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Usability and Robustness - Barriers and Enablers for Projects Operating in Low-Resource Settings

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Abstract

Being able to exploit resources to its fullest have been important throughout history. How can projects operating in low-resource setting optimize their resource utilization? In this thesis I have looked at some of the challenges this task present through an interpretive case study. Standardization and robustness as properties, and user-involvement as a tool, have been identified as important aspects of the task.

I have worked on a project operating in a low-resource setting, with the aim to develop and implement a mobile application. The application is used by teachers to report student health data. Five schools are participating in a one-year pilot-project in Shimla, India. The teachers' task is to identify, report and follow-up suspected cases of Rheumatic Fever (RF) and Rheumatic Heart Disease (RHD), using the application that has been developed. If the project becomes a success, other schools and additional diseases can be included.

Working in a low-resource setting imposes challenges towards manpower, time, money and technology, which is something that we experienced during this project. My findings indicate that enhanced standardization and robustness will enable a more optimized resource utilization, and increase the project chances of succeeding. However, a prerequisite for accomplish this, is increased user-involvement; to be able to derive the right standard or ensuring robustness, the users has to be involved. Otherwise the project's scope can be misinterpreted.

Sammendrag

Å kunne utnytte ressurser til sitt ytterste har alltid vært viktig oppgjennom historien. Hvordan kan prosjekter som operer i lavressursmiljøer optimalisere sitt ressursforbruk? I denne oppgaven har jeg sett på utfordringer knyttet til en slik oppgave gjennom et fortolkende casestudie. Standardisering og robusthet som egenskaper, og brukerinnvolvering som verktøy, har blitt identifisert som viktige aspekter ved en slik oppgave.

Jeg har jobbet på et prosjekt i et lavressursmiljø der formålet har vært å utvikle og implementere en mobilapplikasjon. Applikasjonen skal brukes av lærere hvor de skal rapportere informasjon om studentenes helse. Fem skoler deltar i et pilotprosjekt som skal vare et år i Shimla, India. Lærernes oppgave er å identifisere og følge opp mulige tilfeller av revmatisk feber og revmatisk hjertesykdom. Dersom prosjektet lykkes, kan det bli utvidet til å inkludere flere skoler og sykdommer.

Å jobbe i et lavressursmiljø skaper utfordringer i forhold til arbeidskraft, tid, penger og teknologi. Mine resultater tilsier at økt standardisering og robusthet vil kunne føre til en bedre utnyttelse av ressursene, og øke sjansen for at prosjektet lykkes. En forutsetning for dette er økt brukerinnvolvering; å være i stand til å utvikle den riktige standarden eller forbedre robusthet, må brukerne involveres. Hvis ikke dette blir gjort er det stor fare for at prosjektets omfang blir misforstått.

Acknowledgements

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Glossary

ADMS Automated Drug Management Systems.

ANC antenatal care.

ANM Auxiliary Nurse Midwife.

ASHA Accredited Social Health Activist.

CDSS Clinical Decision Support System.

CHC Community Health Centre.

CPOE Computerized Physician Order Entry.

DHIS District Health Information System.

EHR Electronic Health Record.

EMR Electronic Medical Record.

GNP Gross National Product.

GP General Practitioner.

GUI Graphical User Interface.

HIS Health Information Systems.

HISP Health Information Systems Programme.

HP Himachal Pradesh.

ICT Information and Communication Technology.

IGMC Indira Gandhi Medical College Hospital.

IID Iterative and Incremental Development.

IS Information Systems.

IT Information Technology.

J2ME Java 2 Micro Edition.

NGO Non-Governmental Organization.

NRHM national rural health mission.

NSS National Service Scheme.

PHC Primary Health Centre.

PHR Personal Health Records.

RF Rheumatic Fever.

RHD Rheumatic Heart Disease.

SC Sub Centre.

SMS Short Message Service.

UID unique identification.

UIDAI Unique Identification Authority of India.

UNICEF United Nations Children's Fund.

WHO World Health Organization.

Chapter 1

Introduction

While there are no projects with unlimited resources, *low-resource settings* are usually associated with developing countries. In this paper, low-resource settings are not defined by Gross National Product (GNP), but rather by the project's actual available resources: Time, money, manpower, knowledge and technology. It is not a question of whether a project operates in a low-resource setting or not, but rather to which degree.

Open Source Software projects are good examples of projects operating in low-resource settings outside the third world. Their economy is usually the most limited resource. Another example is Wikipedia. While its economy is dependent on external funding, the project has managed to produce an encyclopedia 50 times the size of Encyclopedia Britannica, in approximately 270 different languages [2]. This would not have been possible by traditional economical models; instead of hiring the required number of writers, they have given everyone a "pen". This illustrates how resources can be exploited to its fullest.

When trying to optimize a project's resource utilization, there are some aspects that should be prioritized. One is standardization: To find a "best practice". For information and communication technology projects, this is to define what information should be communicated and how[3]. For more traditional projects it is about economy of scale - similar things are cheaper to produce than different things.

One of the major challenges within healthcare projects is to define a "language" which can be spoken across multiple local settings and systems, ensuring that different healthcare facilities are able to collaborate and share information. It is a complex task where deriving good standards is impor-

tant for resource utilization.

Another aspect of importance when exploiting resources is robustness. *Robustness* defines how well a system reacts to change. If a project has a low time budget or poor access to information, it is likely that the scope of the project is not fully known until the system has been deployed. Developing a system without knowing its full scope can result in big and costly adjustments late in the process. To avoid such costs, it is important that the project reacts well to change.

Early user-involvement can help providing a better understanding of a project's scope. While this can be an expensive activity, it is also closely related to the usability aspect of the project. The *level of usability* describes how easy it is for a user to accomplish a desired task within a system, and it is often an important success criteria [4]. There is a range of principles for usability that are broadly accepted within the industry; user-involvement is a fundamental corner stone of these principles. How can user-involvement be ensured in projects within low-resource settings? What are the consequences of neglecting user-involvement?

Low-resource settings often limit the choice of technology. In developing countries we see a rapid growth in the availability of mobile phones[5]. This provides an opportunity which have sparked a new optimism within the healthcare. There is a global recognition that improved Health Information Systems (HIS) can significantly contribute to improve the healthcare service delivery [6]. Information retrieval is identified as the main challenge within HIS in developing countries. Information about the current situation is needed in order to take the right actions, evaluate and conduct new strategies, and distribute resources equally. Currently, this process is characterized by incomplete, inaccurate, and untimely paper reports. Mobile phones are cheap and the infrastructure well established, at least compared to other types of infrastructure. By equipping healthcare workers with mobile phones, the reporting process can be improved. Instead of reports being picked up or delivered once a month, the data can be sent in real-time through e.g. SMS. This allows a quicker response to recently gathered data, improved data quality and less time spent on reporting.

