

The use of DHIS2 within Malawi

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Martin Theodor Vasbotten

Silje Klevstul

Kristoffer Adam Tronerud

Ola Solberg

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Introduction

With information technology being an ever-increasing part of modern day society, so are information infrastructures (II). II's can be defined as, "*a shared, evolving, open, standardized, and heterogeneous installed base*"[1]. In this paper, we will look closer at what that actually means and go into the depths of what makes an information infrastructure.

We focus our study on the information infrastructure of the health management system in Malawi and the use of the District Health Information System 2 (DHIS2). The main aim of this paper is thus to look closer at what DHIS2 is, as well as how and why it is used. The research is based on interviews with one of the people working with the software, Professor Jens Johan Kaasbøll at the University of Oslo, written literature about DHIS2, hands-on experience with DHIS2 in Malawi, as well as articles considering Information Infrastructure.

DHIS2 is a web-based open-source information system used to store, monitor and analyze health data[2]. Which in turn enables the focus of resources where they are needed the most. We argue that DHIS2, with the use of a centralized server, is a far better solution than the previous use of locally stored data, due to a significant reduction in the chance of data loss.

Through the interview and the use of course literature, we have looked at DHIS2 as part of the information infrastructure. DHIS2 is available on several platforms, both online and offline, and provides a wide range of solutions[2]. This paper will look closer at which benefits as well as challenges faced when using this solution in a developing country like Malawi.

This paper will give insight into information infrastructure in general, and illustrate the different aspects relevant to DHIS2 through the perspective of practical use of the software in a development country. The paper is organized into two main sections; first and second delivery, with different sub-sections; explanation of information infrastructure in general, the DHIS2, the use of DHIS2 in Malawi and problem domain, and finally relevant strategies.

First part

Information Infrastructure

Increased processing power, higher transmission and storage capacity have made it possible to build increasingly integrated and versatile information technology solutions with dramatically increased complexity. The complexity of IT solutions has also been continuously growing as existing systems, new and old, have been increasingly integrated with one another. Complexity can be defined here as the dramatic increase in the number and heterogeneity of included components, relations, and their dynamic and unexpected interactions in IT solutions[1].

This growth in complexity has brought a new line of research to the table which has adopted a more holistic, socio-technical and evolutionary approach, putting the growth in the combined social and technical complexity at the centre of an empirical scrutiny. These complex systems can be seen as new types of IT artifacts and denoted with the generic label of Information Infrastructure (II)[1].

In other words, Information Infrastructures can be defined as a shared, open, heterogeneous and evolving socio-technical system consisting of a set IT capabilities and their user, operations and design communities[3]. This can for example be seen as large-scale, integrated and interconnected workplace information technologies, used within larger organizations[4] - such as business and government infrastructure[5]. In other words, new information systems supporting information sharing and integrating processes at a global level[6].

The term “information infrastructure” has been increasingly used to refer to integrated solutions based on the now ongoing fusion of information and communication technologies, and to describe national and global communication networks for communications within specific business sectors.

Inside individual corporations, the number of information systems has continuously been growing. At the same time existing systems have become increasingly integrated with each other - most companies do not have just a collection of independent systems. The integration of and interdependence between the systems implies that they should

rather be seen as an infrastructure independent of their geographical distribution and the use of telecommunication.

DHIS2 as an Information Infrastructure

We were to find one such system and take a deeper dive into understanding the term Information Infrastructure, and how this precise system can be seen as one. As mentioned above we chose the DHIS2-system, which is developed by the Health Information System Programme (HISP).[14] Their vision is to develop and implement sustainable and integrated health information systems that empower communities, health workers and decision makers to improve the overall coverage, quality and efficiency of healthcare services. [14] We wanted to research the use of DHIS2 within in Malawi.

