

## The Change Strategy towards an Integrated Health Information Infrastructure: Lessons from Sierra Leone

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### Abstract

*In this article we describe and reflect on an ongoing project to develop an integrated health information system (HIS) in Sierra Leone. We emphasise the complexity of such an effort and on challenges faced with building a health information infrastructure in the context of a developing country. The main lesson of the paper is in the design of a change strategy towards an integrated HIS in Sierra Leone influenced by information infrastructure literature. The key elements of the strategy are 1) to facilitate a gradual change process building on the existing systems and practices (the installed base), 2) to bootstrap political will through quick wins and pilot projects, and 3) a flexible standardisation approach to integration to smoothen the change experience for users and stakeholders, and minimise resistance.*

### 1. Introduction

In this article we describe and reflect on a project to develop an integrated health information system (HIS) in Sierra Leone, which has been ongoing since early 2007. Our main focus is on the design of a change strategy towards an integrated HIS. This strategy is influenced by the literature on information infrastructure [1] which seeks to understand complex systems such as national HIS. HIS are particularly complex as they represent a diversity of stakeholders at multiple hierarchical levels, spanning across multiple vertical health programs and geographical areas, all in all representing a heterogeneity of interests and potential conflicts. In the context of developing countries, international actors represent an additional factor to complexity as a wide variety of donors organisations and non-governmental organizations (NGOs), often with conflicting interests, tend to have huge impact on local decisions and actions, and sadly

often functional as a catalyst of further in-country fragmentation.

The health information system in Sierra Leone consists of a large number of peripheral health units (PHU), community health centers (CHC), hospitals, and other health centres shared between facilities, chiefdoms, districts and national level. These are essentially heterogeneous health units that share vital health information as well as report to the government health authorities. The collection of health data is partially computerized but highly fragmented as in many other developing countries [2] due to many parallel data collection systems driven by different donors and programs. An initiative to counter this fragmentation by integrating and strengthening the HIS supported by novel information and communications technology (ICT) solutions to cope with the extreme infrastructural challenges, has been ongoing since 2007. In order to address the fragmentation created by various health initiatives, an integrated district-based data warehouse approach has been developed. The aim of this approach is to strengthen the national health system by unifying and integrating the various existing systems, thereby standardizing the information system. This project, which started out as a four-district pilot, later scaled to the whole country, and is raising the interest of other health programs and organizations. The outline of the paper is as follows; a theoretical background, an outline of the methodology, then the case study from Sierra Leone, followed by an analysis of the change strategy applied there and finally the lessons learned and the conclusion.

## 2. Theoretical background

### Socio-technical approaches

Building on “web models” [3], where information systems are seen as a dynamic web of technology, procedures and social practices, we apply a social systems model to information systems. “Information systems are part of the social context of use, and vice versa” [2] – consequently, information system design needs to be part of wider processes of social and organizational change.

The socio-technical approach to information systems and technology design, which is seen as integral to organisational change, has a history dating back to the 1960’s through the work of Enrid Mumford [4]. Her longitudinal research has focused on humanizing the introduction of new technology and the related organisational change process by giving employees and workers a voice and a role in the process. This is seen as a humanistic set of principles aimed at increasing knowledge while improving practice in work situations, and thereby trying to “mould change so that it can offer a route to a better quality of life” [4]. Through this work she was also a pioneer in developing practices and approaches to action research in the information systems field.

Jolly et al [5] describes techno-social systems as a dynamic tension between the technologies, the organisation of work in various settings within, and the values held by workers, and promoted by management. Introduction of new ICT, or alterations to existing ones can easily fail unless due consideration is given to users’ needs and perceptions. The whole techno-social system needs to be taken into account when designing systems.

### Information Infrastructure

To inform our analysis of the change strategy applied in the HIS reform in Sierra Leone we deploy concepts from Information Infrastructures (II). II literature seeks to provide a better understanding of how complex large scale information systems develop and function, and a central element is to understand the interplay between the technologies and the surrounding organisations or increasing networks of organisations and other stakeholders. As such it fits nicely with the complexity of HIS, especially in trying to understand how a HIS evolves and changes over time.

