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Applying ICT to Health Information Systems (HIS) in Low Resource settings: Implementing DHIS2 as an Integrated Health Information Platform in Lao PDR

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Abstract. In the 3 years since initial discussion on application of ICT for the Lao Health and Management Information System (HMIS) and initiation of the Lao Health Sector Reform process, DHIS2 has become the official national health information reporting platform for the HMIS including the major health programs, such as MNCH, TB, Malaria and HIV. The platform now provides a data warehouse that collects and manages routine data from all public health facilities nationwide and dashboards for dissemination and use of information. The system generates programme reports, national health system reports, statistics reports as well as other reports serving monitoring purposes for the Ministry of Health (MOH) and the Government of Lao (SDGs; UHC). This article describes the process of developing the integrated HIS in Lao People Democratic Republic (PDR) from 2013 to December 2016. Overcoming challenges of human resource capacity and infrastructure disadvantages; strengthening the utilisation of health information especially for planning and decision making have been and will be crucial for the strength and sustainability of the integrated HIS on DHIS2 platform similar to other setting in developing countries.

Keywords: DHIS2; integrated HIS; ICT for health;

1 Introduction

This article documents the process to develop an integrated Health Information System (HIS) in Lao PDR. Fragmentation of HIS into different health program and disease specific systems, which was the situation in Lao PDR, has been a general problem in developing countries for a long time [1, 2]. Responding to the HIV pandemic and other public health problems in the developing world the first decade of the new century saw a drastic increase in funding and efforts in fighting killer diseases, such as HIV/AIDS, Tuberculosis (TB) and Malaria, as well as other poverty related health problems, such as maternal and infant mortality. The UN Millennium Development Goals were formulated in 2000, the Global Fund to fight AIDS, TB and Malaria

(GFATM) was established 2002 and the United States (US) Government PEPFAR program to fight HIV/AIDS commenced in 2008. One unintended consequence of this surge of funding for disease specific health programs was poor coordination and increased fragmentation of overall HISs in developing countries. Fit for purpose HIS was seen as critical for achieving the MDGs [3] and the World Health Organisation (WHO) established the Health Metrics Network (HMN) in 2005 as a global effort to support countries develop strong integrated national HIS, a measure to counteract the tendency of increased fragmentation of national HISs. The MDGs have now been replaced by the SDGs, but the international focus on strengthening country HISs as a key vehicle to achieve these goals remains pertinent. In 2016, WHO and other international agencies established the Health Data Collaborative as a forum, or 'low scale' agency for coordinating funding and support to countries for their efforts to strengthen their HISs and to pursue the SDGs [4]. Fragmentation and lack of coordination are still seen as key impediments for countries in developing their HIS.

We present the case of strengthening and integrating the HISs in Lao PDR, which has many challenges similar to other developing countries, such as fragmented and uncoordinated vertical disease specific programme HISs. While this case study starts with the efforts to strengthen the HIS in 2013, it is worth mentioning that in 2009-10 Lao PDR participated in the HMN process of 1) conducting a situation analysis of current systems, and 2) developing and implementing a strategic plan to harmonise and guide all HIS inputs. This HMN process, however, was not finalized due to lack of funding and a relatively abrupt termination of the HMN initiative in 2011, due to problems of funding and conflicts over strategies. It is important to note here that the integrated architecture promoted, called the HMN Framework [5], was largely accepted in the country and it has to a large extent been implemented during the process we present. The HMN architecture promotes a data warehouse approach to integration, where a central data repository integrates and manages aggregate data from multiple data sources, and uses various analytical tools, such as dashboards and GIS, for the output.

In Lao PDR, the DHIS2 open source platform has been utilised as the central data warehouse in line with the HMN architecture. It is employed first as a web-based data collection tool for the Health Management Information System (HMIS) in the Ministry of Health (MOH), then as data warehouse for other surveys, with legacy data supporting the analysis and development of national health statistics reports. Three years after it was implemented based on the HMIS reporting data sets, DHIS2 is an integrated HIS platform that hosts the reporting systems from 8 health programmes, which were previously uncoordinated separate HIS 'silos', one for each program. Given the current success, more health programs and reporting structures, such as reporting on financial data, are in the pipeline to be included

The development of the system was a participatory process with active involvement from both government sectors and development partners with coordinated support and use of the system under the national framework of the health sector reform, led by the MOH.