As mentioned above DHIS2 is a free and open-source software-based highly configurable data collection, aggregation, management and analysis tool that uses a datasource hierarchy to capture and report on health data from its source, up to and including well-structured, decision-supporting information. It is currently used in more than 30 countries around the world as a routine health management information system and data warehouse. [14]

The DHIS2-system can be seen as a shell enabling different possibilities within work sectors in the health sector. The outlined shell of DHIS2 gives the adopting countries the possibilities to create interconnections between numerous modules and systems [4], to create a customized health information system in their favor. The DHIS2-system enables openness [4] to its number and types of users, such as within the health sector in the country, on a governmental level, as well as different foundations, and not in the notion of fixed users. The aim is to make the different work task digitalized, but because of different contextual limitations; such as electricity, knowledge and human resources, this has proven to be difficult and are still under development. At the moment they try to include the different practices within the health sector as best as they can, even though all the tasks aren't digitalised at this point. The hope is make what you can call an ecosystem of systems, also including suitable existing systems and practices. [4] This DHIS2-project has been under development since 1996, and are currently used in more than 30 countries. [14]

The Interview

To understand the system better we arranged an interview with Jens Johan Kaasbøll who's working with DHIS2 as what he calls a technical assistant, as well as being a professor at the University of Oslo. He travels to different countries who's adopting DHIS2, helping them with the preparation phase before the implementation of the system, as well as the implementation and early adoption phase.

The interview was conducted as a semistructured interview with the aim of gaining a better understanding of DHIS2, both as an II and in general, as well as understanding the use of the system within Malawi. As a preparation we prepared some themes we wanted to talk about with the informant. The reason we choose themes, instead of fixed questions, is because we wanted to conduct an exploratory interview who could lead into different directions and unpredicted knowings. The different themes for the interview were as follow:

1. Jens connection to DHIS2 in Malawi
2. The aim of DHIS2
3. The reason for selecting DHIS2 as Malawi's health information system
4. The primary users
5. Areas where the system is available
6. The different components in the infrastructure
7. The type of information/data which is saved within the system?
8. The aim of the data collected
9. Challenges while using DHIS2 in Malawi
10. Challenges since the system is free?
11. Sponsors influence
12. Platform accessibility
13. Aspects which DHIS2 doesn't cover

The interview was conducted at the institute of informatics, at the university of Oslo, and lasted about an hour.

The District Health Information System

Information systems are becoming very central in collecting, distributing and processing patient information[7], and DHIS2 is one such system. It's a tool for collecting, analysing and presenting aggregated statistical data developed by Health Information Systems Programme (HISP). The system also provides information sharing across institutions, as well as supporting coordination and cooperation between departments and professions at a national level. The primary usage of DHIS2 in Malawi is to provide health information to enforce decision making in the health sector, as well as supporting fragmentation of health systems within the country[7]. The system *"[...]helps governments and health organizations to manage their operations more effectively, monitor processes and improve communication.[2]"* When registered in the system, the information instantly become available anywhere, any time. Based on the experience in other countries, and the general success, the ministry of health decided to implement DHIS 2 in Malawi. It is seen as an massive upgrade to the outdated DHIS 1 and usage of excel for data management. In general, there is one deployment of DHIS 2 for each country that uses the system as their Health Information System (HIS). This means that the system can be tailored to the needs of a country, without knowing much programming skills.

DHIS2 gives easy access to different information sources and support data sharing[7], which is an important aspect in using the data. One of the most important aspect is to use the information to highlight which parts of the system is performing as expected, and which parts should be taken action upon and improved. In addition, when it comes to the concept of feedback, a number of studies have demonstrated the effectiveness of constructive feedback as a powerful aid to learning[8] and feedback is important as it motivates the health workers as well as use indicators to compare facility performance[9].

Before implementing DHIS2, DHIS1 was used, but were not ideal as the system were installed on different standalone PCs around the country. With these PCs, there were many problems like power cuts, heat issues and so on. When one of these PCs did shut down, data was often lost as it was stored on these standalone PCs and the backup functionality not being good enough. Now however, the data in DHIS 2 is stored on a

centralized server and are accessed by a web browser, which is a more stable solution according to Kaasbøll.

