UiO : University of Oslo

INF5210

INFORMATION INFRASTRUCTURE

DELIVERABLE 2

ANALYZING DHIS2 AS AN INFORMATION INFRASTRUCTURE

SUBMISSION DATE: NOVEMBER 5, 2015

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1. Introduction

In this paper we will look at DHIS (District Health Information System) 2 as an information infrastructure with a closer look at Ghana. We will use Hanseth's (2002) definition of information infrastructures which describes information infrastructures as "an infrastructure is a shared, evolving, open, standardized, and heterogeneous installed base". The data in this report has been gathered in an interview with a member of the Ghana Health Service who we will refer to as John and articles written on DHIS2. First a more in-depth DHIS2 and its use in Ghana is presented followed by a discussion of DHIS2 in comparison with theories on information infrastructures, complexity and generativity.

1.1 District Health Information System

The District Health Information System (DHIS) is a free open source platform for reporting and analysis data for health programs. DHIS is developed by the Health Information System Program (HISP) which is a research network organized by the University of Oslo dedicated to the development of health information systems (HIS) in developing countries. DHIS started as an effort to implement a HIS in post-apartheid South Africa, but has now spread to include partners all over the world(Karuri, 2014. p.7). Today DHIS2 is used in 47 countries and has become a national standard in 16 of those countries (Braa 2015).

DHIS2 is a flexible platform that can be tailored to the requirements of the users. New functionalities can be developed through the open API's and app development. An example of this is the functionality of offline registration of data. In Ghana (and other third world countries) there is a lack of a constant coverage of internet or even electricity. In Ghana they measured a 95% coverage of internet in the country, however in some remote parts the internet is unstable. When DHIS2 was implemented there were issues in the regions with unstable internet. A suggestion for adding the feature of offline registration was then sent from Ghana to the University of Oslo, which is one of the developments sites for DHIS2 (John, 22.09.2015). This feature is now implemented in DHIS2 as a result of this and does not only benefit Ghana, but also other countries using or contemplating using DHIS2.

1.2 Ghana and the use of DHIS2

Since the 1920's Ghana has been experimenting with health care solutions. They've used the District Health Information Management System (DHIMS) which was an EU project. This was a proprietary system and was difficult to maintain due to cost and lack of technical expertise. In 2012 they adopted DHIS2, which was merged with DHIMS and today is used across the public health sector (John, 22.09.2015).

At the top of the health service hierarchy in Ghana is the Ministry of Health (MoH) which is the policy making body. Below that is the Ghana Health Service (GHS) which implements the policies made by the MoH. The public health sector in Ghana is divided into three levels:

Primary level - community level of health care (clinics)

Secondary level - district and regional hospitals

Tertiary level - teaching hospitals and special facilities

In the private health sector there are also several hospitals such as police hospitals, mining hospitals and religious hospitals. Other than a few religious hospitals no of these use DHIS2. At this point DHIS2 is only used to generate statistics, however they are implementing a Tracker which is used to track mother and child from pregnancy to infancy. The data which DHIS2 uses is being collected in paper form at the various clinics and sent to a district office where it is entered into the DHIS2 system. When DHIS2 was first deployed they trained 1000 people for data entry jobs and they have been training 15-20 each year after. This means that there is still a lack of people for data entry, but the goal is to diffuse DHIS2 usage down to the community level by next year (John, 22.09.2015).

2. DHIS2 as an information infrastructure

As mentioned in the introduction we will use Hanseth's definition of an information infrastructure. In this part we will use the parts that make up an information infrastructure: enabling, shared, evolving, open, heterogeneous and installed base,(Hanseth and Monteiro 1998 p.45-49) and apply these to DHIS2.

2.1 Enabling

The infrastructure has to be designed to support a wide array of activities. This means that the technology needs to open enough to support new activities, not just improving or automating existing ones (Hanseth and Monteiro 1998 p.45). Although DHIS2 is primarily geared towards health information needs, DHIS2 can also be used for social franchising, forestry, finance, human resource information system and logistics management information systems (Øverland 2015 p.8/13.). DHIS2 also enables the use of external tools (PDF, PNG, R for statistical analysis and visualization), legacy systems (often MS Excel, Access) and web services (Google Maps, OpenStreetmap.org) (Staring n.d p.11). In the case of Ghana they used a proprietary system called DHIMS which used Microsoft Access, this system was integrated into DHIS2(John, 22.09.2015). This enables DHIS2 to be open to a new whole new set of modules which can be developed as per user needs as a loosely coupled application interacting through DHIS2's Web-API (DHIS2.org 2015).