The remainder of this article has the following sections; 1) key concepts, 2) methodology, 3) the case study, 4) discussion, and 5) conclusion.

2 Key Concepts

Fragmented and poorly coordinated HIS, often to report to donor funded projects and programmes, are common problems in developing countries [1]. This situation creates both duplication and overlap of data collection and reporting and increased workload for health workers. Lack of coordination and integration also creates gaps in that essential data is not collected. In Lao PDR, such gaps are identified in the cross cutting areas of human resources, governance, finance and logistics, at all administrative levels. The HMN architecture promoted a data warehouse approach to integration, where aggregated data from different sources are managed in a central repository [5]. In a study of the efforts in countries to implement data warehouses to integrate national data, Sæbø et al [6] identify three overall strategies:

1. The HMIS strategy; key data from different health programs are collected by the HMIS in order to have all data required to calculate essential indicators in 'one place', or in one data collection system. A consequence of this strategy is that data will be collected from multiple places. It might be seen as a legacy of the paper based systems, where sharing of data across (paper based) systems was difficult. This strategy has successfully been applied in South Africa.
2. All data in 'one bucket': All data collected are managed in one data warehouse. Data are not properly harmonised before being collected; due to different data collection procedures and sometimes also different definitions, the same data are collected by different health programs. This is an approach that needs to be part of a process to harmonise the data sets and to attain at a situation where all data are well defined and collected only once.
3. Aggregate data from all health programs are integrated within the data warehouse. Instead of running their own systems, all health programs use central data warehouse for their data. The advantages are; sharing of data, shared dashboards, and ease of coordination.

The first of these strategies, the HMIS strategy, was the typical strategy used by countries during the period of predominantly paper based systems. Today, many countries are applying a variation of the third option. A key challenge in being able to manage aggregate data from multiple programs is to be able to extract data from other transaction based systems, for example from HIV/AIDS electronic patient record systems.

The four cases studied by Sæbø et al [6] all used various versions of the DHIS open source platform and they were all part of the so-called HISP action network. HISP is an international collaborative network where independent HISP groups, universities and health authorities in countries, all engaged in implementation focused

projects, are sharing experiences and best practices [7]. The DHIS2 open source platform is a central part of the HISP action network. While the software development is being coordinated by the University of Oslo, participation and feedback from country implementations are the key components of the DHIS2 process.

With current technology development, especially the internet, ICT has become part of the health sector development, from supporting the networking and communication within health care facilities and administrative issues, to HIS, visualisation, sharing and disseminating of information. The establishment of the Asia eHealth Information Network (AeHIN) in 2010 has been important in bringing ICT solution into the core business of the health sector in the region. In Lao PDR, HIS is under the department of planning and international cooperation, it has the advantage of mobilising funding and the 'one shared plan' concept has been well supported by all involved development partners. Other partners such as JICA, Swiss Red Cross and Save the Children have provided additional support for training of MOH staff at central, province and district levels [8].

3 Methodology

The impetus behind this paper is to share learning from the process of applying DHIS2 for the health management information system as well as its expansion to become an integrated information platform in Lao PDR with the global health and ICT community, highlighting issues that are common to the process and describing how challenges were overcome.

The research methodology used has been based on action research approach [9], where three of the authors are part of global HISP network with experience in implementation of DHIS2 in different countries along with regional and global challenges facing HIS implementation. Implementation of DHIS2 in Lao PDR has followed a collaborative approach with team members from Ministry of Health, Development Partners both at country and regional/global level. The progress and challenges of implementation process and its output was shared and discussed in broader forums such as Asian eHealth Information Network conferences, regional DHIS2 Academies in Vietnam and conference and development partner meetings at country level.

