Advancing Health Information Systems: Experiences from Implementing DHIS 2 in Africa

The Health Information Systems Programme (HISP) is a global network established, managed and coordinated by the Department of Informatics at the University of Oslo. Based on long term support from the Norwegian Research Council, The Norwegian Agency for Development Cooperation (Norad), the University of Oslo and the Norwegian Centre for International Cooperation in Education, HISP designs, implements, and supports the sustaining of Health Information Systems in developing countries based on the DHIS 2 software. The approach is fundamentally participatory, supporting the local management of health care delivery and information flows in communities, health facilities, districts, and provinces, and its further spread within and across countries and regions. DHIS 2 is free and open source software for online data management, capturing, validation and analytics. It has a generic data model which can be tailored through the user interface to a wide range of use cases. It can be used to manage statistical data as well as transactional data and personal information, and be accessed from laptops, tablets and mobile phones. Currently, DHIS 2 is in use as a Health Management Information System in more than 30 developing countries and even more organizations across four continents.

In this essay, we share experiences from three country implementations of DHIS 2 in Africa (Malawi, Kenya, and Uganda) as well as a regional effort in West Africa. In each of these cases, we highlight different lessons learned and challenges we have encountered through our engagement in software development and implementation activities.

Malawi: The Challenge of Human Capacity in Data Collection and Use

DHIS 1 (an earlier offline version of DHIS 2) has been used in Malawi for the last 10 years, with one health information officer in each district office collecting core Health Information System (HIS) data. In parallel, the various health programmes have been using Excel, specialized software or paper forms for data collation at the district level and reporting to the national level program offices. DHIS 2 was piloted in 2011 and a national server established in 2012. Throughout the last quarter of 2012, all programme coordinators (in total 500) in all 28 districts plus core zonal staff was trained in workshops on DHIS 2, as well as on data interpretation and use. It was discovered during the pilot period that while districts claimed they had Internet connection, it was experienced as too slow, and many programme officers were in fact not connected. The data on the server for 2012 reflects this, in the sense that there are significant variations between the districts on the reporting rates. To assess performance, five districts were visited in late November 2012. Around 25 coordinators, HIS officers and clerks were interviewed on data recording practices, reporting and use. A key finding was that there were substantial variations in approaches and competence within each district. For example, some programme coordinators could without difficulty discuss coverage rates and the significance of old census figures. Some of the immunization and malaria coordinators also demonstrated how they used their indicators for planning interventions and mobile campaigns, even if the lack of funds for transport hampered implementation. Furthermore, these HIS officers demonstrated a good understanding of data and indicators. At the same

1 Algeria, Bangladesh, Benin, Botswana, Burkina Faso, Congo DRC, The Gambia, Ghana, Guinea Bissau, India, Kenya, Liberia, Malawi, Mexico, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Solomon Islands, South Africa, South Sudan, Tajikistan, Tanzania, , Togo, Uganda, Zambia, Zanzibar, and Zimbabwe.
time, the majority of the coordinators did not have such skills. Some mixed up data and indicators, and others could not even explain the meaning of the numbers they reported. Also, the majority had not entered data in the DHIS 2 yet, but rather continued to use their old tools, commonly blaming network problems.

**Kenya: Reaping the Benefits of an Online Solution Hosted in the ‘Cloud’**

In 2010, the Kenyan Ministry of Health (MoH) decided to use DHIS 2 based on an extensive evaluation by the University of Nairobi. The MoH requested technical support from the University of Oslo, and the implementation process was initiated in October 2010. A central concern from the start was whether to use an online central server or multiple standalone installations at district offices and hospitals. There was considerable uncertainty about the status of Internet coverage across the country and serious doubts whether all districts (approx. 200 at the time) would be able to use an online system. Building on the experience with DHIS 2 in Sierra Leone, the HISP team knew that standalone installations could be problematic both related to the timeliness and consistency of data, as well as imposing a huge challenge on the maintenance team to keep all local installations functional, virus-free and up to date. An online server does not eliminate all delays, but data is available to all users and levels once entered, enabling comparative data analysis. Further, using a single database makes it easier to avoid variances in metadata over time as well as maintaining data integrity.