An Information Infrastructure (II) is a shared, evolving, heterogeneous installed base of IT (information technology) capabilities developed on open and standardized interfaces [6]. It is the set of

organizational practices, technical infrastructure and social norms that collectively provide for the smooth operation of scientific work at a distance [7]. Specific to health information systems, an II has been described as being composed of technological and human components, networks, systems, and processes that contribute to the functioning of the health information system [2] or it can also be regarded as heterogeneous networks of actors [8]. In an information infrastructure, all components - technical and social - are important and play roles that are interdependent and tightly linked.

The concept of information infrastructure, first used in the early 1990s in political settings [9, 10], has become increasingly popular among researchers trying to understand, design and implement complex information systems. An II is designed as an extension to or an improvement on the installed base and its successful or unsuccessful implementation depends according to information infrastructure kernel theory [7], on a codification of five design principles which when applied will increase the likelihood of achieving a desired set of system features i.e. managed complexity, openness and growth in the installed base:

- Design initially for usefulness
- Draw upon existing installed bases
- Expand installed base by persuasive tactics
- Make it simple
- Modularize by building separately key functions of each infrastructure, use layering, and gateways

The term “integration” in information systems is understood in many ways, from the technical integration of software applications to integration at the political and strategic levels. Wainwright and Waring [15] divide integration of information systems into three domains; technical, strategic and organisational domains. A number of authors are discussing the political, social and economic aspects of integration [13, 16]. It is a way to get more control of information in such a context like developing countries where the HIS is often desperately fragmented. The solution proposed by the integration process is not solely to provide software to integrate all information flows, but a broad approach taking the whole information infrastructure into consideration, which comprises both technical and non technical components, and human and non-human actors. However this integration brings reflexive side effects and leads to less control [17].

It is then a good approach to enable heterogeneity and flexibility in order to counter this.

Flexibility, as in the ability to adapt to emerging changes and new contexts of use is seen as an important criteria for scalability [2]. Standards play an essential role in any health information system, both when it comes to the non-technical data definitions (what is collected and reported), and the technical solutions applied to facilitate computerised data exchange between the various stakeholders of the system and on a larger scale between co-existing computerised systems. The definition of a standard is more than an element in the design of a technological system; it is part of the design of a socio-technical network. The standard is just one element, an element linked to a number of other elements, technical and non-technical, in this network [18]. In order to provide scalability these standards must be flexible to change, and rather than applying one complex all-encompassing standard, an approach of many smaller manageable standards between them is suggested [7].

### 3. Methodology

This paper draws on experiences from an ongoing HIS reform project in Sierra Leone and more broadly on a long term action research project called the Health Information Systems Programme [2, 19, 20]. The HISP project was initiated by universities in Cape Town and Oslo in 1994, and has later grown to a number of African and Asian countries. Within each country the projects are comprised of various actors in the health administration (community, sub-district, district, provincial, and national), universities, non-governmental organizations (NGOs), and funding providers. At the global level, with the Norwegian and South African nodes as the major coordinating bodies, HISP has over the last decade been engaged in development and implementation of health information systems with emphasis of facilitating sharing of software and best-practices. In the specific case of Sierra Leone which is the focus of this paper, the Health Information Systems Programme (HISP) project played a major role in supporting the development of the new HIS.

This research is based on action research, a form of participative research where the researcher takes part in the change processes in an organization, actively trying to improve some stated problem [21, 22]. The authors are all actively involved in the HISP project. Through in-depth involvement in the HIS development process, field trips to Sierra Leone, and close collaboration with the various stakeholders, the authors have gained a good understanding of the context and processes taking place. Data collection was done via observation and a

series of informal interviews with stakeholders at all levels through a participatory approach where the authors and stakeholders have discussed and solved problems together.

Two of the authors were involved in the initial (baseline) assessment of the Sierra Leone HIS and three of them are involved in the development and implementation of the change strategy discussed in this paper. One of the authors has been part of the M&E officers training, in software installations in the districts and has participated in awareness seminars; one other is a researcher and has been an implementer of the District Health Information System (DHIS) in another country. All authors are members of the University of Oslo HISP research group, which have been employing an implementer-researcher approach to understanding health information systems in developing countries.