I have had the opportunity to work on a project operating within a low-resource setting. The project's objective is to provide teachers with a mobile application used to report student health data. More precisely, it is a surveillance programme of students where potential cases of Rheumatic Heart Disease and Rheumatic Fever are reported by teachers. *The annual incidence of rheumatic fever in India is 100-200 times greater than that observed in*

developed countries and fluctuates between 100-200 per 100.000 children of school age (from 5 years to 17 or 18 years depending on the study)[7]. The condition is life threatening and treatment is extremely costly. Thus lives and resources can be saved by introducing preventive measures.

The application take advantage of the close relationship between student and teacher. It is easier for a teacher to spot changes in a student's health, than a doctor who only have 2 minutes to correctly diagnose the student. If this project succeeds the potential of including other diseases are huge. Even different arenas can be explored.

1.1 Research Questions

The resources available throughout this project have been limited in multiple ways: time, manpower, money and technology. I have tried to understand some of the challenges this poses, and discussed potential areas where resources can be utilized more efficiently. I have created four research questions that I hope will help to undertake such a task.

RQ1: How is the development process of a health information system affected by a low-resource setting?

- **RQ1.1:** Given a broad acceptance of usability principles, how should these principles be operationalized in a low-resource setting?
- **RQ1.2:** What strategies exist to enhance robustness of the implementation processes in low-resource settings?
- **RQ1.3:** What forms of standardization can facilitate the generalisation of the school health module to other modules?

1.2 Organization of the report

Chapter 2 - will present the theoretical framework used within this paper. This chapter attempts to provide a broad theoretical basis for understanding

the many challenges faced for projects operating in low-resource settings in general, and for HIS particular.

Chapter 3 - gives an account of the research method chosen, and the data collection methods used. An evaluation of the various factors that may have influenced how data has been gathered and interpreted is given at the end.

Chapter 4 - provides important background information which tries to illustrates some of the project's terms. Understanding the Indian healthcare system and the school system are important aspects of this task.

Chapter 5 - this is where the case is presented. The project's objectives are described in detail. The focus have been on how the project has unfolded with descriptions of important events.

Chapter 6 - this chapter discusses the challenges faced during the development and implementation process. Standardization, robustness and user-involvement are important aspect of this discussion. The research questions are tried to be answered, and suggestions for improvements are given at the end.

Chapter 7 - summarize the findings and give suggestions for further research.

The report is comprised of seven chapters. The first chapter, *Introduction* presents the case and the research questions of the report. Chapter two,*Literature Study*, consist of the theoretical framework that is used, starting with HIS and followed by HIS in developing countries. Further, a description of usability, standardization and mobile development is given, before ending the chapter with management and leadership.

In chapter three the research setting of the project is presented together with description of the different data collection methods used. Further, an evaluation of different factors that can have affected the project, interpretations and results is given.

Chapter four gives a description of the case background including India and the Health Information Systems Programme (HISP). Where in chapter five the results of this study is presented, together with descriptions of process and development methods.

In chapter six the findings are analysed with regards to the research questions. In chapter seven the results are concluded

1.3 Contributions of the thesis

There are many projects operating within low-resource settings, both in developing countries and industrialized countries. In this thesis I seek to look at some of the challenges that can arise within such projects. User-involvement, standardization and robustness have been identified as key areas. Even though the usability principles are broadly accepted, this study shows some of the challenges user-involvement poses in low-resource settings. This study also show how limited technology affects robustness. I believe that my findings can shed light on the cause of the challenges experienced, and provide a better understanding of the complex processes involved. Thus, it can prove helpful for current and future projects operating in low-resource settings.

Chapter 2

Literature study

In this chapter, the theoretical framework that is used will be described. This include health information systems in general and specific within developing countries. Followed is a description of usability, standardization and mobile development, before ending the chapter with management and leadership.

2.1 Health Information Systems

Health information systems are in a phase of rapid development, but still with many challenges not being solved. In this section I will first give an introduction to the healthcare sector and how it is organized, and give a definition of health information systems. Further, I will look at how far the HIS has come today, using Norway as an example. After follows a discussion of the challenges health information systems faces. At the end a summary will be given.

2.1.1 The Healthcare Service

Before going into HISs in detail, I will look at how the healthcare sector is organized using Norway as an example. The healthcare sector is characterized by many different healthcare facilities and professionals (doctors, nurses, psychologists) which are geographically dispersed. General Practitioner (GP) and pharmacies are privately owned, and hospitals and healthcare centres which are municipal owned. In addition, there are different private actors

like private hospitals and various specialists. The government and *the ministry of health and care services* are the upper governing bodies.

The healthcare sector is organized in different levels. The first level is GP which is where most of the population receives adequate treatment. A GP does examinations, tests, write prescriptions and do referrals to hospitals and specialists. Due *fastlegeordningen* one no longer receive a permanent GP, but chooses among available GPs through a website hosted by HELFO (Helseøkonomiforvaltningen) [8]. A website where people can write reviews of their GP was launched in May 2012 with mixed response [9].

The second level is hospitals. This is where the more serious cases are treated which the GP can not attend, like surgical procedures, consultations, births and so on. The hospitals are complex organizations where standardization and efficiency is critical. Mistakes or slow treatment might result in serious injuries or deaths. If we look at St Olavs hospital in Trondheim it employs over 9700 people and have in total 1018 beds [10]. That is almost 10 people per patient. The level of cooperation is high which require excellent communication tools. For a surgical operation the team varies in size, but the following roles are in principle always attended: surgeon, anaesthesiologist, nurse anaesthetist and surgical nurse. After the surgery is finished other nurses and doctors will attend the patient. All these persons with different interests and responsibilities need to collaborate and communicate.

The third level is specialized, national centres like *Oslo university hospital*. They are responsible for the national medical competence centre [11]. This means that they shall ensure national competence development and share knowledge within their specific field of highly-specialized medicine. This includes a lot of research, counselling, monitoring of treatment outcomes, contribute in developing and implementation of national guidelines and practises, and yearly report to the ministry or other designated organs.