The action research approach applied has not followed the prescribed cycles of design, development, implementation, use and evaluation [10] in a formal way. Rather, these concepts have been applied without following the sequence in the cycles in a strict way. Activities carried out during the project including the following:

- Repeated prototyping cycles of the DHIS2 application to incorporate the Lao PDR health administrative hierarchy and reporting structure and cycles of new requirements and the gradual incorporation of new health programs.
- Standardization and harmonisation of the multiple data collection tools in use by engaging and negotiation with various national health programs
- Inclusion of key necessary data field in the routine HMIS to meet global standards and discussion with various stakeholders at country level

- Adaptation of standard data dictionary with its data source, frequency of reporting, common problems
- Creation of national core DHIS2 team including members from different health programs, departments and member of cabinet and linking them to global networks such as DHIS2 and AeHIN.
- Restructuration of DHIS2 to enable integration of national health programs such as Malaria, TB, and HIV/AIDS
- Continuous discussions and updates of progress and challenges with Development Partners in Lao PDR and Global level
- Evaluation of the DHIS2 national implementation (June 2015 and Nov 2016)
- Routine update on progress and challenges to Cabinet of Lao PDR (2014 to 2016)
- Development of three dashboards highlighting the status of Lao PDR including Universal Health Coverage, MDG and Integrated HIS
- Presentation, meeting and discussion in regional form such as DHIS2 Regional Academy in Vietnam (2014, 2015, 2016) and AeHIN conference (2013 and 2015)

The implementation process of DHIS2 in Lao PDR began with joint appraisal missions with members from MOH, DHIS2 experts from the Oslo University and the private sector, development partners such as World Bank (WB), WHO and AeHIN members. The missions visited all administrative levels of the health system: from the community and health facility levels, to the district, province and national levels. The discussion engaged all potential stakeholders and users of health information to determine the country's situation, information usage and ICT landscape to support the reform of HIS. This process resulted in the joint decision of applying DHIS2 for HMIS as the first step toward an integrated health information system, as well as convincing new partners, such as WHO and the World Bank to support the process.

A team form HISP Vietnam (www.HISP.vn), experts on DHIS2, has provided technical assistance throughout the process. DHIS2 structure and operational procedures were designed with active participation from not only the software specialist, but also with public health staff from MOH at central level, and sub-national level HIS staff, together with some of the hospitals at central and provincial levels. This process ensured that the DHIS2-based HMIS reflected well the organisational structure of the Lao health system, yet retained flexibility and adaptability that are key features of the DHIS2, in order to meet the user's needs.

4 Implementing DHIS2 Application for Health Information System in Lao PDR

4.1 Background

Lao People's Democratic Republic is a landlocked country in South East Asia, bordering with China, Myanmar, Thailand, Cambodia and Vietnam. According to the Census of 2015 report, Lao PDR has a population of 6.5 million from 47 ethnic groups, 32% of them are between 10 - 24 years old and 67% live in rural areas. Despite the fact that the Lao HMIS has been set up with routine data collection since 2008 [11], the information was hardly generated and poorly used. Reasons for poor data quality and use are varied, but fragmentation of data collection and reporting systems that created burden for health facility staff to collect the data and to fill the required data collection forms represent a key problem. Delay in publication of National Health Statistic Report made it difficult for MOH and other stakeholders to use evidence for planning and decision making. As the information systems were organised in vertical 'silos' with limited data sharing across the program, using data from these systems to get an overview across program areas was difficult.

Furthermore, the health statistics division under the (former) planning and finance department in the MOH performed the only mandate of collect the HMIS data set. Other functions such as setting standards; developing policy and coordination with other reporting systems; database management etc.[11], despite having been stated in the HIS Strategy 2009-2015, was not effectively carried out, thus made HMIS another silo in the Lao HIS landscape. Non-wage domestic funding for the HIS implementation was not available, thus the implementation relied on the donor funding and supports.