DHIS2 is available on several platforms, both online and offline, and provides a wide range of solutions. This paper will look closer at the benefits and challenges of using DHIS2 in a developing country like Malawi.

From paper to digits

So how is DHIS2 used in Malawi to better the flow of information? How is it connecting districts in a more rigorous way than before? Where lies the challenges, and how does the system provide a better overview of peoples health within the country?

The whole process starts at every health station in the country that means clinics, hospitals, health centers and more. Here the workers register patient information in registers where each patient gets one row. At the end of each month, this information is tallied up to see how many people has malaria, vaccines against measles etc. This process is done manually on paper. Afterwards these documents are manually delivered to the district office, where the data are made into digital statistical numbers by being registered into the DHIS2 system. When the data's are registered anyone with a username and password can read the statistics[10]. This makes DHIS2 a very open system. In other words, anyone with an access to the DHIS2 system can read data from any district about any health station. The only real restrictions are the writing privileges. You are only allowed to write data about your own district.

There are a few issues with the process of getting the data into DHIS2, and most of them are human errors. As previously mentioned, there are about 600 health stations in the country. Each health station registers around 1000 numbers per month and each district office gets all of these numbers from the approximately 20 health stations in each district. So there is a lot of data that pass through human hands. When a lot of people are handling the data, and sometimes these people are lacking training, errors will occur[10]. These errors can be just random mistakes like someone forgot to count a patient row, or they can be systematic errors caused by lack of training of the person entering them. Systematic errors in the system are the ones that can cause a lot of damage to the data. This is because, as they are systematic, they happen repeatedly over

a lot of data. Most of these errors happened during the tallying at the health stations. By systematic errors, we mean that for example a health worker doesn't understand the difference between two numbers and the adds them together when he/she counts them. This makes two entire columns of data useless. One can imagine if this takes place over a longer period of time, which could happen if the error is subtle enough to go unnoticed, this could cause a lot of damage to the data. So having sufficiently trained health workers is very important[10].

Information flow and accessibility

There is a wide range of options when it comes to capturing data, as DHIS2 "...can capture data on any type of device, including desktops, laptops, tablets, smartphones and feature phones. Most solutions work-offline, enabling improved reach in locations with poor connectivity.[2]"

When the data is in the system, it can theoretically be accessed by anyone. Can, but that doesn't mean it will. Accessing DHIS2 requires some IT equipment like a computer or smart-phone/tablet. These things are not all that common outside of the district offices. Even if they were, knowledge of how to use such equipment is scarce in Malawi, especially at the lower levels like the various health stations[10].

Another important reason IT-equipment is not very common at most health stations in Malawi is due to the state of their power-grid. It doesn't reach everywhere, which means that some places just can't get any electricity without using a self-powered generator, and it's not very stable or reliable. The power can go out at any moment and then you really can't do much without a battery powered device. This makes working with computers and such more of a hassle than just using pen and paper[10]. So, even though DHIS 2 has these data-capturing options available, the majority of PC-use concerning data collection is done at district office level[10]. As Kaasbøll says; "There is usually no electricity at the health centers, and even if the electricity is present, it is very unstable which doesn't make it suitable to keep PC's at health stations to access to DHIS2.

This all leads to very little use of IT-equipment at the various health stations in Malawi, which in turn translates into very little IT competence. So without means of acquiring IT knowledge in an economically viable way, there is little incentive to equip health

stations with IT equipment. And without IT equipment, there is little incentive for health workers to bother learning how to use it or how it works. We can see that this quickly turns into a cycle where it is hard to fit in anything IT related.

In the district offices where they usually have computers, the DHIS2 data is mostly used to monitor the health state of the respective districts. The data can be used to see who is doing poorly in what areas. Or you can do the opposite and see who does best when it comes to solving common problems and then learn from these and pass that knowledge on to those who are not doing so well.