We have seen that the healthcare sector is quite complex. It is organized in "silo structures" based on facilities and professionals, and it is geographically dispersed. The same structure and complexity is found in ISs. However, the healthcare sector is under a huge pressure regarding efficiency improving. Tearing down the boundaries or silo structures are an important part in achieving this. The Norwegian government spent over 249 NOK billions in health expenditures in 2011 [12]. This is 9.2 % of BNP or 50. 000 NOK per person. Only USA spent more with 17.4 % of BNP (2009). The most expensive post is hospital services where patients are staying overnight [13]. IS is seen as a key part to nearer the differences and unify the healthcare service, and thus increase efficiency. Take paper based systems as an example,

it inhibit cooperation across silos and it is seen as little efficient.

2.1.2 Definition of Health Information Systems

To understand what a HIS is, it might be a good idea to have a look at the definition of Information Systems (IS) in general. Information systems can be defined as a system that collects, stores, process, presents and transfers information. It consists of humans and technical components, and it is the interplay between these actors which characterize the system [14] [15]. Health information systems are thus systems for collection and processing of data from various sources. The information is used for decision making and management of healthcare services [16]. The overall goal is to improve the healthcare service by increasing effectiveness and efficiency through better management at all healthcare service levels [17]. It is more about improving actions rather than gaining information.

Health information systems are usually huge and complex, consisting of many different systems. Some for small designated tasks, others for huge overlapping tasks where many stakeholders are involved. This leads to challenges towards standardization and interconnectivity between the sub-systems. However, standardization and interconnectivity is reckoned as important factors for improving healthcare services, but it poses great challenges to achieve.

In addition to the many systems mentioned, HIS also consists of many healthcare workers with different roles. There is everything from doctors and nurses to administrative chiefs and politicians. This leaves organization structures which are quite extensive, but also should be adaptive to change, especially when there is so much happening on the technology front. If the healthcare sector is going to benefit from it, the organization needs to be able to change.

Where are we today

With all the new technology, it is really interesting to imagine how the healthcare sector can develop. What if every person could easily access their medical history records. Or if you got sick in another country, the doctors would had access to all of your records as well. How far have we come today and what challenges are the healthcare sector facing?

In 1990 research stated that nurses only used on average 31 percent of their time with patients [18]. One of the initiatives that was suggested to increase

the time spent with patients was more use of computers. But how can computers help to increase patient care? The answer lies in a doctor or nurse daily routines. To ensure patients right every medication, cut or test needs to be recorded whether you are at an hospital, primary care or even home care. Diagnosis and treatment plans also need full documentation. This leads to a considerable amount of time used on recording. Before the introduction of electronic information systems, this was done by using pen and paper.

There are many useful functions with using paper records; it is easy to compare multiple pages making information retrieval efficient. Different colours and paper texture can make it easy to spot the right page, and it is possible to recognize the writer due characteristics of the handwriting. It is also easy to carry around and does not require internet access or an electronic artefact [19]. But paper records also makes copying very difficult and potential dangerous. It further complicates the collaboration between different healthcare practitioners and making intercommunication between different healthcare institutions impossible. Handwritten notes also introduce challenges like misinterpretation of words, storage and retrieval issues, expensive backup options, if none, and it is time consuming. By introducing electronic information systems, many of these issues are addressed. E.g. Storage and retrieval will be considerable more efficient and secure, collaboration on the same record can be done without making conflicting copies, and it is easy to get the complete picture of the patient by accessing its medical history. This is some of the reasons why the paper in 1990 suggested introduction of electronic health information systems, and why the enormous interest in electronic solutions. How far have we actually come?

When thinking of the enormous amount of data an hospital can produce an obvious place to start is to make information retrieval and storage efficiently. Therefore, a lot of different system with the aim to replace paper records have been developed. Electronic Health Record (EHR) and Electronic Medical Record (EMR) started as simple systems for patient information storage and retrieval. Later they have been coupled with more sophisticated systems like Computerized Physician Order Entry (CPOE) and Clinical Decision Support System (CDSS) for hospital use.

Take Norway as an example, if we look at the development of primary care and hospital care it is clear that the hospitals are far behind when it comes to adopting new technology. Primary care have used electronic health records for a long time, and have almost 100 percent coverage. The same can not be said about hospitals. The government has stressed the importance of achieving health information systems that collaborates on a national level.

The first step is to establish a common electronic health record system which your general practitioner, midwife, or even yourself can access. In Norway this is going to be achieved through a system called *Kjernejournalen* [20].

The Norwegian government is spending a lot of money and resources in the development of Kjernejournalen. In 2010 the health directorate conducted a preliminary, and in 2012 they started the implementation. For 2012 the aim was to establish a service bus, national security solution and a register for services that needs to be established with Kjernejournalen. The first pilot will be run in 2013.

Recently a national system for electronic prescription was released, called eResept. eResept provides electronic prescriptions based on a national database. When ordering or renewing a prescription the physician adds the medication into the system. The user can then go to any pharmacy and retrieve the medication by showing identification proof. The user can also log in to a web interface and access his or hers prescriptions. In a Kjernejournalen perspective, the eRespet project must be a success if the Kjernejournalen is going to be a success, because the pharmaceutical information is an important aspect of Kjernejournalen. So far the implementation of eResept has been successful.

If we look at hospitals, other types of systems have been developed. Two of them are Computerized Physician Order Entry (CPOE) and Clinical Decision Support System (CDSS). The different CPOE systems offers automating medication ordering processes which ensures standardized, legible and complete orders [21]. The aim is to prevent medication errors and adverse drug events. CDSS are often, to various degree, a part of the CPOE systems. It provides suggestions regarding drug doses, routes and frequencies, allergy checks, drug to drug interaction checks and drug-laboratory checks.

Ahus, which is a new hospital (2008) in Oslo has as goal to be the most modern hospital in Europe [22]. They have invested in a CPOE like system called Automated Drug Management Systems (ADMS). The ADMS allows the clinician to issue an electronic prescription and transmit it directly to the pharmacy for verification. When verified, the orders are sent to a robotic system that automatically gathers and deliver the prescribed medications to the final nursing unit (using a tube system). The nurse receives a text message when the delivery is ready. The system also offers a *significant level of safety protection* . E.g. the nurse can validate that all information is correct by scanning the medication and the patient's ID band. This sounds very modern and secure, but Ahus was forced to close down the system just days after the hospital's opening. *Problems with both hardware and software*

in relation to the complexity of the system and volumes, will require some upgrades and changes - was reported [23]. After a year, it was still not in use, but some improvements had been made.