As of October 2013, each health centre had to collect data into at least 17 different forms that were then reported upwards to the district. Many of the forms had overlapping data. The vaccination reports, for example, were submitted to both the EPI (Extended Programme on Immunisation) and the MCH (Mother and Child Health) programmes. Information sharing required issuance of lots of official documents yet standards and quality of information were uncertain. The HMIS reports were normally submitted very late to the central office, incomplete, and almost impossible to verify, for example, prior to the introduction of DHIS2, only half of the districts were recorded to have submitted their monthly reports to provincial level before these reports were consolidated to provincial quarterly reports for submission to central level [12]. The provinces did not see the need to follow up, and no national report would be published. During the period between 2005-2013, two national annual health statistics reports were produced, both by external consultants funded by donors through WHO Lao, indicating little local participation and ownership of the data and its utilisation.

The Ministry of Health of The Lao People's Democratic Republic developed a National Health Sector Reform (HSR) Strategy 2013 – 2025 [12], which highlights the twin goals of Millennium Development Goals (MDGs) by 2015 and Universal Health Coverage (UHC) by 2025. Key to this will be a creation of sufficient techno-

logical health infrastructure, to "establish and strengthen an effective health information system to monitor and evaluate the progress of achieving MDGs and UHC".

Under the HSR framework, the Ministry of Health (MOH) of Lao PDR decided to switch their health management information system (HMIS) from excel paper based to web-based DHIS2 at the end of 2013. After 3 years of further implementation, DHIS2 and the HMIS are now extended to include the reporting from the maternal and child health (MCH) programme; the immunisation programme (EPI), key intervention of the nutrition (NUT) programme; hospital in and out patient flows (OPD, IPD); and Malaria, TB and HIV programs [13].

4.2 Reforming the Lao HIS with DHIS2

The key components that Lao MOH considers as crucial for a successful implementation of any programme/ project in the health sector, are the following:

- Leadership, legislation and coordination
- Internet connectivity and system configuration
- Technical capacity at all levels
- Financial sustainability

4.2.1. Leadership, legislation and coordination

In countries with centralised planning and governance structure like Lao PDR, ensuring the ownership and leadership of the government is critical. Informing and engaging with health sectors leaders have been the key to Lao DHIS2 integrated platform. The approval and support from MOH leaders have led to a number of legal documents that officially recognised DHIS2 and enabled the application to roll out smoothly. In addition, despite no domestic funding was invested in the DHIS application, leadership support have given a very strong signal to involve all development partners in health to support the system technically and financially. More importantly, it indirectly supports a single routine reporting system in the country, avoiding fragmentation and duplication. Legislation also plays a crucial role as an implementation framework for rolling out the DHIS2; a Ministerial decree stated that the country would implement DHIS2 countrywide and specified policy guidelines for unified data collection, data flow policy and implementation guidelines. This legal document also served as the foundation for the MOH statistics division, which, with support from HISP Vietnam, WHO, World Bank and other development agencies, could develop the national health information system policy and reporting guidelines [14].

Coordination and collaboration among partners in the support of the MOH to implement DHIS2 have played a crucial role in the process in Lao. The WHO country office has played the role of coordinating the other development partners and to en-

sure that the support to the MOH have kept the momentum, which is important in a country where most activities are funded by donors. At the strategic level, major donors like the WB, GF, Lux-Development, ADB and WHO, all have voiced their support on the integration of health information systems using the DHIS2 platform under the umbrella of the health sector reform. Given that donor driven systems are typically the main reason for the fragmentation of HIS in developing countries, this is an important shift for the health sector in the country. At implementation level, collaborated efforts made by other agencies have joined the support by using the reports generated by DHIS2, or build capacity for local staff on data use and analysis; supporting computer and internet connectivity, etc.

It's the collaboration between the complementary capacities of Lao MOH HIS unit, WHO HIS unit and HISP Vietnam that has ensured the day to day leadership of the project. These capacities have proven to be a good complementary blend:

- The MOH HIS unit represents the ownership, makes sure that legislation and regulations are in place, leading the standardisation process and coordinating within the MOH and with other ministries
- WHO takes the leading role of coordinator of the project, provide technical public health competence and they have the necessary authority to coordinate the partner community
- HISP Vietnam provides technical leadership and guidance on the DHIS2 system structure and configuration, server management and IT support

However, looking at how DHIS2 is implemented in other countries at the time of this paper being written such as Myanmar [15], Bangladesh [16], Mongolia, Indonesia where the government plays a strong leading roles in the implementation process, more balance is needed in Lao PDR between the needed leading role of the government and the support provided by partners.

