries, make up an important generator of “win-win” collaboration between the countries, while at the same time providing a concrete means of distributed learning, sharing of best practices and the circulation of software and training materials.

Following the increased focus on HIS globally, increasingly international donors and agencies play a role in the circulation of best practices, also in the countries included in this study; WHO and Health Metrics Network initiated the project in Sierra Leone and DANIDA (the Danish aid agency) in Zanzibar.

3. CONCEPTUAL FRAMEWORK

National HIS in developing countries are often plagued by fragmentation, where vertical, disease-specific programs run their own information-gathering systems (Stansfield et al. 2008). A typical situation in a developing country is that; 1) there is a national HIS run by the Ministry of Health aiming at covering data from across the various health services and disease specific health programs (e.g. HIV/AIDS, Tuberculosis, Maternal & Child Health, Disease Surveillance, Vaccination Programme (called EPI)); 2) the health services generally and the national HIS are relatively weak with insufficient resources; 3) while the vertical programmes are comparatively rich as they are funded from international sources (e.g. HIV/AIDS), they need to provide their funders with quality information on their activities and achievement in order to maintain their funding. As a consequence, 4) not being satisfied with the data from the national HIS, the vertical programs develop their own sub-HIS with international funding, funding which is difficult to achieve for national HIS, and further fragmentation is generated (Braa et al, 2007) . The involvement of multiple funders and organisational actors make integration highly political. HIS integration is thus a non-trivial process, involving more than just integration at a technical level. Sahay, Monteiro and Aanestad bring the attention to the political aspects of integration, and claim that, with a few notable exceptions, literature on the topic seems to be too positive and too technology-oriented (Sahay, Monteiro, & Aanestad, 2008). For instance, integration would also include aligning the efforts of several ministries (Sæbø, Braa, & Chandna, 2007), a challenge of institutional nature.

Standardisation literature argues that standards are evolving through use rather than being established through consensus (see for example David 1986). Building on complexity science, Eoyang argues that “attractors”, e.g. successful pieces of software, play a key role in adapting the various actors to common practices within a complex system by creating momentum through shared practices (Eoyang, 1996). Building on this concept

again, Braa et al 2007, argues that attractors are crucial in the evolution of new standards generally, and in the complex health system context particularly. An important part of HIS integration at country level is to get the various actors to agree on shared standards. Attractors, such as successful examples of software or data standards, may be important in convincing, or align through practice, the various actors in health care (ibid.).

Having worked extensively with national HIS in South Africa, Braa and Hedberg argues that inscribing flexible standards in the software used for an HIS could allow a “hierarchy of standards” (Braa & Hedberg, 2002). For health management, there are different information needs depending on the hierarchical distance to the patient. Doctors would need detailed information on patients, districts would need community information to supplement their core health indicators, while national levels would only need a few health indicators to prepare a budget and take strategic decisions. Typically, the amount of information required would diminish as one went higher in the hierarchy, that is, closer to the national level. Scaling of national standards to lower levels had to be complemented with the ability of lower levels to define their own, additional, information standards.

In addition to technical solutions to facilitate integration, some solutions may promote it. Drawing on the concepts of inscriptions (Hanseth & Monteiro, 1997), we can see that certain solutions prescribe certain behaviour, and that inscribing software with incentives to integrate can be a fruitful approach. If attractors; successful standards or artefacts that offer a gravitational field among seemingly disparate actors (Braa et al. 2007) embedding such inscriptions can be created, a powerful tool for integration has been created.

4. CASE STUDIES

4.1. The DHIS software - flexible design to enable integration

Very often a computerised HIS is a direct computerisation of the various forms and reporting structures that exists in the paper-based HIS. A result of such an approach is often lack of flexibility to modify the systems when the paper-based equivalent changes or to incorporate new needs like integrating additional programmes or additional indicators arise. Such approaches, which strengthen the existing structures of fragmentation, are typically found in the various health programmes where focus is often on reporting huge amounts of detailed data upwards in the hierarchy to the national level and to donor agencies.