### 4. The Sierra Leone HIS case

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 lasted ten years - it was officially declared over in January 2002. The public health system, suffering 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 supported by the government and the international community through many agencies such as the United Nations Programme on HIV/AIDS (UNAIDS), the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), the German aid organization Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), etc. and aims at achieving 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 [2]. A number of paper based reporting formats and routines are currently in place in Sierra Leone. Some of these are also computerized such as a database application called the Country Response Information System (CRIS) developed by UNAIDS for HIV/AIDS data handling in the districts, where the HIV/AIDS paper-based reporting forms are captured. The fragmentation of the HIS is characterized by the presence of overlapping data collection tools and data elements. The overlapping rate for data elements between forms can vary from 0 to 50%. In 2008, each facility reported about 17 forms, with many overlapping data elements leading to the overburdening of an already stretched workforce.

The Sierra Leone Health Information System is highly heterogeneous, being made up of a number of non identical individuals and groups with varied core interests.

Following from an initial HIS assessment process supported by the HMN (Health Metrics Network, WHO) a decision was made to initiate a HIS strengthening project. This project was started off as a collaborative effort between national and international agencies; the Ministry of Health of Sierra Leone, HMN, Health Information System Program (HISP), the ICT Development Centre (IDC), Inveneo, and the national programs on Mother & Child Health, Immunization, HIV/AIDS and Tuberculosis.

From the fragmented HIS described above, the main problems included the inability to provide meaningful and relevant information for decision making, and the huge and unnecessary workloads being put on the health workers collecting and reporting the data. To solve these critical problems the suggested way forward was to use the DHIS developed by HISP to integrate the various data flows and data sources and thereby to provide an integrated framework for monitoring and evaluation (M&E) and data management.

### **The change strategy applied in Sierra Leone HIS**

The ongoing change process in Sierra Leone follows a 5-step design strategy based on information infrastructure theory. It involves building on a gradual/evolutionary prototyping philosophy where user interest and momentum for change is built up during a pilot phase and change is carried out in a piecemeal manner. Figure 1 (below) outlines this 5-step process. The following section provides details of each step. The steps should be understood as important

conceptual elements that are part of an overall continuous change process, more than as strict phases in a linear process. The steps might overlap and iterations between steps are also likely to happen.

#### **1) Analyse and assess the existing system**

In Sierra Leone the entry point to the HIS building process was a collaboration initiated between UNAIDS and HISP team for the integration of CRIS and the DHIS version 2.0; in order to build a system that supports data dis-aggregation, data analysis, programmatic reporting, local system integration and a more user friendly data entry screen than the one offered by CRIS. But to leverage on the efforts by the government and donors, it was decided in consultation with the Ministry of Health and Health Metrics Network (HMN) to extend this integration project to the national HIS framework in Sierra Leone. The ownership of the project thus shifted from UNAIDS-MOH to HMN and the Ministry of Health (MOH) as well. The approach was to design data entry interfaces that were similar to existing ones in order to enter all data in the DHIS software tool. But at the same time, data could be imported from existing application in DHIS. So instead of entering overlapping data at district level in many databases, data would be entered in one application (DHIS) only, and then exported in appropriate formats to other applications. Because of the reduced work load brought on by the implementation of the new tool at district level, M&E officers at the pilot districts were more supportive of the information system. Thus, the project raised an interest among other health programs and organizations in terms of integration and utilization of resources.

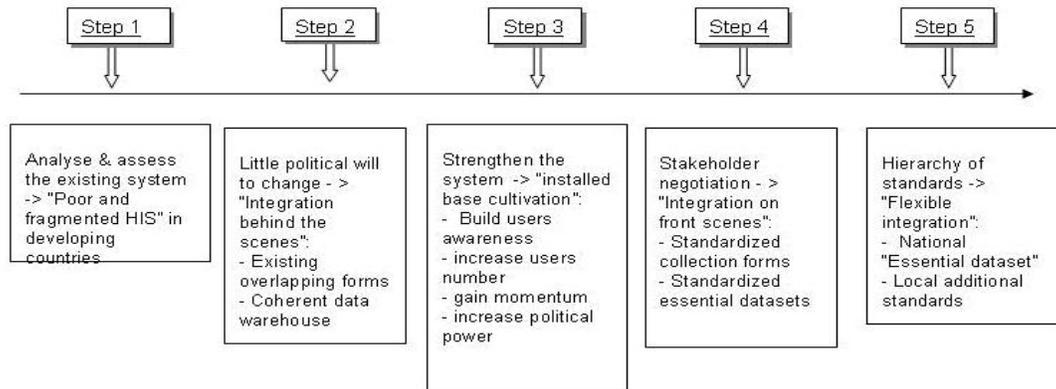


Figure 1: A 5 step strategy to change towards an integrated HIS

**2) Provide integration behind the scenes through software**

Because of the low political capacity and will to change reporting formats and HIS standards in the earlier stages of the project, attention was devoted to the data warehouse as a starting point. Health program specific paper forms used to collect data remained as they were while integration of data was taken care of under the hood by technical integration in the data repository.