The decision was made to proceed with a hybrid approach with one central online server to be used by all online entities, supplemented by standalone installations were Internet was not available to keep the number of standalone installations at a minimum. Again, the approach was informed by experience from Sierra Leone were 13 district installations had caused a headache. The idea of having hundreds in Kenya was not tempting at all. However, testing the DHIS 2 online server in a district hospital in October 2010 changed the deployment approach completely. After a power cut, generators started and the power came back, but the fixed-line Internet was gone. The team was just about to conclude that Internet was not an option in Kenya, when a staff member suggested using his mobile Internet modem to re-connect. Apparently, mobile networks were not affected by power cuts. Without delay, mobile Internet modems were tested successfully around the country and by the time the rollout had completed, it was clear that all districts and district hospitals in the country could use the online DHIS 2.

The Coast Province was selected for piloting, and DHIS 2 was implemented in districts and hospitals there in January 2011. The implementation did not involve any software installation, as only an Internet browser and a connection was required. Freeing up resources, much more time could be spent on user training and discussions and feedback on functionality. This was a major step forward from a standalone setting where hours are spent at each office just to make sure the system is running smoothly. Another key feature with the online server approach is the ease of rapid prototyping at large scale. When addressing a number of user requests, changes were implemented once at the server and instantly become available for all online users. Once implemented, this approach also radically reduces long-term maintenance costs.

Even if online, many offices suffered from fluctuating Internet connectivity and a common complaint was that data entry processes were interrupted. To deal with this, an offline data entry feature was introduced, making use of the local storage in the browser (enabled by the new HTML 5 standard). In this way, the data forms and data entered are stored on the local computers and data entry can continue seamlessly also when the connectivity is lost. Later,
when the connection is restored data is automatically submitted. Further, to allow for offline data analysis, a light-weight desktop application was developed to allow users to download their own data from the server to use in local Excel PivotTables when disconnected.

While an online server solution reduces the challenges of distributed software, a centralized approach is heavily reliant on the central server and its configuration. Since all users depend on the server, its constant availability should be assured. During the implementation, issues of weak connectivity, lack of adequate power back-up and a generally insecure server environment were identified in relation to the server at the MoH. To solve this challenge, a commercial virtual server was rented as a provisional solution. Due to lack of local capacity, the HISP team configured the server and handled the day-to-day maintenance through online tools. Again, the online server approach replaced challenges of local hardware, software versioning and maintenance to a much simpler online maintenance approach. This ‘cloud’ based approach resulted in a server that was secure and reliable from day one. The pilot was successful and the rest of the country was covered during April-October 2011. Such a country-wide approach with a national online server was unique in the public sector in Sub-Saharan Africa at the time.

The HIS data completeness and timeliness in Kenya has been revolutionized with the introduction of the online DHIS 2. Going from a non-functioning system with major problems of reporting from the districts, Kenya reached 80 percent completeness shortly after completing the rollout in October 2011. Since January 2012, the completeness has stabilized just above 90 percent for the major HIS forms. While experiencing major improvements on the availability of data, improving the quality and use of the data has proved a much tougher task. Kenya is currently going through a phase where HIS data suddenly is widely accessible, both within and outside the MoH, and as a consequence more complaints about data quality is being raised. As a response to this, gradually more and more focus has been put on data analysis and use; training users in the DHIS 2 reporting and analysis tools, and making stakeholders at all levels aware of the possibilities of the system. For example, 15 of the district health records officers have been selected as members of a ‘super-user’ group and have participated in a training-of-trainers programme since 2011.