4.2.2 Internet connectivity and system configuration

The big advantage of a web based system like DHIS2 is that no local software installation is needed; the disadvantage is the reliance on internet connectivity, albeit intermittently. Although the bandwidth required for users to enter data into the DHIS2 server is modest, computers, electricity, and some amount of connectivity are required. The DHIS2 server has been located to and managed by the eGovernment Centre, managed by the administration of Ministry of Telecommunication under a MOU between the two ministries. Server maintenance and connectivity are problematic due to the low internet speed and infrastructure set up, especially outside big cities.

The MOH (with support from WB and GF) has contracted internet providers to provide internet connection to all province and district health offices. 3G mobile network also covers >90% of the country geographically in 2015, according to the Ministry of Communication. By the end of 2016, Internet connectivity is available in all districts and most health facilities, but remains slow and unreliable many places. Computers and laptops are available in all health facilities, but appropriate use of them as shared tools for data entry and report generation are limited because they will

typically be owned by particular projects and programs, making sharing difficult. Managerial instruction to share IT equipment is often required.

4.2.3. Capacity development

Capacity development is the key to rendering the system sustainable and useful. National and provincial teams play a crucial role in ensuring data quality and that the data are being used and that the system is managed and adapted to the needs of the users. According to the appraisal assessment, capacity of the staff working in HIS across country is generally low. The job assignment to these staff prior to the DHIS2 application was to consolidate reports for submission to higher level. This historical legacy has made building capacity the most important part of the HIS strengthening process in Lao PDR. The role and function of HIS staff at all levels will need to change from only focus on data consolidation and reporting to have data analysis, monitoring and feedback as the major focus.

Building a national core team (NCT) is critical and essential to the effectiveness and sustainability of the DHIS2 based HIS. This was prioritised at the beginning of the implementation with focus on building a team with members from key related departments and partners. WHO, in collaboration with MOH and Global Fund have recruited and built capacity of a team of local young professionals working in the core team to support the country in the longer term. WHO has mobilized from other networks such as UNV to have additional staff working closely with the national team, building their capacity in system management and DHIS2.

Building subnational teams for provincial and district levels was the next step to sustain the new web based HIS. The provincial participants are trained to be able to manage DHIS2 at their level, support the district team and to provide reports, dashboards and enable managers to use data.

The biggest shift in the reporting system is that district information staff at district hospital and district health offices are now responsible for capturing data in a national system, while the roles of district and provincial health statistics teams are to ensure data quality and to approve data before submission, or publishing. The National Core Team functions changed from data consolidation to setting standards, coordinating with involved health programs and generating regular periodical reports to be disseminated countrywide within the health sector, government and other sectors. The provincial and district managers play a crucial role in improving the reporting system by regularly checking data quality, ensuring that reports are submitted on time and requesting for support when needed.

4.2.4. Funding and Financial Resources

The DHIS2 platform is free, but like any sophisticated software platforms, significant resources are required for customization and training – both initially and ongoing, as the Ministry wishes to introduce more functionality and extend the system to new categories of users. The implementation started in five southern provinces with World Bank funding. Then, under the flagship of health sector reform and WHO technical assistance, the MOH was able to mobilise support from other partners to cover the rest of the country with funding from Lux- Dev. UNFPA, UNICEF, KOICA, KOFHI. In this way, coordination of funding from multiple partners made it possible to roll out the DHIS2 countrywide. The Government also allocates a budget to the implementation.

The concept of one plan - one routine HIS system, and the Vientiane Declaration of Aid Effectiveness, which calls for harmonisation of donor funded plans and government plans, have enabled MOH to shift the ownership of DHIS2 to beyond a vertical programme and make it a crosscutting area of the health system. A main challenge is to be able to continue the domestic funding of the DHIS2 and HIS strengthening process so as to arrive at financial sustainability.

5 Discussion

The most significant advantage for the DHIS2 process in Lao PDR is that the process started when the health sector reform strategy and framework had just been approved and the existing HIS was of poor quality. The reform document provided a policy pathway and strategic framework on which the concept and design of the DHIS2 application were discussed and agreed upon. This was also an opportunity to strengthen the use of HIS in the sector for planning, M&E and budgeting, thus making HIS a more significant part of the national health system.