To integrate information at the district level and to provide flexibility to meet the rapidly changing requirements of the health care domain, the DHIS design strategy is based on a more flexible model that goes beyond the typical “computerise the forms”-approach. Instead of computerising the form, the DHIS is computerising every data item or data element in the form independently. By breaking up the form into more fine-grained building blocks of data the software also breaks up the fragmentation the forms represent and provides the possibility of manipulating and presenting data across health programs and forms, a prerequisite for integrated data analysis. This design enables the user to define custom reports, tables and graphs for analysis that are completely independent of

the collection forms and can instead be understood as user-defined assemblies or reconstructions of the data (elements) that was captured using the forms.

4.2. Sierra Leone

Sierra Leone, a relatively small country in West Africa, is one of the poorest countries in the world and was ravaged by civil war that had lasted for ten year before it was officially declared over in January 2002. The public health system, which suffered from a huge loss of both personnel and infrastructure during the war, is slowly rebuilding the capacity to improve the service provision across the country. This effort is led by the government and supported by many international agencies, and aims at achieving the health millennium development goals. The rapid growth of various health initiatives has created a situation of fragmented information systems, common also in other developing countries (Braa et al, 2007, Sæbø et al, 2007). Figure 1 depicts the fragmented situation characterized by overlapping data collection tools and data elements. The overlapping rate between two different forms can vary from 0 to 50%. In 2008, each facility reports about 17 forms.

From the fragmented HIS described above, the main issue was to provide meaningful and relevant information for decision making and to diminish the workload of staff who are collecting and reporting the data. The suggested way forward was to use DHIS to integrate the various data flows and data sources and thereby to provide an integrated framework for M&E and data management. To achieve this, attention was devoted to the data warehouse as a starting point. All data elements were identified and sorted out in order to identify and avoid a) duplication from overlapping data forms b) overlapping data elements – in term of their definition. As a result a coherent integrated data warehouse was built, where one data element in the database can be related to a field in several data collection forms. Figure 2 shows how multiple, duplicate data elements from the existing paper system were integrated “behind the scenes” in the data warehouse.

In January 2008, this integration approach was implemented in 4 of the 13 districts in Sierra Leone, and 6 months later in 3 more districts. Intensive training was carried out, each district captured their data in the DHIS and exported the data to the national DHIS by the use of memory sticks. An extensive process to capture and import from the various electronic storages old data from all districts was put in place and a rather extensive national data set was available for analysis during the last half of 2008. All stakeholders were made part of the process which convincingly documented the problems with the current system such as overlapping data collection forms, inconsistent data definitions, poor data quality in terms of both correctness and completeness. At the same time, through actually doing it, it was also documented that shared common data sets in a national repository was possible to achieve. Given this learning process, in January 2009, all stakeholders agreed on new harmonised shared data collection forms to be implemented from March/April 2009, and to implement the DHIS in all districts immediately in order not to lose momentum and data.