All in all, the biggest obstacle for DHIS2 in Malawi is the power grid. Without a stable power supply, one can't really expect to get work done in time when using DHIS2. This means that using computers becomes less efficient than just using pen and paper which gives health workers at the lower levels little incentive to learn how to use anything else. This is part of the lack of training of the personnel there.

Future plans and functionality

At the time of writing, DHIS 2 only aggregates data originating from the health centers and district offices. In the interview with Jens Johan Kaasbøll it was told that a future goal is to have a module that supports patient systems. At the moment, there is already implemented a module called "TRACKER" in DHIS 2 which can track individual patient records. However, the general infrastructure in Malawi doesn't support such features yet, but is something that should be implemented in the future. Another long-term plan is to involve financial systems into DHIS 2. In a developing country like Malawi where resources are scarce, there would be a great advantage to analyze what kind of measures that gives the best result considering the resources used. Lastly, Kaasbøll mentions that to integrate logistics systems for medical equipment and medicines would also be very useful. However, it's also a long-term goal as such an integration is very difficult because Malawi already have their own logistics systems which is hard to change quickly.

Another aspect is the topic of lock-in effects in Malawi's health information system. Lock-in can be explained as "... when a technology has been adopted, it will be very hard or impossible to develop competing technologies"[11]. The situation in Malawi is

somewhat special, as they haven't had a long history with digitalized systems in the health sector. However, DHIS1 and Excel were the predecessors to DHIS2, and is still considered a better solution by many in Malawi. This is because it's something they're familiar with, even after three years of running DHIS2. In other words, to learn the functionality of DHIS2 is often considered a burden by many workers, as they consider Excel as adequate[10]. One can say that the earlier use of Excel has created a lock-in effect on Malawi health system, because of the coordination problems that occurred when transitioning to DHIS2.

When it comes to potential lock-in effects in the future we believe that the technical aspect around DHIS2 itself is good as DHIS2 offers a shell that can be customized. Moreover, adding new functionality is made easy as it is possible to integrate both applications and modules to the needs that arise[10]. This flexibility makes the system loosely coupled from within, but from an outside perspective the system is tightly coupled[7]. As Kaasbøll says, the aim of the system is to collect all health information within one country under one system, to make easy access and a better overview of the health within the country. A transition to a new system would of course lead to some implications, but the the general data formats and data structures seems rather portable. However, potential lock-in effects might appear in the future as well, because a large problem around the technical solutions is the human aspect, Kaasbøll tells us. The knowledge in relation to IT is suboptimal at the moment, and it is hard to find and keep the right people to set up and maintain the system by cause of the job positions being unattractive and the lack of enough IT graduates in the country.

Further research

We started with the scope of understanding:

- *"the use of DHIS2 within Malawi"*.

The reason we chose this scope is because we were uncertain of the focus of our study. We felt like we knew too little about DHIS 2 from inside, what you read on DHIS 2 public space on the internet doesn't say much about inside information. We therefore wanted to keep the study relatively open, until we found a relevant and interesting problem to look into. After conducting the interview we got aware of several different interesting

problems, as described earlier, concerning the adoption of DHIS 2 within Malawi. These are problems such as electricity, human errors and knowledge.

The electricity is one of the major problems they have concerning the use of DHIS 2 within Malawi. Many places don't have electricity, and the places who do are highly unstable - both within urban and rural areas. Bigger hospitals have generators running on diesel, but occasionally the diesel runs out too and the generators stops working. Because of this power problem, it's very difficult to use technological solutions for registration of data within the health centers. This means that the data has to be registered manually on paper within every center. In the end of every month someone within the center goes through all papers and convert them into statistical number, still manually on paper. Afterwards these numbers are sent to the district office, which then makes them digital by typing them into DHIS2. This process helps the enablement of problems defined as human errors. This is the main problem concerning the patient data; counting up manually and writing it down on paper. These errors can be divided into two main categories: accidental and systematic.

Accidental errors can be seen as skipping a patient because it's the end of the day, and you're tired. These are not that crucial errors, and in most cases even each other out. The systematic errors on the other hand, they are more crucial. When systematic errors occur they pushed the result of data in one direction. One example can be that the guy writing down the statistical numbers hasn't understood how he is supposed to do it, and because of this, does it wrong.