2.2 Shared

"An infrastructure is shared by the members of a community in the sense that it is the one and the same single object used by all of them (although it may appear differently)"(Hanseth Monteiro 1998. p45.). DHIS2 is comprised of a large network of developers, local users, ministries of health, NGO's and Universities. It is important to note that this network is always changing and never static. New members are always added to the network and these members play different roles depending on their interests, agendas, capacities and resources (Braa and Sahay 2012).

2.3 Evolving

DHIS initial development was characterised by rapid prototyping with new builds being released on a weekly or daily basis. Users could easily report bugs or request new functionality which was a central part of the development process. After DHIS became a country-wide standard in South Africa, several attempts to scale DHIS to be used in other countries followed. Along the way there were complications such as the "learning by doing" approach which had proved effective in South Africa, was relatively ineffective in Mozambique. In order to evolve

even further DHIS became an Internet enabled web-based platform, which is where DHIS turned into DHIS2 (Braa and Sahay 2012).

2.4 Open

One key characteristic of II's is unbounded openness that allows new components to be added and integrated in unexpected ways and contexts (Hanseth and Lyytinen, 2010, p.4). DHIS2 is developed under the BSD licence(DHIS2.org). However the term open in open-source differs from the one used in the definition of an II. When it comes to open-source, open means that the software and source code is distributed freely that allows users to modify to their specific needs.

Since DHIS2 is developed under an open-source licence it enables each country that adopts DHIS2 to extend it with functionality that is specific for that country (Braa and Sahay 2012, p.45). The countries can either to this themselves or send a request to the developer team in Oslo. DHIS2 has also been internationalized and translated into 8 different languages and because of DHIS2's open source nature it also allows the content of DHIS2 to be translated into many languages (DHIS2.org 2015).

DHIS2's architecture is a modular one (DHIS2.org 2015), this allows new components to be integrated and added with ease. The software consists of loose couplings which also makes development easier as you only need information about what you are making and the API.

2.5 Heterogeneity

Hanseth and Lyytinen (2010) describes that II's become more heterogeneous "as the number of different kinds of technological components are included, but first of all because IIs include (an increasing number of) components of very different nature: user communities, operations, standardization and governance bodies, design communities etc.". DHIS2 is currently used in 47 countries (Braa 2015). This means that there is a vast mix of people, cultures, needs and contexts. Different countries use DHIS2 differently and different people perform different roles, and different systems interact with DHIS2 in many ways.

If we use Ghana as an example where the public health sector is split into three levels (i) community level; which consists of clinics etc, (ii) district level; which consists of district and regional hospitals, (iii) tertiary level; which consists of teaching hospitals and special facilities.

The entire public sector uses DHIS2 and they are currently in the process of diffusing DHIS2 to the community level. The different roles and work practices makes this a heterogeneous mix of people, work practices and systems.

In addition to the in-country heterogeneity there is also communication and involvement of developers in Oslo. Countries that have adapted DHIS2 have an open line to the developers in Oslo where they can suggest features and improvements. As mentioned above DHIS2 has a modular architecture, where modules can easily be added. The heterogeneity of DHIS2 is therefore both technical and non-technical

2.6 Installed base

Information infrastructures are "shaped by an installed base of existing system and practices"(Monteiro et al 2012. p.2). Since DHIS2 is used in different countries the installed base in each country will differ greatly.

In Ghana for example they've experimented with health care solutions since the 1920's. This means that when they adopted in DHIS2 in 2011/12 there was already a governmental health infrastructure in place with a policy making body (Ministry of Health) and Ghana Health Service as the implementing body. The health sector in Ghana is divided into public, private and traditional medicine. The last one is not endorsed by the government, but many citizen still use traditional medicine. The public health sector is again divided into three levels as mentioned above.

Before using DHIS2 Ghana was using a proprietary system called District Health Management System (DHIMS), this was hard to maintain and they lacked the technical expertise to maintain it (John, 22.09.2015). When Ghana adopted DHIS2, these two systems merged. Which means that there was already a bunch of aggregated data that could be used in DHIS2.