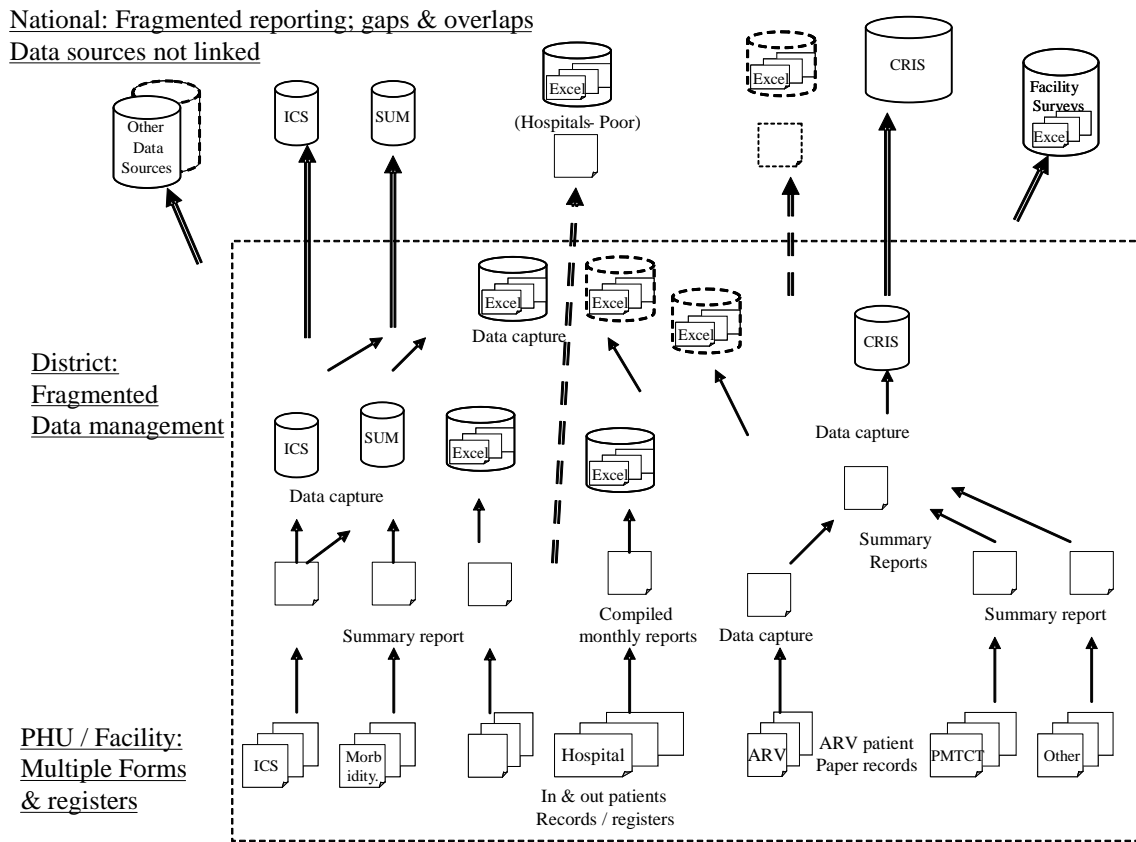


Figure 1 SUM, ICS(MMRCS), Excel, CRIS are existing software used to collect and analyze health data

4.3. Botswana

The HIS in Botswana is extremely fragmented, with several ministries involved in the collection, compilation, and use of health data. A centralized initiative to integrate the health information systems was established through the Health Statistics Unit (HSU), which was to collect one form containing the essential data from a range of health programs. However, the main reason for collecting this data was for the compilation of an annual book on health statistics, not for supporting local health information use. At the national level, the compilation of the health statistics book was two years delayed (Sæbø, Braa, & Chandna, 2007). As a response, various health programs still relied on their own systems, which were designed and run by each individual health program. At the district level, however, most of these information systems were handled by one or two persons in one office, representing a form of human data warehouse. Some of the richer health programs, most notably the Prevention of Mother To Child Transmission (PMTCT), set up their own infrastructures to collect timely data by hiring their own people and equipping them with computers and software solutions.

The approach in Botswana was to make a direct mapping of the paper-based system into the DHIS version 1.4, meaning that each cell in the paper forms represented a unique definition in the software. Even if the paper forms had overlaps and duplications, the duplications were transferred to DHIS, without standardization of, in essence, equal data definitions. This approach would not reduce the amount of data to be entered, it would not solve the duplications (which turned out to sometimes contain different figures in different forms), but it did allow for a fast implementation by avoiding “political” obstacles in the set-up of the database. As long as no paper form was changed as it was copied to an electronic format, a database could easily be agreed upon by the various stakeholders. This strategy opted for a quick solution in an environment where the capacity to negotiate an integrated solution was not present at the time. The semi-integrated data collection tool, the DHIS, was then to be used as a platform for further integration. The nature of the project organization posed severe limitations in this direction;

As part of an EU funded research project (BEANISH¹), the Ministry of Science, Technology, and Communication oversaw the initiation of the data warehouse implementation. Assigning the administration of the implementation to their IT-unit seconded to the Ministry of Health, the project was distanced from the health domain from the start. While the IT-unit physically worked at the Ministry of Health building, its main activities here consisted of setting up the network, assigning e-mail addresses, procuring hardware, and the like. The placement of the project implementation with the IT-unit meant that the project came to be seen as a “computer project” by the various health-affiliated stakeholders. This division between health and IT became stronger over time, and the project failed to enlist “champions” in the health programs. To complicate further, public health services at the district and facility levels were run by yet another actor, the Ministry of Local Government. Unable to tie the necessary links with the Ministry of Health-run national health programs and the Ministry of Local Government, the IT-unit, formally under the Ministry of Science, Technology, and Communication, became increasingly focused on just the computer-technical side of the implementation.