Other reason for not using technology is because it costs money, but an even more important aspect is the one defined as the digital divide. The digital divide described discrepancies between social groups in access to, use of, and empowerment by networked computers and other digital tools[12]. Kaasbøll says providing people with the right knowledge enable them in the use of technology, but

This is maybe the most expensive part of the project. The most advanced technology the people at the health center are used to is telephone - not smartphones, but regular, old fashion desk phones.

This is also why they want to make the system adaptable on as many platforms as possible - reducing the technological restrictions. But then we loop back to the power

source problem. On the other hand, it's easier to charge a smartphone or tablet, especially in places with sun panels, compared to laptops and stationary computers. As Kaasbøll said: "the smaller, the better". Then people only need to be convinced into using this technology, and then we're right back at the knowledge problem.

As you might imagine, it's not easy. It might seem like a project where you think "as long as they have enough money they'll make it", but this is not the case. "Money is not the problem right now. We have enough money. The problem now is people. we need capable and qualified people" Kaasbøll tells us during the interview. He continues by saying "when you've been there for a while, you realize that it's not easy to make things work". It's much worse than what you think when you're sitting in Norway as an outside observer.

These problems are all linked to the context which DHIS2 is adapted within, and they are the reason for changing the scope to.

"What kind of contextual challenges limits the evolution of DHIS 2 within Malawi".

Second Part

Challenges related to the information infrastructure

There are numerous challenges that throttles further growth of the current information infrastructure of the health management system in Malawi. In this section we have focused to include the challenges we believe have the most impact on the data quality and the ability to base decision making on. The challenges range from fundamental ones like the earlier mentioned problems regarding sufficient power supply to the more complex problems like aligning the operation between Non-Governmental Organizations (NGO) and the MoH. Two of the group members, Martin and Kristoffer have experienced some of the challenges first-hand in Malawi, and will refer to interviews regarding the Malawian HMIS.

Power supply

Malawi lacks a stable and reliable power sources that reaches everywhere. The power can go out at any moment, and is an important reason why IT-equipment is not very

common at most health stations. The places without electricity needs self-powered generator, and even they're not very stable or reliable. This makes working with computers and other power dependent devices a challenge, and more of a hassle than just using pen and paper. So, even though DHIS 2 has these data-capturing options available, the majority of PC-use concerning data collection is done at district office level.[7] As Kaasbøll says; "There is usually no electricity at the health centers, and even if the electricity is present, it is very unstable which doesn't make it suitable to keep PC's at health stations to access to DHIS2. It can also cause loss of unsaved data. Naturally the lack of power renders the digital information system useless during black-out periods in the affected areas, delaying reporting of data.

Internet Connectivity

The internet capacity in Malawi is very limited. The connection is unreliable and often very slow, especially in rural areas. This makes doing things online very time consuming which in turn makes it hard to fit in things like data reporting etc. into a busy health workers schedule. During an interview with a District Health Management Team(DHMT) in a district in Malawi there was an absence of internet connection during our whole stay. Most of the Districts can be defined as rural, including the district we visited. One of the members described the situation when asked how the internet connection in their district was impacting their tasks related to using DHIS2;

*"The connection is not good, it's always giving us a headache." - Health Assistant
Statistician at a District Office*

Personnel without proper training

One common challenge at the lower levels is the lack of computer-literate. A computer-literate can be defined as;

"(Of a person) having sufficient knowledge and skill to be able to use computers; familiar with the operation of computers" [15]

This makes otherwise trivial tasks like writing words, numbers and navigating in a web-page etc. very slow. The benefits one gets from using a computer is then limited, making manual alternatives like pen and paper a competitive alternative.

Those who actually do have decent IT knowledge usually have much more attractive job alternatives from outside organizations. According to Kaasbøll, the facilities struggle to keep these people to retain a good base level of IT competence. Over and over it's needed to spend unnecessarily much resources on staff training because new staff needs to be trained every time they lose someone.