**Uganda: Implemented Swiftly Based on Best Practice Knowledge Sharing**

After Kenya and Ghana, Uganda was the third country in Africa to implement a nationwide online DHIS 2 system in August 2012. The first preparations of the Ugandan implementation started in August 2010 when the Center for Disease Control (CDC) Uganda, supporting the Ministry of Health in regard to HIS, initiated contact with the University of Oslo. An Ugandan team attended the DHIS 2 East Africa Academy in Dar es Salaam in 2011, and met the Kenyan team who at the time where in the midst of their national DHIS 2 rollout process. This was an excellent opportunity for the team to learn lessons from other countries, informing the approach in Uganda. The Ugandans had much stronger IT backgrounds and skills, and were all recruited by CDC or USAID, either seconded to or working very closely with the MoH.

A few months after the Academy, the MoH took the decision to roll out DHIS 2. Training sessions were carried out in the four pilot districts in Western Uganda in January 2012. The districts were the Saving Mothers Giving Life pilot districts, and the idea was that these could quickly start to use DHIS 2 to capture data on maternal health. The initial support was funded by the University of Oslo, while a few months later a PEPFAR/USAID project (MEEPP)
came up with funding for a second round of training, carried out by resources from Oslo and neighboring Kenya. The national rollout was initiated in June, and in September, only 4 months later, all districts where using DHIS 2 online and reporting monthly HIS data. The rapid rollout was organized as concerted effort involving many different partners. In addition to the national HIS system, HISP has in collaboration with resources in Uganda developed a module in DHIS 2 to track women through antenatal care, delivery, and postnatal care to strengthen retention. This includes the use of mobile phones to capture data at remote facilities and also to send out SMS reminders to the pregnant women missing scheduled appointments at the clinic.

**West Africa: Standardizing HIS Regionally**

The strong position of HISP in West Africa started with the implementation of DHIS 2 in Sierra Leone during 2008-2009. The Health Metrics Network (HMN) and WHO had selected Sierra Leone as their pilot country for implementing an integrated Health Information System, with HISP as a partner. Together with HMN and the MoH, the DHIS 2 went through many cycles of improvements in order to be able to work well in Sierra Leone. The project was widely regarded as a success, and promoted by the HMN. Achieving success in a war-torn country Sierra Leone also created much attention among other West African countries, along the lines of “If it can work there, it should be possible also in the rest of the region”, and was the stated reason for why the West African Health Organization (WAHO) started collaborating with HISP from 2010.

In 2009, WHO initiated a process to develop a data exchange standard for health metadata and aggregate data (SDMX-HD). By 2010, HISP and HMN decided to pilot this standard in Sierra Leone by implementing the OpenMRS medical record system to track patients on Antiretroviral Therapy and to share this data with the DHIS 2. At the same time, CapacityPlus, a partner of HISP and HMN specializing in strengthening Human Resource information systems, was partnering with WAHO to pilot the open source iHRIS application for human resource management in Ghana. Given the early success of and growing attention to what was now seen as the ‘integrated Sierra Leone architecture’, WAHO became interested in also including iHRIS to the interoperable package of DHIS 2 and OpenMRS. A workshop was organized in Accra, Ghana, in partnership with HMN, CapacityPlus and HISP, to promote the integrated architecture, and conduct training in the three open source applications. At the end of the Accra workshop, SDMX-HD implemented for interoperability between DHIS2, iHRIS, and OpenMRS, was officially launched by WHO. Despite only being a test implementation of interoperability, it created awareness and interest for implementing more comprehensive integrated health information architecture both in countries and at the WAHO level.

During 2011 and 2012, HISP worked with WAHO to develop an assessment of HIS in the region, and based on this situation analysis develop a regional HIS Policy and Strategy2. A primary finding of the assessment was that integration of HIS was a key challenge in all 15 ECOWAS countries, arising from technical and institutional conditions. Institutional conditions included struggles with vertical and fragmented donor-supported HIS, and technical issues malfunctioning and inflexible software which could not interface with other software. Additional key factors leading to HIS fragmentation include the absence of standards and a guiding policy framework to ensure integration, which in turn contribute to

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2 “Situation Assessment of Health Information Systems in the ECOWAS Region”, Final Report, Commissioned by the West African Health Organization (WAHO)
poor data quality and use. Through the policy development process, 8 objectives across three categories (policies and resources, systems development within an integrated framework, and information use and dissemination) were identified as the pillars of the HIS policy, with a set of implementation strategies provided for each objective.