A spin-off of the data warehouse project in 2007 is worth mentioning. Looking for a software to ease data collection for their CRIS analytic software, UNAIDS adopted DHIS. Driven by local champions both at national and district level, UNAIDS rolled-out this new software bundle nationwide over the following year. Representing so far a new, independent, vertical reporting structure, the network UNAIDS has established of national and local actors might also manage to integrate the other health information systems in place, from which UNAIDS retrieves their HIV/AIDS specific data.

4.4. Zanzibar

In November 2004 a joint survey to study the HIS status was conducted by the Danish International Development Agency (DANIDA), World Health Organization (WHO),

¹ Building Europe Africa collaborative Network for applying IST in Health care sector, see <http://208.76.222.114/confluence/display/BEANISH/Home>

Ministry of Health and Social Welfare (MOHSW) and University of Oslo. The survey revealed poor HIS characterised by fragmented data collection and reporting due to many subsystems in healthcare service provision, and little use of information. As a result of this, in 2005 HISP started working with the newly established Health Management Information System Unit (HMIS Unit) at the Ministry, to implement a computerised HIS. Key objectives of the project were to 1) strengthen information use at the district level, and 2) set up an integrated data warehouse at the national level to facilitate access to information by all health programmes and stakeholders. Ministry stakeholders, health programme managers and district medical officers, and HISP consultants conducted a series of meetings met to agree on a set of standardized data collection forms (datasets) that would form the basis of the integrated data warehouse.

To implement the same integrated data repository approach throughout the country, an important requirement of a national HIS, a combined paper and computer strategy was implemented. The glue between all levels were the standardised essential datasets including essential data from all health programs taking part in the integrated approach (Reproductive and Child Health, Immunisation, HIV/AIDS, and Disease Surveillance). These standard datasets were both made available on paper forms to be used for data reporting between the health facilities and the district level, and electronic forms as part of the DHIS software used to register, validate, analyse and report data at district and national levels. In 2005 the customisation and implementation of DHIS started by using the new version 1.4, which was actually under development. This caused some technical problems during the first 1-2 years, as Zanzibar acted as a test site and bugs documenter for the new DHIS version being developed in South Africa. . Every year since the first version of the unified data collection forms there has been a revision process (a 3-5 days workshop) whereby the data sets are revised and updated based on negotiations among key stakeholders, and as a result the paper and electronic forms are updated on an annual basis to adapt to these revisions.

4.5. South Africa

South Africa has followed a different trajectory from the three other countries. Here the process started in the 90's after the abolishment of apartheid and was part of the ANC Reconstruction and Development Plan (ANC 1994a, Braa & Hedberg 2002). During apartheid the health services were extremely fragmented and inequitable and health services and geographical areas were separated according to race and the system of "homelands". Until May 1994 there were 14 departments of health at the central level; the general National one, separate "white", Coloured" and "Asians" administrations, and 10 "black" homeland administrations. As a result, there were no health data standards and a multitude of forms for reporting data were in use. The new national health plan (ANC 1994b) made it very clear that the health system needed to be reconstructed based on equity in health services provision to ensure the inclusion of those who had suffered during apartheid. In order to monitor to what extent this goal was properly addressed and to pinpoint communities in particular need, access to good quality essential health data, integrated across services and geographical areas, was seen as an absolute requirement.