The Department of Planning and International Cooperation, who is in charge of HIS, has suggested that the best way to sustain the current DHIS2 based system is to institutionalise the integration of multiple sub-systems using the DHIS2 platform. This can be seen as a strategy to both 1) continue strengthening the current DHIS2 based system, and 2) be flexible and ready for further expansion and justification to meet additional needs of the MOH at different levels.

The case of Lao PDR shows that applying ICT such as DHIS2 to strengthen HIS in a country low on resources and human capacity and with a poorly functioning HIS, has certain advantages. The advantages have been the opportunity to setting up standards and norms for an IT foundation nearly from scratch, enable the government to use their authority to set the legislation for a systematic implementation of the project, and the request from donors and partners to use and support one single system have created a supportive environment for the implementation of the system. Particularly important has been the ability to establish shared standards for both the DHIS2 system and for data reporting and thereby being able to overcome the traditional fragmentation of reporting systems from different health programs and competing software systems. this conducive environment for setting standards have been an important

enabler for the relatively rapid rollout and expansion of the reformed HIS in Lao PDR, as compared with other countries [6].

Funding of the HIS remains a challenge, as all activities and key staff are funded through donors. The HIS Centre have applied the concept of one single routine system – multiple partners, allowing partners to send their staff to work together with the MOH team and build their capacity. This is just a short term solution, for the longer term, securing domestic funding and capacity will be a key priority in order to ensure sustainability. Data use among managers and decision makers at all levels of the health system remains as another priority and goal of the system. Progress in this area will be crucial for the sustainability of the system.

Apart from TB, all health programmes now integrated in DHIS2, previously used a paper based system with Excel as their 'database', thus making the switch from Excel to DHIS both sensible and relatively easy. The paper based routine reporting systems, however, were not easy to change, as they represented well established systems and standards, or installed base [17]. At the early stage of developing the roadmap for integration, several of the vertical paper and Excel based reporting systems were found to be underperforming. After the successful roll out of the HMIS data collection forms using the DHIS2 platform, the various vertical programs and projects realized that a web based database system would be both possible and easier to use for managing their data than their current systems. They could see that the new HMIS using the DHIS2 had already laid the basic human and technical infrastructure that they also could use. It was therefore relatively easy to reach consensus on integration and to make use of the new online system, which also included dashboards, GIS and data visualisation features. The fact that the major health programs have all joined the DHIS2 process means that DHIS2 has become part of the installed base of pre-existing and long-time running reporting systems, which is promising in terms of being able to institutionalise and sustain the DHIS2. Challenges ahead will include building capacity and strengthening the infrastructure to support the expansion of the system, while at the same time maintaining the current operational and productive platform.

Comparing the Lao PDR process within the framework of 4 strategies for integration described in Sæbø et al [6], we see that the Lao PDR process started out as pure HMIS system in 2013 (as South Africa), including the key data variables from several programs. During the following process of incorporating new health programs, data elements and data sets have been standardised in order to remove duplications and to be able to accommodate multiple data sets and data sources within one data warehouse, similar to the example from Zanzibar in Sæbø et al. [6].

6 Conclusion

Three years after the initial discussions on applying ICT for strengthening the Lao HMIS in September 2013, DHIS2 has been established as the official health information platform in Lao PDR, integrating an increasing number of sub-systems. Routine data reported from health facilities countrywide are collected and managed in the platform, which is now established as a national data warehouse and dashboards and statistical reports are used for dissemination of information and for monitoring key indicators by MOH and the Government of Lao.

As in many similar settings in developing countries, key challenges are related to insufficient human capacity, poor infrastructure and little or no systematic use of data for planning and decision making. Further strengthening and sustainability of the platform will depend on. Sustainability will depend on how well these challenges are being addressed. The current and planned expansion of the platform to other health programs and reporting systems will help pooling more human and other resources to the platform, as well as widen and strengthen the ownership at all levels of the health services.

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