The major problem was that they wanted 80 percent coverage of the medication delivery done by the ADMS from day one. The system did not have enough capacity to supply all the medication orders, so nurses had do use the paper based systems as well. Instead, as they pointed out, the implementation should have been done gradually, taking section for section. Then user faults could have been discovered and fixed, and the training session optimized. This would have done the system more secure.

So far we have seen the healthcare service developed from paper based systems to electronic based systems. The data gathered is not only used for treatment but also for planning and research. It contains rich descriptions like images and molecular level data and not only numeric information. We have also seen a shift from institution centred HIS to regional and global HIS.

What challenges are we facing

We have seen the development of systems which mainly focus on replacing paper based systems with electronic systems (EHR and EMR). We have also seen systems which focus on improving physicians and nurses work situation, like CPOE and CDSS. As well as systems like the kjernejournal and eResept. What challenges do these systems bring, and what will be the next step in the healthcare sector?

What we have not seen is systems with primary focus on patient care. The systems mentioned above all contribute to patient care indirectly by making more fault proof systems or release more resources, but none of them is made purely to improve patient care. Personal Health Records (PHR) tries to address this issue to a greater extent. The idea is to give everyone the opportunity to access their medical records at any time, at any location. Hopefully this can lead to people taking their illness more seriously, especially diseases like diabetes mellitus type 1 and 2, overweight, chronic obstructive pulmonary disease. The problem is that PHR systems are only used by a handful of people. Research done by [24] and [25] shows that the users are interesting in using such a system and they believe it's valuable, so why do not more people use it? How can the reason be determined when *almost all the investments in PHRs have focused on product development*

and implementation, and not on evaluation or research, as demonstrated by the low publication rate in this field [26]. An outcome of a review of PHRs done in cancer care suggest that until PHRs provides some kind of care the adoption rates will remain low. It is not obvious that the amount of care in an electronic system determines its success. Thus, research will still be an important aspect for development of future PHR systems.

In a TED-talk [27], Thomas Goetz talks about redesigning medical data where he gives an example of a document containing a blood test result. He had some designers to redesign the document with focus on how the information should be presented and what type of information that should be given. Figure 2.1 shows the old version compared with the new version. As we can see, in the new version colours is used to make it easier to understand the meaning of the results. I have diabetes type 1, and if I say to my friends that today my blood sugar level is 12, they always ask me what does that mean. So by indicating on a scale from "good" to "bad" the test result will actually give meaning for a person who does not know anything about diabetes. This example illustrates an easy measure that can be done to increase patient friendly healthcare services.

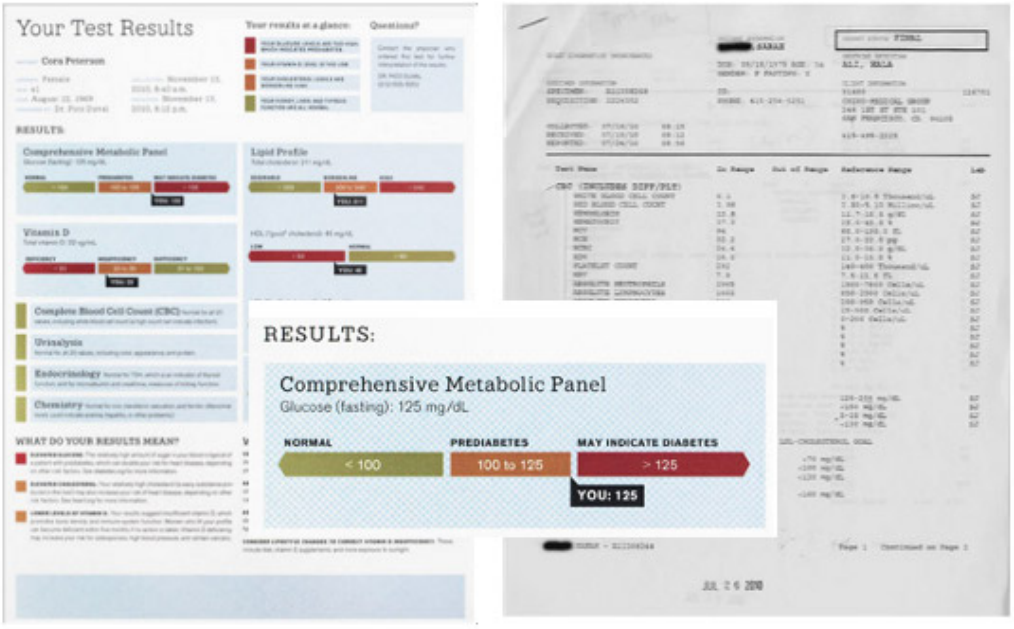

Figure 2.1: On the left side is the new version of the blood chart, and to the right is the old.

Searching for CPOE in databases like *web of knowledge* results in many papers regarding the positive effects of CPOEs. However, not as much research

have been conducted regarding the drawbacks of using them. The few that do, shows that the implementation introduces new types of errors [28] [29]. Many of them regards human-machine interactions, but also on the level of organizational integration with previous systems. Typical errors concerning human-machine interactions are misspelling of names or drugs, selection of wrong patient, different settings on different computers causing confusion, duplication of medication records and so on. This is typical challenges that comes with transition from paper based to electronic systems. It is important to not get blindfolded by the seemingly success of a new technology or system, but have awareness of the drawbacks it might have. There will always be new and different challenges with changes in routines, tools and organizational structure. Evaluation and research is important factors to discover them.

When looking at the success of the implementation of EHR or EMR in primary care, it is obvious that good systems exists. Why can not the hospitals use the same systems? The problem lies in what separates hospitals from primary care. At primary care it is usually only the general practitioner who is involved in the treatment, maybe some tests are needed, but it's still he og she that decides the treatment. The treatment as well is performed outside the office. At an hospital or care home, doctors and nurses collaborates in diagnosing, conduction of treatment plans and the treatment itself. This requires more advanced systems.

One of the challenges is the use of many different and separate systems in the healthcare sector. The need for standardization is pressing. In Norway, each hospital can decide which system to use. The same goes for the general practitioners [30]. Some of them are new, other old. The challenge lies in making a system that is compatible with the other existing systems, but also contains the previous stored patient data. Politics, resources, prioritization, and clear and specific demands are necessities that must be present. There will be many stakeholders and it's important to involve all of them. In addition, good research, evaluation and many tests must be the foundation of the development process. Maybe then such a system can succeed.