HISP started in 3 pilot districts in Western Cape Province in 1995 with the aim of developing a district based integrated information system. It turned out to be difficult to get all the actors to agree on common standards for reporting. After an “endless” array of workshops, the breakthrough came with the development of the DHIS in the conjunction with the testing of a first version of a minimum integrated data set in the pilot districts in 1997/98. The Province agreed to test it further and the success was rather instant; for the first time health managers had data available at their own desktop computer without having to wait for annual reports or enquire for data at various head offices. Having seen the success in Western Cape, the neighbouring Eastern Cape province also wanted to go for the DHIS software. In Eastern Cape, a project funded by USAID had developed and implemented a minimum data set in all the health facilities in the province, but had serious problems with the software they were using. They contracted HISP and implemented the DHIS successfully at the end of 1998 and could provide full coverage data for the province early 1999. Seeing the success in two provinces, other provinces also wanted to join the process and by 2001 the DHIS and data set approaches were endorsed by the National Health Information Systems committee of South Africa (NHISSA) as a national standard. Since 2001 South Africa has established national standard essential data and indicator sets which all provinces are required to report. In addition to this, and given the federal institution of South Africa, each province is free to collect and manage the data and indicators they want. The principle of hierarchy of standards, enabled by the DHIS, was important in creating agreement among the provinces and other actors. According to this principle, each organisational unit in the health hierarchy is free to collect the data they want and thereby pursue their own interests, as long as they adhere to the standards of the level above. Each province could then continue to collect their own data as long as they reported the required standards to the national level. There are large differences between the data sets collected by the different provinces, but they all include the core national standards. The national core standards have gradually been expanded to more use areas since 2001.

This standard reporting format was in the beginning an addition and “on top” of all other reporting forms. Through its relatively instant success in terms of data quality and easy and immediate access, more provinces joined, but also, as the momentum grew, gradually vertical programs included their basic data requirements within the national minimum data set, which later changed name to “essential data sets”. The immunization program, for example, realized that the quality of their data that were included in the minimum report was higher than in their own data reporting system, and subsequently “gave in” and included their vaccine reporting in the now national essential data set.

There are several electronic record systems in South Africa, or computerized transaction systems as seen related to the data warehouse debate. For the Tuberculosis electronic register and from some Anti retroviral Treatment electronic registries for AIDS patient, “extract, transform and load” functionality is established with the DHIS, the standard more technically advanced “Western” data warehouse model is gradually being adopted.

4.6. Summarising the cases

Table 1: Summarising the cases

	Botswana	Zanzibar	Sierra Leone	South Africa
Data warehouse standardisation approach	Including all existing report forms – little revision of overlap and inconsistencies between forms and data elements	Full revision of all report forms – no overlap between forms and data elements. Annual revision process	all existing report forms – no revision of forms, overlaps solved in database, inconsistencies identified and addressed	Essential data sets. Specific paper reporting forms collected uniformly across country, eventually in addition to other forms
Process started	2005	2005	2007	1997
Why this approach was selected	Capacity to lead integration not available. Data warehouse to highlight to stakeholders the need for integration.	All stakeholders agreed to revise and coordinate their reporting forms and solve problems of overlaps	Previous efforts failed because not all programs were included. Now include all data reporting and stakeholders. Show overlaps and inconsistencies.	Extreme fragmentation caused effort to establish new unified reporting forms in addition to all other reporting routines
Main challenges with the approach	To direct the early momentum gained into real integration. Avoid entrenchment of fragmented system by computerizing it.	Annual revision process tends to add data standards haphazardly program by program making consistency over time difficult	Align all actors in the integration process. Local capacity building. Supporting infrastructure. Harmonization of collection tools and indicators	Keep pace with new developments and technologies and remain in the forefront; e.g. on top of HIV/AIDS reporting development
Main benefits of this approach	Quick computerization, fast results in populating the data warehouse	Systematic approach, combine management of data from all programs	Reduce amount of manual data entering, highlight overlaps, all data available in database. Shows early the benefits.	The smaller and simpler data sets gives better quality and availability of needed data from across programs
Status	Slow to gain momentum within MoH, but full local responsibility assumed by 2008. UNAIDS-fork in nationwide use.	National standard. Use of data and data quality is increasing through regular district data use workshops	Stakeholders agreed on shared harmonised data sets to be implemented countrywide.	National standard. High quality data and level of use. Being gradually extended to new data sets and use areas

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Figure 2 Integration strategies and degree of integration.

5. DISCUSSION

In this section we discuss and compare the four technically different integration approaches in relation to how they panned out in practice, that is; how the technical approaches related to the political processes. We use the term attractor to bridge or

correlate the two dimensions of technical and organisational political development.