As a result a coherent integrated data warehouse was built, where one data element (standard) in the database could reference data collected (in a duplicated way) across several data collection forms. This integration “behind the scenes” in the data warehouse was achieved while maintaining the existing (although overlapping) paper based forms. This strategy helped in the adoption of the system by all the stakeholders and raised the interest of the first users. Essentially, this step was preparatory to further integration and standardization. This strategy enabled an integrated data warehouse demonstrating to key stakeholders the improved meaning of collected data by allowing correlation of data collected across different programs and sources. This also created a lot of interest from the various local stakeholders who understood the opportunity to improve the quality of the data collected by their own vertical systems. They were therefore willing to be part of the process and are now participating in the negotiation towards a standardised minimum dataset.

**3) Pilot the tool and new integrated solution**

The project started with four pilot districts (Moyamba, Kono, Makeni and Western Area) where the new HIS was implemented. The focus at this stage on the local-level capacity building through “on site” training and later, through country-wide M&E officer training. In each district, two monitoring and evaluation (M&E) officers were working to collect, prepare, report, and analyse aggregated data. During six weeks in May-June 2008, extensive training was given to all M&E officers in order to give them the skills to use and customize the system to fit their own local needs and also to allow them to impact the HIS design process by discussing how the system could fit more closely their need and improve the national HIS. The findings from this training and from HMN and Ministry of health were used to improve the system and facilitate the roll out of the project to the whole country.

**4) HIS reform - integration in the open**

The standardization of forms has been an ongoing process since 2008, following feedback from the pilot implementations and initial use of the data warehouse. Most health programs want to keep their data elements, indicators and definitions and are reluctant to the integration suggested. To get the ball rolling despite conflicting interests, the behind-the-scenes integration, described in step 2 (above), was further strengthened. However, the reporting forms still needed to be integrated and this complex process will take a while. At the time of writing this paper, a stakeholder meeting has been held to revise the forms and consensus has

been reached on datasets and indicators. As a result of this integration process, the data collection forms will be reduced in number (from seventeen to four) to contain only the most essential data elements.

In commitment to this process, one of the stakeholders, UNICEF, is printing the four new forms for countrywide rollout.

HMN and the Ministry of Health and Sanitation wanted to follow an approach of a minimum national dataset and core indicators in order to reduce the work load at the grass root level and to improve the data quality, but the different health specific programs would like to see all their indicators and data elements included in the national set. But there is also a need to consider more specific sub-national needs for standards, at the district level, which needs to be balanced with the national needs. The fact that the project is gaining more and more users and raising more and more interest at district, national and international level is impacting the integration process in a good way by inducing more political will for change.

#### **5) Gradual reduction of data collection and increased focus on information needs at each level**

At the grass root level, health care providers who are also those who are producing data had understood that the new solution can trigger a process that will lead to harmonization of reporting tools which in turn will diminish the 17 overlapping forms they have to fill at the end of each month.

The HISP team, HMN and the Ministry of Health and Sanitation have actively been trying to drive the HIS in Sierra Leone towards the South African model of hierarchy of standards [3] that allows addressing the different needs of information across contexts and at the different levels, and at the same time a need for a standardised national dataset. In short it allows lower levels of the organisational hierarchy to define their own additional local standards as long as they comply with the standards set by the level above. The DHIS software supports such a hierarchy by allowing users at all levels to define additional data elements and indicators to be used and keeping track of data to be reported to the higher level.

A key challenge of an integrated HIS is to manage and coordinate all the data when more and more health programs and other data sources are standardised and included in the same data repository. Action-driven data collection and focus on essential data for monitoring and evaluation at all levels are key

components of a mature integrated HIS [2, 14] and objectives to work towards for any HIS. Standardised essential datasets reducing the amount of data collected are difficult to swallow for many health programs located in the more traditional data-led end of HIS design, but when exposed over time to the benefits of integrated data repositories and indicator driven data analysis, this perception of what is a useful HIS can change.