With increasing development of national centred HIS it is likely to believe that the traditional institution-centred architectures will not be adequate [31]. Many of today's systems are not interconnected which make the healthcare service appear fragmented. By developing new architectural solutions more patient-centred architecture can be achieved. However, this pose strict security requirements when sensitive information is going to be accessible everywhere and from any device.

2.1.3 Summary

I think the next step in the healthcare sector is to succeed with an implementation of a national medical record system across the different healthcare sectors, like Kjernejournalen. Situations where patients get harmed due the lack of information about drug allergies or complications from conflicting medications will likely be avoided. There is great value in such a system, but also huge challenges.

With a growing population together with increased life expectancy will consume even more resources. The solution lies in development of new technology and better information systems. In the movie "Frank & Robot", robots are used to take care of dementia patient by giving each patient its own robot. Maybe this will be the future for the healthcare service?

2.2 Health Information Systems in developing countries

Many information systems in developing countries seem to fail. Why is this the case, and what can be done to avoid it? In this section I will look at some of the challenges HIS in developing countries face, and how they differentiate from industrialized countries. I will also look at what characterize a project as failure since so many of them fail. The section ends with a success history.

2.2.1 Differences between developing countries and industrialised countries

Traditional health care is based on knowledge passed from generation to generation gained from experience, luck and coincidences. Plants, rituals, and spirits have been important parts in the treatment process. Things like equipment, medicine and sanitary conditions are often poor or none existent. This limits the treatment abilities which is one of the reasons to low life expectancy. The solution however is not necessarily easy. To get all the needed resources might still not be sufficient. With strong traditions and believes it might prove difficult to convince a pregnant woman to seek help outside her home at a foreign healthcare institution. Even if she wants to, poor infrastructure can make it impossible to reach the healthcare facility. Thus home visits are still a common practice, at least in the rural areas. Rural areas are

often the areas where the health situation is worst and least documented. To be able to take the right actions, develop good strategies, and equally distribute resources, having knowledge and information that illustrating the current situation, is critical. An example is immunization coverage. By knowing the immunization coverage for infants across districts, province and so on, resources and action can be directed towards areas with the poorest coverage. By improving HISs, collection, management and analysis of such information is possible. When combined with appropriate practices, it can, for this case, directly contribute to reduction of child mortality by improving the immunization coverage [[3]]. Thus, improvement of health information systems are seen as crucial to strengthen the healthcare service [32].

The healthcare organization structure is usually strictly hierarchical, lead by the government. It is split down into districts, sub-districts, block levels and smaller areas where primary care is given. In addition, there are healthcare centres specific for programmes like malaria, tuberculosis and so on. The institutions are managed by a number of institutional bodies which are service and geographical organized. The government is responsible for allocating resources, develop healthcare strategies and make sure they are carried out. Thus the structure is quite similar to industrial countries. However, there are still huge differences. Corruption, donor actors, lack of resources and knowledge are typical problems seen in the third world countries which western countries experience less of.

When it comes to primary healthcare, the facilities are small and primitive with none or few beds. The equipment support only the most basic treatments and might contain a small medication stock. As mentioned above, home visits are also still a common practice. With high population density, poor sanitary and water condition, infectious diseases travel rapidly creating huge challenges for the healthcare service. In the slums where people also live close to animals, diseases only found in animals are now seen in humans [33]. This increase the chance of worldwide pandemics. It is a serious challenge which one country alone can not be responsible for.

When it comes to accessibility of the healthcare service, figure 2.2 illustrates the patient doctor ratio in a world perspective. It shows clearly a distinction between industrialized countries and developing countries, even though there are some exceptions like Cuba with 170 and Turkmenistan with 240 (compared to Norway with 320). This means that the time each patient have with its doctor is minimal; *An Indian doctor can on an average day attend up to as many as 150 patients in a 6 hour day (...)(2.5 minutes per patient on average!)* [34]. For a western doctor, this is extreme. Each time I see

my general practitioner I use around 15-30 minutes, and I can still complain about not being listen to, or how long I had to wait before I got an appointment. The poster actually hang on the walls of waiting rooms in the Netherlands. However, the trade off between how advanced (expensive) the healthcare centres are and the density should be carefully calculated. It is important to make sure that everybody is offered healthcare service and the quality of that service is sufficient.

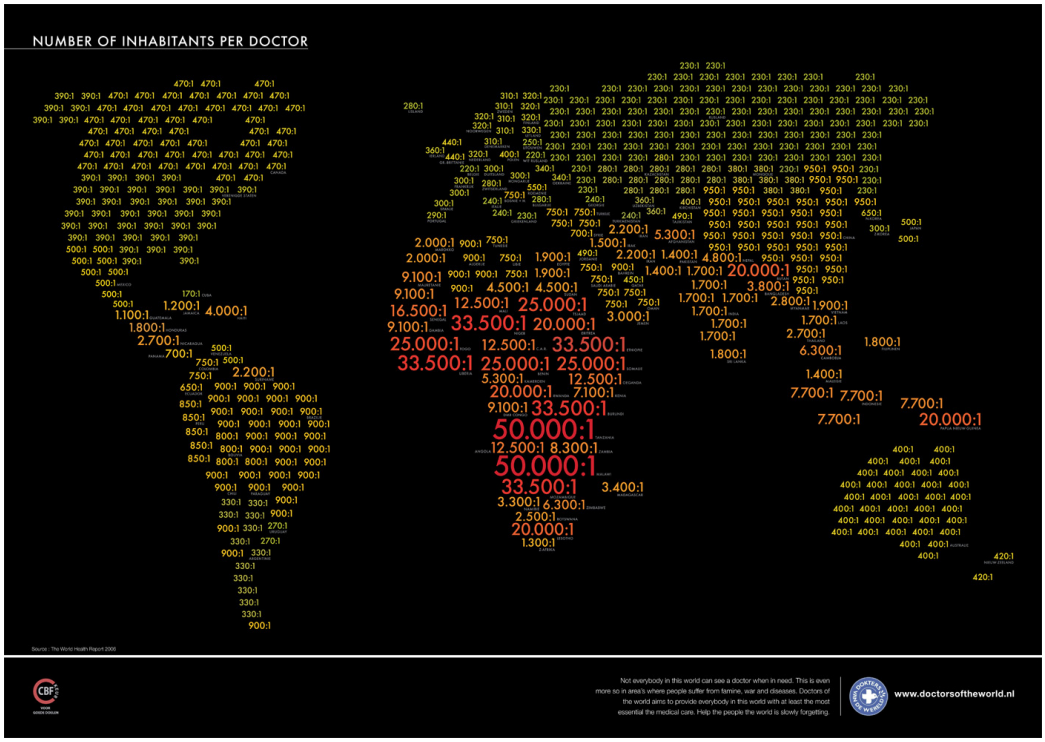

Figure 2.2: The map show the ratio between patients and doctor on a world basis. As we can see there are huge differences.