In Ghana there were also phone and internet coverage in most of the country which meant that they could adopt DHIS2 relatively easily. However they asked for the ability to report data offline, which is a feature that has now been implemented. There are also still issues today with loss of connectivity or electricity (John, 22.09.2015).

3. Complexity in DHIS2

Based on previous discussion we conclude that DHIS2 is an information infrastructure. Complexity is often associated with information infrastructure, therefore in this section we will uncover the complexity of DHIS2 through complexity science.

3.1 Complexity science

Complexity can be defined as the dramatic increase in the number and heterogeneity of included components, relations, and their dynamic and unexpected interactions in IT solutions (Hanseth and Lyytinen, 2010). This means the more number of types of components and number of links and the faster speed of change, the more complex an information infrastructure is. DHIS2 includes vast components ranging from technical and social aspects, human and non-human. It also involves various stakeholders and their interaction in DHIS2. For instance, in Zanzibar and Tajikistan, ministry stakeholders, health program managers, district medical officers, and HISP consultants conducted a series of meetings to agree on a set of standardized data collection forms that would form the basis of the integrated data warehouse (Braa and Sahay, 2012). It implies that the link created by many numbers of stakeholders point out the complexity of DHIS2 as it needs integrations and harmonization in the data flow. Karuri (2014, p.55) notes that there is continuous need to take care of all stakeholder's needs in the system and at the same time avoid introducing redundant tools that risk overloading the system. DHIS2 is also complex in terms of various needs it can serve. Because it supports different user groups, the system is possible to be used for different purposes. Thus it manages to have various features from capturing, analyzing, to reporting data.

To understand complexity that lies within information infrastructure, we can also look at how information infrastructure is constructed. Establishing a working information infrastructure is a highly complex socio-technical task which at least includes: designing a large collection of communication standards, testing and adapting these to a wide range of different use situations and ensuring that the standards are run through the bureaucratic procedures of international standardization bodies (Hanseth and Monteiro, 1997). This means that not only technical but also social components that take parts into information infrastructure will add complexity. What makes DHIS2 in Ghana complex is technical and social constraints that follow the

implementation, development, use, and maintenance of the system. The specific constraints are defined as follows:

Technical constraints: the shortage of computers is an obvious technical constraint, but there are other common technical problems that influence implementation and use. For example, insufficiency of Internet connection and electricity. Lack of equipment can interrupt the use of such a complex system like DHIS2.

Social constraints: Ghana has more than 200 hospitals around the country register totally about 1000 new admission everyday using DHIS Tracker (DHIS2 in Action). This shows that the system has been rolled out nation-wide yet Ghana does not have adequate developers in location to fix and develop the system. The technical support comes from University of Oslo (UiO) as the base of DHIS2 development. The system should be developed according to user's needs thus it would be best if it is done by people who know the context better. The developers in UiO being mostly Norwegians, it can be problematic.

In the greater context, there is issue that might not be easily resolved but need to be addressed.

Economic constraints: in Ghana, DHIS2 is primarily distributed and used up to district level in public sector. They wish the system was implemented in the whole community level but that would be expensive to do so. Also, in order to develop the system faster, they would need to collaborate with developers in private level, but up until now they are reluctant to do so due to problematic economic factor.

Those technical, social, and economic factors add complexity in the use of DHIS2 in Ghana and make the developers to think of solution to resolve the complexity. For instance, in order to overcome the limitation of Internet connection, messaging system is built to support the communication between the workers. This reduces challenge in communication in the field but at the same time increases the complexity because mobile phone as one other component, is added into the DHIS2 information infrastructure, hence an increased the link of components.

DHIS2 extends its reach through mobile to support the communication between districts or hospitals, clinics, community health workers, and villages. It includes technologies such as short message service (SMS), Java, browser, Android, and tablet. This innovation supports

collection of data in the field which can be technically challenging and expensive. DHIS2.org on DHIS2 Mobile Introduction notes that

“Mobile phone solutions have the potential to significantly reduce the complexity of deploying a distributed data collection system, by using a simple Java client installed on a mobile phone or web browser which works on the mobile phone, field workers can report directly to DHIS2 database through their mobile device. While mobile phone solutions have a great potential, there are complexities with such deployments. Phones lack processing power and have a small display, they need to be charged, and often such deployments make the most sense in areas with poor or intermittent network coverage”.