Following the relative success of the implementation of DHIS 2 in Sierra Leone and the interoperability pilots, a number of countries in West Africa have embarked on projects to customize and implement DHIS 2. In 2009, the Gambia started implementing DHIS 2 on their agreed data standards, which previously had been implemented using Excel spreadsheets. From 2010 and onwards, Burkina Faso, Ghana, Liberia, Nigeria, Niger, Togo, Benin and Senegal have also decided to develop and implement DHIS 2 as their national system. In 2012, Ghana and Liberia went online nationwide, and Burkina Faso and other countries such as Nigeria will follow during 2013. WAHO takes part in coordinating technical support on DHIS 2 to all West African countries. In 2012, DHIS 2 was selected as a regional data warehouse, a shared list of indicators for reporting from 15 countries developed and agreed, and a test database was developed. The regional data warehouse will function as a health observatory, containing online data analytics down to district level or equivalent across the whole region.

**Challenges Encountered and Lessons Learned**

The implementations of DHIS 2 in Malawi, Ghana, Uganda and the West African region has the potential to improve the access to and the use of information for health management. Through the implementation efforts described here, DHIS 2 has proven capable of scaling from pilots to nationwide implementations rapidly by taking advantage of local and regional human capacity and leveraging recent technological developments. Below, we pinpoint what we see as key aspects contributing to these efforts as well as the major challenges.

*The online server approach*

Entering and accessing data online has the potential to radically improve information quality and utility. First, the cost of physical data transport is replaced by the cost of network connectivity. Second, eliminating the logistics and the challenge of physical transportation (e.g. bad roads during the rainy season) timeliness and completeness of data are improved. Third, an online solution is based on one or a few servers, reducing the challenge of syncing databases as well as variances in metadata. The online approach also supports data usage as data entered online is instantly accessible on all levels. DHIS 2 strongly supports transparency by granting peers access to data. This encourages entering accurate data, as well as self-evaluation and peer-discussions. A key cost with offline installation of software is maintenance and software upgrades. With local installations, significant time must be spent travelling to each site for the initial installation as well as for maintenance and software upgrades, or local capacity must be developed to a level where each installation is self-sustained. With an online solution, software maintenance is handled centrally on one or a few installations, by a dedicated team of experts.

It is the radical development of the mobile network together with the new fiber cables along the coasts of Africa that have enabled implementation and scaling of DHIS 2 relatively rapidly across large African countries. Still, when using mobile Internet modems for PCs as well as mobile phones, network fluctuations will occur. Being designed to handle both online and offline situations, DHIS 2 seamlessly supports offline entry and data transmission when connected. This is more resilient compared to an online only solution. Data entry is enabled at
any time and without the risk of having to enter data twice. As mentioned above, offline data access to own data is also supported based on a light-weight desktop application.

**From DHIS 2 implementation to data used for action**

While the number of DHIS 2 implementations can be used as a proxy for its success, we argue that the success of an HIS can only be measured in the quality of data and whether and how the data is used for action. Only through a strong information culture where data is not only analyzed, disseminated, fed back and used locally, but also used for planning and evaluation of achievement of prior plans and carrying out impact assessment, the full potential of an HIS is utilized. For example, in Malawi, some malaria coordinators are using information actively for planning, while the majority is not. Another example is Ghana, were facilities have well-kept registers, used for service delivery, making summaries and graphs on wall, while on the national level, data is not yet integrated. There is ample room for improving the level of information use in health management at all levels in all countries. One successful intervention which has proved as a remedy for this is regular data use workshops every quarter for adjacent clinics or districts. Unfortunately, such activities are easily cut when budgets shrink or patient demands increase. While project funds often are available for new interventions such as software implementation, the sustainability of data use workshop depends on a steady flow of resources from the MoH.