Data reporting

There are a few issues with the process of getting the data into DHIS2, and most of them are human errors. As previously mentioned, there are about 600 health stations in the country. Each health station registers around 1000 numbers per month and each district office gets all of these numbers from the approximately 20 health stations in each district. In other words, since data input is mostly done at district level, there is a lot of data that pass through human hands.

Too often workers plotting data into the system is lacking training and thus errors will occur.¹ These errors can be just random mistakes, like someone forgot to count a patient row, or they can be systematic errors caused by lack of training of the person entering them. Systematic errors in the system are the ones that can cause a lot of damage, because they happen repeatedly over a lot of data. Most of these errors happens during the tallying at the health stations. An example of an systematic error is that a health worker doesn't understand the difference between two numbers and proceeds to add them together when he/she counts them. This makes two entire columns of data useless. One can imagine if this takes place over a longer period of time, which could happen if the error is subtle enough to go unnoticed which often happens due to the limited statistical skills of the workers. The lack of statistical skills and critical thinking cause a lot of damage to the data, decreasing the value one can extract drastically.

Organizing multiple stakeholders

According to WHO, external resources funded 68.3% of the 2013 health services budget in in Malawi.[16] The NGO's are many, rendering the effort of aligning and cooperating different tasks between the government and the NGO's difficult when it comes to

¹ Interview with Jens Johan Kaasbøll

providing health service. The complexity of organizing the different stakeholders is making the communication hard causing loss of efficiency it's hard to get an overview of what others are doing. Many projects overlap as a result of missing communication. Another point is that it is hard to maintain processes, programs and systems at the district level when NGO's are pulling out. The reason being that funding may have its criterias like programs or datasets that the NGOs want the recipient of the funding to deliver. Often when the NGOs change or pull out the work put into delivering their criterias might not endure. For example; one district did not have the resources to do review meetings and have sufficient internet connectivity without an NGO funded it which impacts the decision making.

Lack of motivation/reluctance to try new systems/transitioning to DHIS2

"...very few create graphs within the system, instead they pull out the data and create the graphs in Excel." [17]

The situation in Malawi is somewhat special, as they do not have a long history with digitalized systems in the health sector. However, DHIS1 and Excel were the predecessors to DHIS2, and is still considered a better solution by most of the peers using DHIS2 in Malawi. This is because it's something they're familiar with, even after three years of running DHIS2. In other words, to learn the functionality of DHIS2 is often considered a burden by many workers, as they consider Excel as adequate. [4] One can argue that the use of earlier use of excel has created a *lock-in* effect in Malawi's health information infrastructure as a lock-in can be described as

"... when a technology has been adopted, it will be very hard or impossible to develop competing technologies" [4].

In addition, many practices on district level are not conducted done as described. Certain tools and features in DHIS2 are often said to be used to continue receiving funding from donors, but in practice the usage is minimal.

Implementation strategies

Implementation strategies for a large-scale II, such as DHIS2, in healthcare is highly relevant, as both governments and healthcare providers direct a considerable amount of

resources towards achieving nation-wide and fully integrated healthcare II.[18] Strategies can be used to plan, conduct, manage, and so forth, the realization of the health care II - “how do we get from where we are now to where we want to be”. [18] Deciding which strategies to use can be difficult and depends on the project. Hanseth and Lyytinen have synthesized descriptive case studies of II into a normative design theory for II, and distinguish between two generic challenges - the “bootstrap problem”[19] and the “adaptability problem”. [19]

The bootstrap problem illustrates the notion of balance between addressing users needs and completeness of design. It’s important to creating solutions which persuade users to adopt at an early stage, by addressing head on needs of the very first users before completeness of design or scalability.[19] This can however be difficult, since the completeness of the design must be addressed as well. The key is the notion of balance between the two, to aid the II into growth. When the II then start to expand, it can switch into a period of rapid growth. During this period it’s important that the design of the II is flexible enough to overcome unforeseen and diverse demands, both technical and social. This defines the adaptability problem of II design. [19] These two demands contradict and generate tensions at any point of time in II design. [19]