The use of health programs are specific for developing countries. A programme is an initiative either from the government or non-governmental actors with the aim to treat, usually, one type of disease. When the healthcare service is not sufficient and many cases of a specific disease is seen e.g tuberculosis, a tuberculosis programme can be initiated. Own facilities might be build, new positions can be initiated and new routines be implemented. In this way it is easier and hopefully more efficient to deal with the disease. An amount of money might also be earmarked for the initiative.

2.2.2 Challenges for health information systems

For HIS in developing countries, the reporting systems are often uncoordinated and vertical with no common structures or procedures. This results in an excessive amount of data which is poorly used. The type of data that is recorded are mostly aggregated data for statistical purpose. This is the easiest type of reporting since only number of incidents are needed, and not patient specific data. Most of the data is gathered at primary care where reports are made and sent to district and national level. Little of the information is sent back, thus decision making based on evidence is difficult. *"....the data frequently ends up on a dusty shelve at one of the office in the Ministry of Health without being analysed or used"* [6]. This is a serious problem. Lippeveld et al. [17] calls the information systems data driven - not action driven. This leads to poorer healthcare services where the linkages between individual care and public healthcare systems are increasing. In addition, the data collected might also be of poor quality.

The care providers who is responsible for collecting the data might not be trained or given a standardized collection method to use. In addition, lack of motivation can also be a major problem. Why should healthcare workers spend time on reporting data when their children is dying on the hospital's footsteps? With no feedback, the data provides little value for a healthcare worker in the "field". If he/she was able to use the information to ease the patient load or provide better service, then maybe it would give enough motivation to improve the quality. If a patient is referred from one care unit to another, and the test results are inadequate or missing, the same work might have to be done twice. This cost money and resources. By improving HIS it can save a lot of resources and even lives. A problem can be to show this benefit to the healthcare workers: to show them how resources spent on HIS can contribute in saving lives.

Motivation is also important when it comes to introduction of electronic based systems. If to succeed with replacement of paper based system with electronic systems, it has to offer something more. Something that makes it worth changing routines and invest time and effort. Otherwise I do not think the quality will improve, and we will see, something we have seen some many times before: a project with a lot of resources invested failing.

If a patient is referred from one care unit to another, and the test results are inadequate or missing, the same work might have to be done twice. This cost money and resources. Improving HIS can save a lot of resources and even lives.

Infrastructure is also an important factor when it comes to health information systems. It affects the accessibilities of healthcare facilities limiting the care. Different means of communication, mobile network or internet connections, are dependent on the infrastructure, as are the power supply and water supply. All these aspects needs to be taken into consideration when developing information systems in developing countries. An example is a project where all the required equipment, computers, printers, cables etc., were provided, but the system could not be used due inadequate power supply [35]. This illustrates some of the complexity of developing new systems in these countries.

Experience from industrialized countries shows that the more fragmented healthcare sectors are the more different HISs arise. To develop a common national HIS is one of the main challenges in industrialized countries, as discussed in the previous section. This situation is also seen in developing countries [36]. Complexed organizational structures and heavily centralized information systems management, makes it difficult to coordinate the already existing health information systems and to do improvements. Decentralization of information management toward the district level has however, been shown to be an effective strategy to improve the use of routine information [17].

Then there are the donor actors. Since 1952 Norway have donated over 400 billions Norwegian kroner to different countries and projects [37]. The question is always - does it actually help? The donors are organizations like World Health Organization (WHO), private foundations (like Bill & Melinda Gates Foundation), different Non-Governmental Organization (NGO)s, United Nations Children's Fund (UNICEF) and many others. These actors play an important role to provide healthcare, but there is also major drawbacks. For example in Eritrea, up to a fifth of the spendings on healthcare are financed by external donors [38]. With a year-to-year planning and varying budgets, it makes it nearly impossible to plan and implement a coherent national program. To succeed with a national healthcare strategy, reliable and sustained financing is crucial even though the main objective, long-term speaking, is a self financed healthcare system.

There are great international interest in diseases like malaria, tuberculosis and HIV/AIDS. This has resulted in the development of programmes specializing in providing care for only one disease. If countries that are receiving funding don't have a clear policy on how to use this type of money, there is a major chance of getting an imbalanced healthcare system; People with malaria will receive better care than a pregnant woman because international

interest in malaria is greater than newborns. In Africa one can tell by the judging of appearance (specially the car), which health programme that has received the most money. To derive a national healthcare strategy based on equality is thus complicated when resources are earmarked and unevenly distributed.

On my visit to India I experienced power outage almost every day. Imagine a hospital with life supporting treatment depending on electricity with power outages that often. If the system developers are not aware of the situation, and extensive backup solutions are not provided, the consequences will be catastrophic. This might be a trite example, but the point is, you have to know the context and differences in the country you are designing for to succeed. The differences are everything from culture to finance, religion to politics, organizational structure to norms.

2.2.3 Design actuality gap

Many information systems in developing countries seems to fail. What is failure and how is it determined? Analysis from case studies of information systems in developing countries resulted in three dominated categories of reported outcomes: total failure, partial failure and success [39]. It proves difficult to determine which category a project falls under since it is a rather subjective opinion. However, a roughly classification is presented. *Total failure* - when the initiative never gets implemented or immediately abandoned after implementation. *Partial failure* is typical initiatives where major goals are unattained or there are significant undesirable outcomes. Another partial failure, which is typical for developing countries are sustainability failures. The project is seemingly a success but then after a year or so it gets abandoned. This is often due lack of resources as funding, skills and knowledge. *Success* - where most stakeholders attain their major goals and do not experience significant undesirable outcomes.

A reason to why many projects fail in developing countries are the *design-actuality* gap, which are mismatch between the information system design and local user actuality. Where are we now and where do we want the design to get us. The design-actuality gap can be divided in 7 different areas: information (data stores, data flows), technology (software and hardware), processes (user/other activities), objectives and values (culture and politics), staffing and skills (competence) management systems and structures and other resources. By assessing and rating the 7 different areas a overall sense of mismatch is presented. Hence a likelihood of failure can be derived.