**The ICT competence challenge**

Even if focal in HISP activities, the need for human resources and capacity building remains as one of the major challenges for successful implementation of HIS. For example, implementing DHIS 2 in the 15 West African countries will be challenged by lack of human capacity as identified in the ECOWAS policy document. Even where relevant skills may be available, the public sector often cannot compete with private companies on salaries and benefits. This is especially relevant for ICT skills, where experience with server maintenance is short in supply. Through regular DHIS 2 academies, the establishment of local Master programmes and PhD education at the University of Oslo, HISP seeks to build local and regional expertise in HIS implementation as well as data analysis and use. Further, through engagement in policy making, HISP attempts to strengthen data use, data openness and data harmonization. Another approach shown fruitful is cross-country knowledge sharing. For example, when Uganda implemented DHIS 2, they benefitted significantly from the numerous improvements made during the implementation of DHIS 2 in Kenya. Further, they reused training methodologies and materials. The project manager in Kenya was used as a trainer at a training-of-trainers event in Uganda, sharing his experiences from the rollout in Kenya. This is not only a good example of country collaboration in the region, but also how local expertise is being established and showing capacities that previously only rested with the experts from the University of Oslo. The circulation of practitioners between implementing countries is also a driver of innovation, as established practices are exposed to new contexts and ideas.

**Lacking policy frameworks**

The implementation and use of Health Information Systems requires policy frameworks. There are several areas where policies are needed, but often lacking; HIS harmonization, data access issues, IT acquisition and open source, and data ownership and security in a networked society. First, a common key challenge is the fragmentation of HIS into various independent sub-systems. To support the different health programs and different partners and stakeholders involved in a country to harmonize indicators and data sets and ultimately integrate their efforts to share data and avoid parallel reporting, governments must not only understand the merits of integration, but also support it actively. Second, DHIS 2 is built on a philosophy of
open data, granting access to all units in the health system as well as to external stakeholders and other interested parties. This is a challenge, since different entities in a health information system commonly understand the data they produce as ‘owned’ by them, and not as a public good to be shared. To change this, governments must not only understand the merits of open information, they must develop strong policies supporting and not hindering open data access.

Third, the examples of DHIS 2 implementations show that countries are able to benefit by innovation taking place in other countries, since the software is free and open source. While countries often have a cost-oriented approach to IT-acquisition, important elements of innovation, robustness, support-base, and freedom of alteration and use are neglected. For example, the software development in DHIS 2 to support the online deployment in Kenya led to the same advantages being available in Uganda and across West Africa. Even the training material is free and open, allowing adoption and adaptation of these for any particular context. Last, but not least, governments need to develop policies to make the most of the possibilities arising with the Internet, while at the same time retaining the necessary control and security that their health data commands. While renting server space on the international market might be a reasonable mitigation of limited local technical support in the short term, there is a need to sort out legal issues of ownership and access.

Concluding remarks
Above, we have laid out a few lessons learned and challenges encountered implementing HIS. In particular, the online approach has reduced the need for ICT maintenance considerably, pushing the technical issues over to the mobile network operators. Although the connectivity is poor in many rural areas, the networks are improving. Connectivity therefore seems to be a temporary problem in most places, and something that will be dealt with independently of government budgets. Local capacity building for entering, processing and using data for action is a health system issue, however. It can only be dealt with through prolonged efforts amongst all management cadres in the sector with corresponding sustained funding. The challenge of lack of capacity for adapting and implementing software solutions persists. Here, a smaller number of highly specialized technical assistants are needed. The HISP network is cultivating such staff during regular Academies and exchanges throughout the region. Integrated health information systems need government policies underpinning their role. The Ministries of Health need to take firm action to support vertical programmes to store their data in the HIS backbone, from which they may retrieve it and eventually import it into other software. Vertical programmes will benefit from integrated systems by means of access to other sources, including for example population data for calculating indicators.