## **5. Discussion**

In this section we will analyse the HIS reform in Sierra Leone through an information infrastructure lens. First we analyse the complexity involved in the HIS implementation, and second we look in more detail at the 5 step change strategy.

### **5.1 The case complexity and obstacles to change**

The context of Sierra Leone, one of the poorest countries in the world, proved to be a challenging one for HIS implementation. In addition to the political issues discussed, there were practical hurdles to pass in order to get the process moving. Lack of a proper and stable technical infrastructure (poor power supply, lack of Internet, poor roads to remote areas) and an overall low technical capacity to maintain or even to take part in the various functions of an information system like reporting, data analysis, information use, were factors adding to the complexity of the implementation which needed special attention in order to get the process moving at all. The pilot implementation in step three of the change process proved invaluable in terms of revealing the detailed challenges of the context and provided lots of feedback to adjust the system and to make better preparations for the nation-wide implementation to follow. It was clear that the implementation strategy not only had to be sensitive to the political context, but also needed clear strategies for dealing with basic practical problems such as power supply and a hazardous climate for technical equipment. Failing to do so would have meant months of delays and potential severe impact on the user credibility with regards to the new system.

### **5.2 An II analysis of the change strategy**

The five steps of the change strategy will be analysed through an II lens:

#### **1) Analyse and assess the existing system**

Given the complexity of a HIS and the importance of taking the installed base seriously into consideration when designing for change, this step was necessary and

very decisive to the continuation of the change process. Ideally, the best approach and the desired next step to standardizing health data and integrating different vertical reporting systems would be to make all actors agree upon a new set of standards and then implement the new standards. 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 [1, 2]. Similarly the health information infrastructure evolved over time in a gradual and piecemeal process of change sensitive to the political context of the installed base. Steps 2 and 3 outline this gradual change process where trust and political support is cultivated to prepare for the more official reform process of introduced in step 4. Given more political support for change at an earlier stage, e.g. as was the case with HISP in Zanzibar [23] it would have been possible to jump directly to step 4 after an initial assessment (step 1).

## **2) Integration behind the scenes using software tools**

A key point of this phase was to take an important step towards an integrated HIS without disturbing existing data collection processes at the health facilities and districts. Through the use of a flexible software tool the new design of the HIS was hidden through the use of electronic forms as gateways [1, 7] to the existing paper based collection process. The electronic forms looked exactly like the existing paper forms, but behind the user interface, black-boxed to hide complexity from the health workers a modular architecture re-linked the data being collected into an integrated data repository without overlaps and fragmentation. Such a technical solution had not been possible without the inherent change flexibility [1, 2] in the software tool which was necessary to reduce complexity (from the user perspective) and avoid lock-ins in the continuously changing and user-influenced prototype [2, 6].

## **3) Pilot the tool and new HIS integration approach**

Although the idea of step 2 was to limit the change of data collection and paper forms, the benefits and possibilities of having an integrated data repository introduced new working routines and ways of thinking about data. Furthermore, these benefits all depended on proper use of the newly introduced software tool to manage the integrated data repository. Implementation

of the new approach was done in a gradual manner, starting with a few selected health districts, the early adopters, and then by increasing the number of districts in phases. Feedback from the pilot process in the first districts provided an important input to revising the tool developed in step 2, and several cycles between 2 and 3 were necessary before expanding to more districts in what can be described as an ongoing participatory standardisation process. By limiting the implementation of the new approach complexity was reduced, both in terms of size, geographical spread and variety of interests in the user pool, and the chance of acceptance increased. In turn as the first users were satisfied and felt comfortable with the new approach and software, it was much easier to expand to new districts and to gain support among key stakeholders at the national level. Such a prototyping process builds on the bootstrapping principle which is a recommended strategy when designing for II change [24], and in the case of the Sierra Leone HIS reform, a necessary process to reach a critical mass of committed stakeholders to move to step 4.

## **4) HIS reform in the open**

This step which can be described as long term standardisation process consists of many smaller and interlinked steps taking place in the background (many of them overlapping with step 3), but the one critical step towards success is the official meeting where paper forms and indicators are revised and agreed upon by key stakeholders. Without such a sanctioning of revised datasets (and change) there is little hope to change the HIS processes at the lower levels. For such a process to succeed, alignment of a critical mass of stakeholders is necessary [18]. Stakeholders or actors are spread around a heterogeneous network involving health programs, donors, and as well as various departments within the central administration of the ministry. For integration to succeed a common set of standards must be agreed upon by at least the key health programs and most likely other programs and actors will join in at a later stage and gradually the standardised infrastructure will evolve into an increasingly self-reinforcing process [24]. But without an initial push and political will towards integration and change, little will happen, illustrating the importance of step 3. In Sierra Leone, after more than a year of bootstrapping a climate for change (in step 2 and 3) the political willingness for an integrated approach has increased and a major revision meeting just held.