Many information system projects in developing countries are led by industrialized countries [39]. The dominated approach is to try to transfer industrialized country design to developing countries actualities. This domination comes from industrialized countries' leading position in research and development, economic position which makes the industrialized countries able to invest in developing countries, resource and artefact flow, and globalization which has carried industrialized ideas and technology to developing countries.

The problem with this domination is that the information system projects in the developing countries are thus often led by consultants, IT vendors or aid donors from industrialized countries which brings their context into the design. Some even have the attitude that "if it work for us, it will work for you". Others tries to differentiate but due the huge cultural differences. it is difficult to accomplish. The consequence is design-actuality gaps which increase the chance of failure. The worst approach is where information systems are developed *for* and *within* an industrialized-country context and implemented in developing countries without any customization.

One approach to reduce the design-actuality gap is an Iterative and Incremental Development (IID) methodology. Working in iterations makes it easier to adjust the dynamic environment in the developing phase where requirements are rapidly changing.

In the recent years agile methods (based on IID) like Scrum, Extreme Programming or Kanban have become very popular in software development. This is probably a reaction to the waterfall method which was widely used before. The waterfall method originated from manufacturing and construction industries (hardware) [40], making changes extremely expensive after the planning phase. The problems with the waterfall method is actually the same type of problem that we addressed above. Something is developed in one context (construction industry) and used in a total different context (software development).

Since one of the major challenges is getting developers to differentiate between their context and, given that they are from industrialized countries, the context in the developing country, an iterative developing phase is beneficial. The process in learning a different culture, political system, norms, organization structure that are totally different from what you are used to, is quite time consuming and not straight forward. By making room for misunderstandings, communication problems and learning processes it is more likely to develop an successful information system because the design-actuality gap is getting closers. This is possible with an iterative and incremental development methodology which is based on the assumption that changes will

occur.

2.2.4 A success history

As we have seen, the trend in developing countries are failing information system projects. Hence it is very interesting to look at the few that succeeds. One of the IS that has succeed is e-Seva [41]. e-Seva was implemented in Andhra Pradesh, India in 1999. Its objective was to facilitate peoples' interaction with multiple agencies when paying for different infrastructure related services like electricity supply, water supply, property taxes and so on. Monthly payment of electricity could take up to half a day due conversations with different (corrupt) officers, queues and travelling to and from the location. e-Seva centres situated all over the state capital, Hydrabad was developed to cope with the challenges the old system presented. Each centre consist of dozen or more computer terminals which are run by operators. Only one conversation is required, and the queues at the peak hours are well organized. The project was one of the most complexed IS projects in India.

The evaluation done afterwards points out different reasons to why it succeeded. The first was leadership: the leader was knowledgeable and enthusiastic about IT, made a long-term commitment and took detailed interest in the implementation process. He was responsive and had the will to learn, and used political skills for private partnerships. The second point was innovative organizational structures. These were introduced carefully in staged processes over time to lessen resistance. Multinational consulting firms like McKinsey and KPMG provided long-term envisioning and the overall architecture. Indian companies with local knowledge, were used for more specific project implementation plans and efforts. This was a less threatening approach to existing government officials and interest groups, which helped obtain cooperation. A third point was learning and persistence. The ability to learn from mistakes and persist over time. Strategies implementation procedures were refined based on previous projects' mistakes/success. The fourth point was enthusiasm, which was both created within the project and outside the project. Since the concept was easy to explain, and it addressed a common problem like corruption, it was easier to get everybody else enthusiastic about it.

This is not a health information system but considering the involvement of many different organizations with different structures and procedures, data record management, and the amount of services provided it is likely that the reasons for success is applicable for HIS as well.

2.2.5 Summary

Improved HISs are seen as an important part of strengthening the health-care service in developing countries. However, poor infrastructure, donor-dependent politics and design-actuality gaps are some of the reasons why many projects fails. However, it is still possible to succeed, if some precautions are made. If implementing an electronic based HIS, it is important that the system can coexists with the existing paper based system. At least for a transition period since huge changes should be introduced gradually. Learning from mistakes and do evaluation are also important steps.

2.3 Usability

Have you ever been so frustrated that you wanted to smash something? A tv remote that no matter how hard you throw the signals at the tv it still doesn't react? Or the small clever plastic wrapping that comes with every technical gadget you are so anxious to open, but is impossible without using some sort of tool? The problem is usability, or the lack of it. In this section I will first present a definition of usability and why it is important. Further I will look at how usability is achieved by looking at some useful methods. In the end I will look at the ISO 9000 standard.

2.3.1 What is usability

Usability is defined as how easy it is for the user to accomplish a desired task and the kind of user support the system provides. It can further be broken down to the following parts [4]:

- **learning system features** - what can the system do to make it easy to learn system features.
- **using a system efficiently** - what can the system do to make the user more efficient
- **minimizing the impact of errors** - what can the system do so that user errors has minimal impact.
- **adapting the system to user needs** - how can the system adapt to make the user's task easier.

- **increasing confidence and satisfaction** - what does the system do to give the user confidence that the correct action is being taken.

2.3.2 Why usability is needed

Why is usability so important? In a business perspective high level of usability is usually related to profit. It leads to happy customers which often becomes loyal customers. Take Apple as an example: one Apple product is rarely owned alone. Loyal customers are very important, and extra efforts, like special discounts or terms, are often offered to make sure they stay happy and loyal. They also play an important role in marketing by spreading good recommendations. Little is more convincing than a friends advice. Usability also reduces the amount of user errors, which can be quite time consuming, expensive, and not at least hurt the company's reputation.

Reducing user-errors makes the product more safely to use. This is very important when it comes to health information systems. E.g. it should not be possible to delete or modify treatment records. This is to ensure patient rights in case of the hospital administered the wrong treatment. Less user-errors also enhance the experience, making the users more satisfied. However, few user-errors does not matter if there are none that uses the product.

High level of usability can also reduce costs and increase efficiency. If employees in a company can reduce their time performing one task from 5 minutes to 1 minutes. Further say they have an hour salary of 500 NOK and they perform this task 1 time an hour. For a year, they could have saved 64.000 NOK per person. This is just a simple example, but the actual scenarios can be much more. However, increased efficiency does not always lead to cost reduction. If a social service system makes it easier for a person to use the system, it doesn't imply that the officer would be more effective. He/she will most likely get more cases faster which increase the work amount, making him/her even less effective (in the sense of percentage).