The modular implementation strategy

The modular implementation strategy addresses both the central challenges described above. It does so by providing five design principles - the three principles listed first addresses the “bootstrap problem” and the two last ones the “adaptability problem”. [18]

1. Design initially for direct usefulness
2. Build upon existing installed base
3. Expand installed base by persuasive tactics to gain momentum
4. Make the IT capability as simple as possible
5. Modularize the information infrastructure
- 6.

We wanted to look at the DHIS2-system by addressing the problem domains above through the principles of this strategy.

Design initially for direct usefulness

The main focus of this principle is the importance addressing the users head on needs and focusing on solving their problems, without the need of a complete solution or a large user base. Prioritize immediate use value and let the scalability, extension, and completeness of the solution come later. [18]

There are several stakeholders within the user base of the system, meaning that they all have different needs and problems which need to be addressed. Since the DHIS2 is an free open-source software they rely on foundations for development of the systems. This means that these foundations need to be rewarded by getting a personal gain in the II. Then you have the government wanting statistics over the health in the country, as well as many other requirements. The district offices and health centers throughout the country also have their different requirements to the system, as well as the other users of the system. As you can see, there are many different stakeholders involved in the II. It may take some time for the system to address all the stakeholders different problems. If the system gets to massive, complex and complicated to use, it can be hard to keep the involvement of the different stakeholders and get ny users to adapt the system.

Build upon existing installed base

The IIs sociotechnical and practice-orientation includes the physical and social contextual of work, existing technologies and routines, and the worker's skills and beliefs. This is the notion of installed base. [18] The design principle addresses the importance of exploiting these contextual matters. By doing this the initial costs of developing the solution will not only be lower, but more importantly, the adoption barrier for the user will be smaller. [18] The contextual can be seen as everything surrounding the II, and the principle advising to take this into matter.

The DHIS2 system does build upon existing installed base in matters of being an shell, enabling the use of different modules. The idea is for every country to install and develop the different modules they need, to customize the perfect health information system. This has all thou been problematic, since some of the main problems is human resource, knowledge and proper training. The different foundations also provide information from their data selection, as well as getting new data from DHIS2.

They also try to work around problems such as the power supply and internet access, by enabling the system on different platforms with easier accessibility and charging possibility possibilities. And since they have experienced problems connecting to user adoption within the country, they try to include already existing practices, to ease the transition.

Expanding the installed base by persuasive tactics to gain momentum

“User before functionality” is the slogan supporting this design principle, and the idea is to generate positive network effects from extending the user base. Before adding new functionality the user base should have grown enough to sustain the added cost of development and learning that this addition entails. [18]

As mentioned above, there are many different stakeholders involved in the DHIS2 project in Malawi, and they can be seen as a stable user base aiding the further development of the system. The foundations are giving in the interest of helping the countries in getting a better national health, not with the main aim of having a personal gain. Since the DHIS2 system is already adopted within many countries, it already has a lot of pre made modules to use. And because of all the foundations founding the project, there are a lot of resources at hand. This helps enable a quicker adoption of the system. But at this point, the main problem for further adoption is the access of human resource with the right knowledge.

“Making the IT capability as simple as possible” & “Modularize the information infrastructure”

The purpose of these principles is to separate the layers of infrastructures from each other, such as service layers from transport layers, to exploit gateways to connect different layers or regions, and to maintain loose couplings between the connected IIs. [18]

At this point the system is accessible at the district offices, but not at the health centers. This is due to the bad power supply. Because of this the worker use pen and paper at this level, and then deliver these data to the district office, where they plotted into the DHIS2-system. From there the data concerning different health aspects can be accessed by everyone possessing a username and password. How the country want to use the data and the system, depends on the modules implemented. This gives the system

greater flexibility in addressing different goals, and make the system loosely coupled from within. One can easily modify the systems if needed.