To understand complexity, we can also look at information infrastructure aspects. According to Hanseth (2000, p.58) when information infrastructure is open, it implies that there are no limits to the number of user, stakeholders, and vendors involved, nodes in the network and other technological components, application areas, network operators, and so on. With DHIS2 being open it means it can potentially involves large number of users and stakeholders, and causes large network to emerge. It is fair to say that the more open and heterogeneous the system is, the more complex information infrastructure can be.

4. Generativity of DHIS2

“Generativity denotes a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences”

(Zittrain, 2006, p. 5)

Generativity basically describes the capacity a technology have to change and morph, spontaneously, from producers and creators other than the original developer (https://en.wikipedia.org/wiki/Generativity). This means that how a technology can be generated and added without no regard or for other additions and generations. Allowing the technology to grow or morph with no conflicts, meaning that each addition can work independently from other additions or affecting the core of the technology. With this we could say that a technology that somehow allows for new additions and generations are generative. This cannot happen if usage and development are only limited to a few. Either in the way of

competence or restrictions. According to Zittrain (2006), generativity is a function of capacity of leverage, adaptability, ease of mastery and accessibility.

4.1 Capacity for leverage

Technology that makes a difficult job easier, is what denotes this criterium. In terms of how a technology can present more than one functionalities, how easily it can evolve and how it easily it can be used to solve a task, the efficiency of solving a task. A good example is the alphabet. The alphabet can be used to create words. Words can be put together into sentences and so on. This makes communicating easier. (Zittrain, 2006)

The clearest example of this concept in DHIS2, is the use of internet. DHIS2 uses existing technology, leveraging on it. This means that DHIS2 uses internet to its advantage. For example, in terms communication and collection of data, it saves time and resources. Without the use of internet, collecting data and passing data through a system, it would mean that it would have to be sent in a physical form. Meaning everything would have to be on paper form. Collecting data would take much longer time. Moreover, statistics and aggregated data can be presented in a second. This leads us to another example of leveraging on technology.

Much of the preliminary focuses of DHIS2 is to generate aggregated data. Numbers and statistics in other words. The generation of this data in addition to being able to present the data and statistics through an interface will be used in the battle against diseases like HIV/AIDS and Malaria (Interview with John) (Millennium Development Goals), and also provide data that can help improve, for instance, maternal health. An electronic tracker or tracker will help collect data from, in this example, pregnancies, birth deliveries, through post-delivery.

It is worth noting that DHIS2 also leverage or aim to do so on mobile-phone and tablet technology. As phones and tablets often have an option for internet connection. This increases accessibility. Besides, in terms of mobile phones, SMS can be used to transfer data about patients, as well as notify patients about clinic visits, for example. This provides an alternative to internet connection. This leads us to the offline-mode. Whenever there is lack of internet connectivity. Data can be input offline, and uploaded when there is internet connectivity.

A built in message system makes it easier for developers to receive information about bugs, errors and even requests. This is paramount in the development of the technology, because its usage is spread over a great area.(Interview with John)

4.2 Adaptability

Being adaptable denotes the ability to change or evolve to fulfill new purposes. This means that anything that is able to be innovated, is adaptable. A piece of paper that is initially meant to be written on can be used for making a paper-plane, or to wipe something clean. As capacity for leverage is using a technology to maximum extend, it focuses only on doing one task very well. Adaptability focuses on the ability to be used for more than one task. Like farm equipment being used as weapons. (Zittrain, 2006)

DHIS2 is mostly used for generation of aggregated data. However, it is not to say that the system cannot grow into something bigger. Since DHIS2 has a modular architecture, it has the advantages of easily welcoming new features. New ways to generate data, share them, present them. This can be done without extensive knowledge of the core-program or any other modules. Moreover the technology is generic and can be easily transferred to other domains.