The use and applicability of national standards at the district level is another key factor to consider in a HIS standardisation process. Reaching sustainability of a HIS at a national scale is highly dependent on

achieving local sustainability as the national system depends on the quality of data coming from the local levels. This again is a result of how successfully the national standards have been adapted and integrated across the different local contexts [25]. This is more than true in the case of Sierra Leone where various health programs (often backed by donors) are giving incentives to health workers at grass root level to collect programs specific data and indicators in parallel to the integrated reporting structure system working against the huge efforts made by other stakeholders at the MoH to narrow the amount of indicators and data to be collected.

### **5) Gradual reduction of data collection and increased focus on information needs at each level**

This step five is a long term process of upgrading the status of the HIS from acceptable to ideal, and as such an infinite process of improvement. One key challenge is to tackle the complexity of the multi-level nature of the HIS and address the information needs at all levels from local clinics to the Ministry of Health. Although the previous steps are all taking local levels into consideration, especially local participatory design processes in the pilot phase, the major decision-making on health standards take place at the top of the hierarchy. The hierarchy of standards approach described in section 2 follows the principle of flexible standards [2]. A flexibility to change standardised datasets at each level while at the same time complying with the demands of the higher levels, minimises global-local tensions [26] and enables local flexibility to make the standards useful for local action.

## **6. Lessons Learned**

The main contributions of the paper are the empirical lessons from designing and implementing a change strategy towards an integrated HIS in Sierra Leone and the theorizing of these lessons within the framework of information infrastructure theory. The strategy outlined in this paper addresses the political context of HIS reform with reluctance to change as well as various more practical challenges related to very poor infrastructure and insufficient human capacity. Key elements of lessons learned and a proposed change strategy are;

1) The data warehouse approach to integration worked well in Sierra Leone as it enabled health programs and user groups to include their data sets and needs in a gradual way and by building on the existing systems and processes without “rocking the boat”. Evolutionary development based on the installed base is therefore a generalised recommendation.

2) The importance of flexibility in the process of changing data standards is another key lesson. The data warehouse approach enabled health programs and user groups to change data sets and formats in a step-by-step manner, and as they learned what worked. A flexible standardisation approach to integration may smoothen the change experience for users and stakeholders, and minimise resistance.

3) The integration process in Sierra Leone succeeded in getting the various actors to work together and develop a shared collection of data sets and standards because early results were providing solutions to key needs in a convincing way. In the specific case of Sierra Leone, the first version of the data warehouse managed to transform the chaotic and overlapping data collection forms, as input, into consistent output data. This practical solution to urgent needs convinced the health programs that it was possible to also design consistent data standards to enter into the system. While in terms of data standard and database design, this was a relatively easy task, the impact was significant. The more generalised recommendation is to initially go for the “low hanging fruits”, user needs where modest input can create significant results. By providing early significant result, user will learn what can be expected and a momentum is created; bootstrapping political will to change through results on the ground.

The integration process has been going on within the three domains suggested by Wainwright and Waring [15]; technical, organisational and strategic. While the strategic domain, with strong push from the WHO and the Ministry of Health, represented the initiative and the mandate, the organisational domain was where the the vertical health programs found ways to align their interests. The technical domain was where the practical solution, the data warehouse, was developed. In the case of Sierra Leone the integration process and initiatives have cycled through these three domain; from the strategic domain to the technical, to the organisational facilitating the various organisations to modify their strategic visions. The general lesson is that all three domains of integration are important and that they are interdependent – they need to be approached in an integrated manner.

## **7. Conclusion**

Given the nature of the information infrastructure to resist radical change and the need for long term capacity building at all levels of the health system it is clear that HIS integration reforms such as the one described in this paper is a long term process of

change. Only through long term commitment and by proactively *pushing* the process through the many hurdles along the path are there chances of achieving a self-reinforcing step of change in a developing country context like Sierra Leone.

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