Strategies used

“In order to achieve the vision four major strategic streams of activity have been identified. These streams include foundations, ehealth solutions, change and adoption, governance.” - (THE MALAWI NATIONAL EHEALTH STRATEGY 2011 - 2016, Ministry of Health, Lilongwe Malawi, Unpublished, 2014)

In the strategy report from the MoH five major strategic streams are described. Together these streams touch all the aspects related to providing health services in Malawi. Since we are focusing on the infrastructure around the HMIS in Malawi, we will mostly be focusing on the foundations and governance streams because we feel they are the most relevant to the described challenges. In the report from the MoH they describe each strategy with an objective and actions. There are also many relevant actions that could be included, but we have chosen a select few that we felt were the most relevant to limit the scope.

Foundations

Because DHIS2 is dependent to be accessed with internet through computers, we think the foundation stream is highly relevant. Unlike industrialized countries, the challenges within the II is highly affected by basic fundamentals like internet and electricity. This stream focuses on implementing the

“...basic building blocks required to enable the effective electronic sharing of information across the Malawian health sector” [20]

These building blocks includes the five key areas “national ehealth information standards, computing infrastructure, national connectivity services, identification and authentication, reliable power supply and information protection. [20]

The first strategy in the stream, 4.2.1, [20] describes designing and implementing national ehealth information standards. Among the list actions to be taken we find point 4.2.1.5, “Develop and implement national health data collection and storage standards“. Standardizing data collection is very important as many of the users follow their own

processes, instead of standardized ones, impacting the data quality creating ripple effects in the infrastructure.

The second strategy within the foundations stream, 4.2.2, revolves around Computing Infrastructure. It aims to establish mechanisms to encourage care provider to invest in the implementation and maintenance of an acceptable baseline of computing infrastructure. One action, 4.2.2.1 is to accomplish this goal is by developing a national ehealth computing infrastructure architecture.

The third strategy, 4.2.3, National Connectivity Service, is another important one as the earlier mentioned challenges to internet connectivity in DHIS2 are severe, especially in rural areas where DHIS2 are used. The strategy describes the need to

“Coordinate the construction and rollout of appropriate national connectivity services to all care providers” [20]

There are several actions described to improve the situation including designing a national connectivity architecture for all levels of health service providers and collaborating with communication authorities and service providers. The service providers include both Internet Service Providers and Telecommunications Providers which deliver mobile internet.

The fourth strategy we wanted to mention, 4.2.5, shares many of the properties as the third strategy, but focusing on delivering reliable power supply which is a necessity. Actions includes developing and implementing *“...standardized minimum power supply systems to each levels of health care providers”* and *“develop and adopt a maintenance policy for each levels of care providers’ power supply system”*.

Governance

This activity stream focuses on

“... Successful implementation of the ehealth strategy requires a solid governance framework to ensure coordination, funding prioritization and oversight of national ehealth work program activities.” [20]

This is to address the lack of alignment and cooperation between the many stakeholders within the health sector of Malawi.

It requires reviews of the strategy implementation while reporting to the MoH and stakeholders. All this while leveraging existing systems without disturbing existing management structure.

We have included only strategy 4.5.2, **“Establish and formalize ehealth strategy steering committee”**, from this stream.

The goal of this strategy is to

“... Establishing a formal committee at the higher levels that consists of important stakeholders from the health sector. This committee should be responsible for the implementation of the ehealth strategy”.^[20]

To accomplish this you first need to make sure the objectives of the committee are clear and that everyone in the committee are on the same page. This can be done by “... *Develop and adopt terms of reference for the ehealth strategy oversight committee*”.^[20] Then there has to be a way for the committee to follow the status of the strategy implementation. “*Establish within the Health Sector Wide Approach a reporting line for the committee*” ^[20] is the proposed solution to this. Then the committee members needs to be chosen from a selection of key stakeholders, and regular meetings needs to be scheduled where the committee can discuss the progress of the strategy implementation.

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