4.3 Ease of mastery

The easiness to master a technology. This does not mean in every aspect, but in order to use a technology efficiently. A good example is the use of internet. It can be used without having the insight of how it works. Just being able to use it and develop for it, without know the intricacies of the communication that is going on. Another example, the use of a pencil. It is easy to learn how to write, but learning how to draw is harder. This reflect as mentioned that every aspect does not need to be mastered. (Zittrain, 2006)

Basic education and expertise is necessary to use the system. As an example, Ghana educates twenty people each year to be able to use the system. However there is a wide selection of documents on how to use the system, as well as how to further develop it. It does not require more than basic computer skills. However, some countries often does not have that expertise available, thus some training is required (interview with John). There is however no need for a user to have a degree in higher education, like computer science.

4.4 Accessibility

To be accessible, factor like pricing, taxes, regulations and copyright laws are important. A technology that is too expensive is less accessible than a cheaper technology. A proprietary technology is often less accessible than an open technology, in the sense that you often have to pay for it.. Accessibility can sometimes be seen as a combination ease of mastery, in addition to availability and limits of use.(Zittrain, 2006)

Ease of mastery; how easy it can be used. Availability; how many sources it can be accessed from and from where. Limits of use; what the original developer permits in terms of further development and modification.

Being open-source, it is open to anyone to use or develop for. Another valid point is that it is web-based and the interface is browser-based. This would mean that the system can easily be accessed through almost any computer, smartphone or tablet. There is no requirements on, for example, operating system, nor are there any hardware requirements on the client side. As long as there is internet connection and a web-browser, it can be accessed and data can be stored. Another point towards it being accessible, is relatively easy to develop modules. There is no requirements to know everything about the core-program or other additions. All that is needed to know is how to get data.

4.5 Mismatches related to generativity theory and DHIS2

Although the system is adaptable, there are limits to how functionality might extend. As an analysis tool or provider of statistical data, adaption to other areas is easy and potential is great. However, further expanding beyond just being an analysis tool is more limited. It can be expanded to include patient data. The installed base is there. In other contexts it can be used for include other than just aggregated data. It can be used as a communication tool, but further expansion of functionality is hard to imagine. So, potential as an analysis tool is great, but evolving into something different is less likely to happen.

DHIS2 is fairly easy to learn. However, it requires training (Interview with John). This might make DHIS2 create a mismatch between generativity theory and DHIS2 case. Arguably, a

system should be that intuitive that it can be mastered without much training in order to be generative (Personal opinion and Zittrains description of ease of mastery).

DHIS2 is often used in development countries. In these countries expertise can be limited. So in a sense DHIS2 is not so accessible in terms of development. It is hard to expand development to these countries, e.g. Ghana (Interview with John). It is Open-Source, so it is possible for anyone willing to develop for it, but for a development country, it is not so easy to adopt or adapt to. Development is in reality limited to mostly UiO.

4.6 Further on generativity

When we review the four precepts of what makes a system generative, DHIS2 fulfills all of these so-called criteria of generativity in some way. It is adaptable to some extent and accessible. Although, it requires training to use, it is somewhat easy to use. As there is many guides and documents on how to use it, and how to develop for it. These are very important points in terms of the growth of the system. As for maintaining the system it can be done easily. DHIS, the predecessor of DHIS2, had to be installed and maintained locally. There are many issues with that. Some being expertise and time. Being web-based is an advantage in terms of maintaining and adding new features. We can also argue that the solution is simple and flexible, because there are not too many dependencies and constraints. It is evolutionary, it allows for new innovations, grows gradually. All this indicates generativity (Lecture slides: Generative Architectures). Another concept that generative systems often have is bootstrapping.

5. Bootstrapping

This concept is often used related to technology, and is often linked with generativity of technology. A technology that can grow beyond its original scope and purpose. This is best described with an example. Imagine, a programming language. Then imagine writing a compiler with that programming language. The compiler will be made to compile code of the very own language it is being made from. So, a technology is made, and used to develop more advanced technology. Another example is the development from machine code, to high level programming languages. A technology being made to make further advancements in that same technology. (Wikipedia bootstrapping(compilers)) (Hanseth 30.09.2105, lecture)

In order to make that work some strategies must be put to live, and three design principles should be followed:

1. Design initially for usefulness

2. Draw upon existing installed base

3. Expand installed base by persuasive tactics

(Hanseth and Lyytinen, 2010, p. 6)

In the process of the development of DHIS2, we find some bootstrapping strategies. As DHIS2 expands in terms of users, more people are potentially able contribute to the advancement of the technology. Usefulness might increase. This might be more appealing to potential users that might become users. This way we get a self-reinforcing installed base. Developing for usefulness is an important principle in bootstrapping. We can easily argue that DHIS2 is designed for usefulness. DHIS2 is useful by default, data is being used for scientific, medical and educational uses. The installed base was already there in form of DHIS, and some countries already had previous systems (Interview with John), which DHIS2 also is drawn up upon. To expand the installed base, usually what is done is initiating pilot programs.