While South Africa established a new minimal essential data set in addition to the myriad of existing systems, the three other countries, Botswana, Sierra Leone and Zanzibar, all followed different all-encompassing strategies; 1) Botswana: included all data “as they are”, without solving inconsistencies between them, 2) Zanzibar: started with revising the data collection tools and solving the inconsistencies before setting up the data warehouse, 3) Sierra Leone: accepted that there are different overlapping data collection forms in use, but solved the inconsistencies in the meta data structure of the database.

Ideally, the best approach to standardizing health data and integrating different vertical data reporting systems would be to make all actors agree upon a new set of standards and then implement the new standards. This is to some extent what was achieved in Zanzibar. However, due to the wide variety of vertical donor initiatives, which all tend to have their own separate reporting requirements, and overall changes in information requirements within and between the various vertical health programs, standardization of health data is a complicated process. Standards tend to be evolving through negotiations between actors facilitated through ongoing efforts to develop standards in practice, rather than through early agreements (Braa et al, 2007, Egyedi, 2002, Hanseth, Monteiro & Hatling, 1996). The four country data warehouse approaches described in this paper all address the need for integrating data from the different health programs and services by including the data in one database, but they are using different approaches for the standardization process, from the “loose” approach in Botswana, to the much tighter and structured approach in Zanzibar with Sierra Leone in between, and with South Africa following a somewhat different approach of establishing an additional system which is gradually encompassing larger parts of the other systems.

Data warehouse development is typically characterised by involving different groups, departments and structures, contrary therefore to a more limited IS project, one “champion” is not enough, as noted by (Wixom et al, 2001). Champions need to be found in several of the involved structures and departments. This is clearly demonstrated by the case of Botswana where the champions were located in a different Ministry from the Health and Local Government. It has therefore been problematic to reach the needed momentum. UNAIDS, with sufficient resources and strong links with all involved actors, managed to bring the stakeholders together to form an integrated collection tool, though only those programs related to mother and child health, ART provision, and HIV counselling, education, and testing.

The strategy in both Botswana and Sierra Leone was to achieve quick implementation and piloting through avoiding much of the negotiation process commonly undertaken in integration efforts. This was done by mapping the existing systems to a database, though with a not-so-hidden agenda. Using the integrated data within the DHIS software as an attractor (Braa et al. 2007), the data warehouse was still set up to enable and promote further integration in the future, through the inscriptions present in the software. By both highlighting the duplications in the data warehouse, and emphasizing the built-in

flexibility to change the software, the intention was to increase the incentives for integration.

Even though the political aspect is critical, integration entails technical issues. The technical solution must support or adapt to different logics and political compromises among involved actors. It must be flexible enough to meet current needs and further changes (Braa et al, 2007). According to Latour (Latour, 1987) translation occurs as actors enrol allies in the actor-network and align their interests in a continuous process of re-negotiation. In the four countries, one flexible application – DHIS – is used to support integration through a data warehouse approach. But each of these approaches represents a possible point on the evolution line as shown in figure 2. We have two extreme situations. On the one hand, in Botswana the HIS-revision had adapted too much to the previous disorder since stakeholders did not manage to come out with compromises about ordering the mess. On the other hand, in Zanzibar, the local organisational political context favoured order-making and yielded a harmonized national standard of data elements and indicators flowing in the system. In terms of integration approach, the cases of Zanzibar and Sierra Leone situate themselves between Botswana and South Africa. While in Zanzibar, the aim was to include everything in one system, in South Africa only the essential data from the various areas were focused upon. The approach followed in Sierra Leone may be considered a middle path. Here, the mess was embraced among actors and avoided in the database. The compromise was struck to avoid waiting for an agreement about any harmonization, which has shown to be quite a challenging task. The reporting tools were tinkered where and when it was possible and much effort was put on cleaning and avoiding overlaps in the database, while the paper forms used to collect data would still remain as they were. The development in Sierra Leone after the middle of 2008 has demonstrated that the approach was successful; the various actors have been convinced through the process that a better system is possible if they join forces and they have agreed to unify the various data reporting forms.

In the evolution line (see figure 2) the case of Botswana represents an early stage, but that does not mean any integration process using data warehousing approach must start at that point, nor that the next step will be the case of Sierra Leone.