6. Another take on generativity

Compared to Zittrains defintion of generativity, Hanseth and Bygstads definition basically just adds bootstrapping to the definition, or at least as the most crucial difference (Bygstad&Hanseth, unpublished). As Zittrains definition sums up to extensibility. However, in order to describe DHIS2s architecture as a generative one, we must also look at its generative fit with the user communities and how it fits with generative development collectives (Bygstad&Hanseth, unpublished).

Generative fit describes the impact, performance and functionality of a technology, and how well that translates into future growth.(Hanseth&Bygstad, unpublished). In other words how design of a system furthers growing. DHIS2 is developed for usefulness. The user community is able to request, suggest and even make new features. Because of an in-built message system, this is made very easy to do.

To further investigate the generative relationship, Hanseth and Bygstad mentions an article by David Lane. In order to find more evidence of generativity we will base this next section on his writings.

David Lane's theory of innovation (2012) describes five characteristics of a generative relationships;

- Aligned directedness, how actor interactions are focused on achieving similar goals.
- Heterogeneity, in competence and experience. Different experiences and and levels understanding might make up for valuable discoveries.
- Mutual directedness, Different perceptions of the world based on different experiences are shared and viewed as valuable resources. In another sense, more like-minded ,fewer innovations and vice-versa (David Lane ,2012)
- Appropriate permissions, what is accepted to ask, do or use, what is not
- Action opportunities, basically engaged simple interactions that transforms into changes in, for example, a system.

(Hanseth&Bygstad, unpublished)

There are many different actors in the DHIS2 project, from developer to user. They all share the same goal, in short terms delivering or have a comprehensive, easy-to-use and extensible HIS (https://www.dhis2.org/doc/snapshot/en/user/html/ch01s02.html). We have different levels of competence and perspectives, from nurses to computer scientists. However, we have not been able to fully research the the heterogeneity of the developers, we cannot say for sure whether there is more or less mutual directedness, but it is fair to assume that the combination of a heterogeneous group of users and the fact that new features can be suggested, requested or made, there is less mutual directedness.

At least we can find examples in DHIS2 that fits with the three first characteristics. Appropriate permissions and action opportunities are harder to find examples of. We simply do not have enough information to answer that. Nevertheless, the relationship between developer and user is close and open, so we can say that it is a somewhat generative relationship.

6.1 Generative architecture

We distinguish between ACA and CSCA. ACA is basically better for scaling , while CSCA is better for restructuring (Hanseth&Bygstad, unpublished). CSCA might be easier to innovate on, but ACA might be that as well, however, it is not entirely clear. Based on the researched made by Hanseth and Bygstad, CSCA is bootstrappable and ACA is not. With this information it is likely that the architecture of DHIS2 is of the more CSCA kind. The systems architecture is modular, which indicates that there are fewer relationships between features and additions, and that there are fewer dependencies between modules. There is a core, and modules are attached to this core. The user can choose which modules the user will use.

7. Changes

In this chapter we will look at different changes in DHIS2. We will first take a look at the strategies HISP use when developing the system. Afterwards we will try to find some of the key challenges the DHIS2 has. The additional date in this chapter has been gathered in an interview with a developer of the DHIS2 system, who we will refer to as Robert.

7.1 Strategies

To show how the main strategy of HISP development and changes in the DHIS2 we will use the same example that has been used earlier in this report, the offline version requested by Ghana. When Ghana sent the request for an offline version of the system to HISP, they got a response that they needed to make a blueprint. In the blueprint they had to explain what the feature should do and how they want to use it. There is often many different request from the many users for similar features (Robert, 27.10.2015). The users from different countries can have many of the same needs, but often not in the same context. In Ghana they wanted the offline version to be able use the system even with an unstable connection. If the connection was down you could then still input the information you wanted to add, and as soon the connection went back up they could upload the inputted information. But this might not be the same needs as for other countries got for the offline feature. This is one of the main point and also one of the challenges we will take up later. That the different countries have different agendas, and the same feature can be requested from different countries but in different context

and with different uses. When the HISP team get a request or several requests they would like to make the new feature work in as many contexts as possible. Like the Tracker which is used to track mother and child from pregnancy to infancy, could also be used to track HIV/AIDS and diabetes but not only this, they want to make it as generic as possible, the solution is to make a framework (Robert, 27.10.2015).

7.2 Challenges

There are challenges regarding the use of DHIS2 in developing countries. According to Robert, there are two distinct challenges: political issue and funding. Although political issue is not a prominent challenge, the political changes in a country would still influence the use and implementation of DHIS2. Robert implies that the implementation of DHIS2 in a country has relation with the political decision of the country itself. A potential problem that may occur from politics dimension is if the government decides to stop the use of DHIS2 because they have different plan. In the developing countries, it is common to set up priorities for specific agenda and then leave another matter behind. This may seem unrealistic since health area seems to be one of the most important sectors in every country, but since DHIS2 is a joint effort between IT and health sector, it then needs support regarding IT decision from politic side. Robert gives an example of a potential challenge that can occur: if a new government rises and decides not to prioritize IT, DHIS2 could be influenced. The development and implementation would slow down and stop. Developers find making a generic features can help this situation should it arise. Generic features are flexible and can be modified by users so that it fits with their needs. Politics leaders often put priority on the programs that give benefit to the country. Having generic features, DHIS2 gives a benefit in a way that it is flexible. The feature can be tailored according to what the Ministry of Health needs, for instance. As long as DHIS2 continue to give benefit and can be easily reconfigured so that it serves the needs in the country, politic side seems to keep supporting this program.

In addition, we know that DHIS2 is implemented in many countries, and that different countries have different problems in health sector. Ministry of Health in Ghana for example, focuses on HIV/AIDS report, and Ministry of Health in Malawi focuses on malaria. So by making generic features, DHIS2 can facilitate by providing a framework that can be reconfigured according to

country's specific need. This way DHIS2 will continue to accommodate needs although many countries have different focus in health sector.

Another key challenge is funding. As mentioned earlier DHIS2 is an open-source platform which is funded by Norad, Research Council of Norway, PEPFAR, The Global Fund (www.dhis2.org) and donors (Robert 27.10.2015). This means that should the funding stop, the project would collapse. In order for this not to happen the developers are trying to make DHIS2 as sustainable as possible. Making features generic and possible to further develop by the community the makes sure that if funding for DHIS2 should stop, the countries who have adopted DHIS2 or any other organization can pick up where the previous developers left off. There have also been issues where pilot programs have been supported with funding for servers and technical equipment, but when the pilot is over the funding isn't there anymore and the project collapses (Robert 27.10.2015). In order to prevent this from happening the developers of DHIS2 tries to make features as sustainable as possible by including offline modes and making them usable across different platforms such as PCs, phones and tablets (Robert 27.10.2015).

8 Evaluating the strategy

In the interview with Robert, he described for us the process of how the core developers of DHIS2 design the requested features and so further develop the II. After the core developers have processed the blueprints, they make a generic version of the requested feature that look more like a framework that enables the requesters to reconfigure to their specific use. In this way the developed feature can be used in different scenarios and contexts.

The alternative to this strategy would be to implement each requested feature as separate modules, although the consequence of this might be a set of modules that do similar things with small variations and restricted to the specific uses as requested. This strategy would make the II more complex and much harder to administrate. The modules would be less flexible to changes by the users themselves.

By providing a framework in which to get the tools to configure the requested feature to their specific needs, one introduces a much more flexible way to update or reconfigure the features if external factors demands it.

One of the characteristics from David Lane's theory of innovation (2012), *Mutual directedness,* is very central to the development strategy of DHIS2. We see that the core developers try to find a way to implement new features based on the similarities of the blueprints from the users. The small differences that are implemented within the framework would then be a "bonus" as an added feature which the users benefit from. This ensures *mutual directedness* on the process of fitting in the requests that are similar within the framework.

The downside of *mutual directedness* is it undermines innovation by making sure that the process of deciding which requests are included within the framework are similar to each other.

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