Regardless of the approach used, an effective integrated HIS must provide a good tool for M&E and easily produce accurate information for action. In addition it must be able to effectively deal with the continuously changing health sector. By reproducing the overlap and inconsistencies in the database, each program in the health framework in Botswana will still have their own data, make their own analysis and get some output from the system. But their approach will hamper any attempt of cross analysis. Moreover it can lead to inconsistency and produce different figures for the same phenomenon. In SA, the national standard approach can allow them to implement changes in one place, without this overlapping or changing the information requirements of other units. If we consider the South African case as the most evolved among the four, both Zanzibar and Sierra Leone can be improved to reach that step without any change in the database. As far as the Botswana case is concerned, a breakdown will be needed at least at the database level to progress towards the South African situation. This is still doable when the network of

actors – human, health program, the database, etc – does not reach a critical mass. As we can see, the installed base – existing systems – and the way the actors are aligned and the way the compromise is implemented at any moment shape the possible next step in the evolution of the system.

The four cases demonstrates that the political situation in terms of top-level support, extent of agreement among the various health programs, donors and health programs, commitment, leadership and funding are the important factors in the integration process. The technical approach needs to develop as an attractor within this context in order for the process to succeed.

In South Africa the political situation enabled change and the federal constitution made it possible to explore innovations in one province at the time. This is probably the reason why South Africa managed to follow the most radical approach and establishing a new innovative integrated solution as an attractor.

In Zanzibar, and Sierra Leone also, the political situation formed the approaches followed: In Zanzibar both the political and financial support was solid and it was possible to move directly to a unified and shared set of data standards. Despite technical problems in the beginning, the unified data sets and the software provided a sufficient attractor, given the political context, for increased support and momentum.

In Sierra Leone the top level support was solid, but the various health programs were not totally on board, and it was necessary to demonstrate through an attractor that a better and unified system would be possible to develop. It is important to realise that successful HIS in developing countries are rare and that very little knowledge exists among donors and health programs alike. Furthermore, it is important to realise that there are strong incentives to maintain vertical systems; donors provide funding to health programs and integration and sharing of resources means transparency and are easily translated to “less control of my money” among the health programs. And vice versa, the donors might also feel they lose control if their data and other whereabouts are shared among all actors.

In Botswana there were not enough central leadership and political support, and not enough funds, to continue to the next step of solving the inconsistencies in a participatory process involving the various health programs. It is therefore not possible to say that the reason for not succeeding in Botswana was due to the approach followed. What may be said, however, is that the technical solution provided did not become a sufficient attractor, given the political context.

6. CONCLUSION

The four cases demonstrate that while different technical approaches may lead to relatively similar results in terms of integration, the crucial issue is the extent to which the solutions are embraced and adopted within the political dimension. In three of the four cases; South Africa, Sierra Leone and Zanzibar, the achievement was to create an attractor for the further development and integration of the HIS. In Botswana, as a contrast, the creation of an attractor for integration was not achieved. The integrated

technical solution that was developed; the collation of all data including all the inconsistencies in one database, did not demonstrate well enough its enabling character. This together with the comparatively weak political base in the Ministry of Health and the insufficient funding through a research project, have made it difficult to develop the process in Botswana further. The technical approach in Sierra Leone was brought further from the one in Botswana, now the data inconsistencies was solved in the meta data structure, and the technical solution was more convincing. Given the strong political base in the Ministry of Health and the HMN, and the initially more lukewarm support in the vertical health programs, the technical approach in Sierra Leone provided an attractor for change. The first year of the process in Zanzibar was plagued by technical problems related to the development of the new DHIS 1.4 version, but given the strong political support, the process was not derailed, the integrated data sets and the DHIS still provided a sufficient attractor, and the system has since the initial phase grown in strength.

South Africa provides a different experience in that here an additional system was developed and became a strong attractor for change. Again, this needs to be understood in relation to the political context; post-apartheid South Africa was open for changes, old structures were to be dismantled and new structures to be built. Successful implementation of new integrated minimum data sets using the DHIS, in first one, then two, then all provinces, turned out to become a strong attractor for change.

Given this summary of the four cases we conclude as follows: The creation of an attractor seems to be crucial when aiming at HIS integration. Furthermore, the less political support, and the less prepared and aware the organisational-political actors are, the more convincing the attractor has to be, and to some extent vice versa; if the political support is solid, more errors are accepted. An attractor can thus only be understood and created within a political context. An attractor is therefore, at least in the case of HIS integration, acting as a boundary object (Star and Griesemer 1989) between the technical and political dimensions of HIS standardisation.

7. REFERENCES

- ANC (1994a) "The Reconstruction and development programme", Johannesburg, African National Congress
- ANC (1994b) "A national health plan for South Africa", Johannesburg, African National Congress
- Braa, J., & Hedberg, C. (2002). The Struggle for District-Based Health Information Systems in South Africa. *The Information Society*, 18, 113-127.
- Braa, J., Monteiro, E., and Sahay, S. (2004) "Networks of Action: Sustainable Health Information Systems Across Developing Countries" *MIS Quarterly* (28:3) 2004, PP 337-362
- Braa, O., Hanseth, O., Heywood A, Shaw, V (2007) Developing health information system in developing countries: the flexible standards strategy. *MIS Quarterly* Vol 31 Special Issue August 2007
- Chilundo, B. and Aanestad, M. (2004), "Negotiating multiple rationalities in the process of integrating the information systems of disease-specific health programmes" *EJISDC* 20, 2, 1-28

- David, P. A (1986) "Understanding the Economics of QWERTY: The Necessity of History" in *Economic History and the Modern Economist*, W. N. Parker (ed.) Basil Blackwell, Oxford, UK, pp 30-49
- Egyedi, T. M. (2002) "Standards Enhance System Flexibility? Mapping Compatibility Strategies Onto Flexibility Objectives" in EASST 2002 Conference: Responsibility Under Uncertainty, European Association for the Study of Science & Technology, University of York, York, UK, July 31-August 3, 2002.
- Eoyang, G. H. "Complex? Yes! Adaptive? Well, maybe..." *Interactions*, 3(1), pp 31-37
- Hanseth, O., & Monteiro, E. (1997). Inscribing behaviour in information infrastructure standards. *Accounting, Management & Information Technology*, 7(4), 183-211.
- Hanseth, O., Monteiro, E., & Hatling, M. (1996). Developing information infrastructure: the tension between standardisation and flexibility. *Science, Technology and Human Values*, 11(4), 407-426.
- Kossi, E. K., Braa, J, Tohouri, R., Uggowitz, S., Yumkela, F., Bye, K., Turay, M., Koh, P., McEwen, E. (2008) "De-Fragmenting Health Information Systems in Sierra Leone: horizontal and vertical integration" in Proc. IST-Africa, 2008, Ref 95
- Latour, Bruno (1987). *Science in action: How to follow scientist and engineers through society* Harvard University Press, Cambridge Mass., USA.
- Sæbø, J., Braa, J., & Chandna, O. (2007). *A Flexible Approach to Integrating Health Information Systems: The case of Data Warehouse as Integrator in Botswana*. Paper presented at the IFIP WG 9.4, São Paulo.
- Sahay, S., Monteiro, E., & Aanestad, M. (2008). Configurable Politics and Asymmetric Integration: Health eInfrastructures in India. *Special Issue of JAIS on eInfrastructure*.
- Stanford University. (1998). Data warehousing at Stanford.
<http://infolab.stanford.edu/warehousing/warehouse.html>
- Stansfield, S., Orobato, N., Lubinski, D., Uggowitz, S., & Mwanyika, H. (2008, July 13 - August 8). *The Case for a National Health Information System Architecture: A Missing Link to Guiding National Development and Implementation*. Paper presented at the /making:the eHealth>connection*, Bellagio, Italy.
- Star, S., and Griesemer, J. R. (1989) "Institutional Ecology. 'Translations', and Boundary Objects: Amateurs and Professionals in Berkley's Museum of Vertebrate Zoology, 1907-39, *Social Studies of Science*, 19, pp. 387-420
- Susman, G., and Evered, R. (1978) "An Assessment of the Scientific Merits of Action Research," *Administrative Science Quarterly* (23:4), pp. 582-603.
- Wixom Barbara H. and Watson Hugh J. (2001), An Empirical Investigation of the Factors Affecting Data Warehousing Success, *MISQ*, March2001, Vol 25, Nmb 1