In a user perspective, high level of usability makes product or software easy to learn and comprehend. This leads to a more effective use and it is less frustrating, leaving the user with a sense of achievement. In addition, it is strived to adapt the system to the users' need, by providing all features required to perform the needed task in an efficient way. This leads to satisfied users which is the most important premise to succeed.

If usability is not being prioritized until late in the developing phase, critical flaws or drawbacks might be discovered too late, making it very expen-

sive to fix. Thus systems can be deployed leaving the users with inefficient, time-consuming and potential dangerous systems. Ensuring that usability is prioritized during the early stages of the development phase is important. Many might be under the impression of that usability activities are expensive. However, usability activities can be arranged in numerous ways, thus there will be an activity suiting any kind of budget A.1.

2.3.3 How to achieve high level of usability

The question is how do one achieve high level of usability? The key element is user testing. To test something, you need to have something that can be tested. This leads us to the requirement phase. It is during this phase the system features are derived. By user involvement the users' need is easier identified. However, this does not guarantee that their needs are fulfilled. *The proof of the pudding is in the eating;* i.e. a designing process is merely predictions, user test should thus be preformed to measure how well the system actual meets the users' requirements.

The users' needs can be determined through focus groups, interviews, observations, field trips, questionnaires and so on. The important thing is to establish a communication ground with the end-users, so that their needs can be identified. Communication also increases the chance of clearing up misunderstandings, where some types are better than others. By direct observation, things are concrete and materialized which is a lot easier to understand than abstract concepts. In addition, if someone is supposed to explain his or hers work routines, there are always details that are missed. Either the person finds it too obvious to mention, irrelevant, or it just slipped their mind. This is easier to capture through observations.

Focus groups is an effective process used early in the developing process. One typically gather a small group of people, around 5-8 people, which sits around a table where ideas and designs are shown to them [42]. Much of its value comes from participants reacting to other's opinions. Thus focus groups are good for quickly getting a sampling of users' opinions and feelings about things. The participants might be closely picked to match the real users, or randomly chosen. It is a matter of cost prioritization.

When the requirements have been gathered they need to be tested to see if they provide the desired features, and how well these features are provided; the usability of the product. This can be done through prototypes, either paper based or electronic, and working systems. Prototypes materialize a

previous abstract concept and makes it concrete. This makes it easier to give feedback: what works, what does not work, what is missing and what is unnecessary. The user will receive a set of task he/she needs to perform using the prototype. The designers/developers observes how well the tasks are performed. Afterwards a discussion with the user can be held where he/she gives feedback, suggestions of improvements, point out missing elements etc. A usability score can also be calculated. Getting feedback from the user early in the developing phase is extremely valuable. Changes can be done at lower cost, making sure the right requirements are included, and increase the chance of succeeding.

Methodology that facilitates high level of usability has become more common over the years. Iterative and incremental development (mentioned in section 2.2.3) categorize methods based on iterative work processes. Within this category methods like Scrum, Extreme Programming, and Kanban is found. Common for iterative development methods is to refine the design throughout each iteration. This enables the designers and developers to incorporate user and client feedback until the system reaches an acceptable level of usability. One iteration usually last between 1-4 weeks consisting of: planning - requirement - analysis and design - implementation - testing - evaluation. These steps are repeated at each iteration [40].

Usability has gradually become a tool box for techniques and methods; Iterative development, prototyping, and user involvement. There are also other techniques like workshops and scenarios. In a workshops a group of people meet to apply methodologies for problem analysis. It is a setting for creative problem solving which can both include users and developers/designers. The aim is to through collaboration achieve results. Scenarios are stories which specify how users carry out their tasks in a specified context. The stories are told from a user's perspective such that technical backgrounds are not needed. Scenarios are best suited early in the development phase.

2.3.4 ISO 9000 and ISO 9241-11

Quality of use should be the major design objective for an interactive product. The ISO 9000 is a collection of standards addressing quality management systems. ISO 9234-11 is one specific document in this collection which provides guidance on usability (ISO 9241-14 can be used to evaluate dialogue principles) [43]. It explains how usability can be specified and evaluated in terms of user performance and satisfaction. It also provides a definition of usability: *the extent to which a product can be used by specified users to*

achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [44]. The definition emphasize the importance of context of use, environment and different type of users [1]. Thus a broader sense of usability is provided: What really counts is whether a user can achieve their intended goal when they use the product. For this definition, usability includes the aspect of both utility, reliability and runtime. This has led to the perception that usability is synonymous with "quality of use". Thus the ISO 9000 standard is highly relevant. Either which of the definitions one decide to follow, the ISO 9241 can provide useful guidelines to measure the level of usability.

2.3.5 Summary

As we have seen high level of usability is important in software and product development. It gives little room for user-errors which are extremely important in HIS. It can be crucial of whether the outcome of the project fails or succeeds. It can also lead to stronger market positions and be decisive against competitors. It is achieved through iterative development methods and techniques with signifi on user testing. High level of usability will lighten tasks and save resources, leaving satisfied users. The ISO 9241 can be used as a tool to achieve this.

2.4 Standardization

With the ongoing introduction of new information systems, eventually redundancy and a need to crate links between the systems will occur. By strengthening the links between the systems, it is possible to remove the redundancy which will save resources. To achieve this effect, means to integrate the different systems has to be derived. This can be done through standardization. In this section I will start by giving a background description of standardization, its relation to information and communication technology with special attention to HIS. At the end three different approaches to how develop standards will be discussed.

[1] I chose to present the definition in the start because it is more detailed and easier to relate to. However, the ISO standard definition have some valid points and thus these needs to be taken into consideration.

2.4.1 Background

Historically, when thinking of standardization it is usually associated with Henry Ford and the assembly line. Standardization of processes and parts made it possible to produce cars a lot more efficient than the competitors. The primary concerns for standardization have traditionally been efficiency and economy of scale. The idea was simple: many similar things are cheaper to produce than many different things. For Information and Communication Technology (ICT), with production costs towards zero, the concept gets a slightly different meaning.

Standardization in relation to ICT, are agreements about what and how to share and exchange information across multiple local settings and systems [3]. Communication and interoperability are thus the primary objectives. If everyone had their own private language communication would not be possible. An agreement of a common language is thus needed. For ICT this is usually done with protocols, interfaces and APIs. Internet is an excellent example of a common agreement of a set of protocols, which even have been excepted worldwide.

So, how is a standard derived? Who decide which language to speak? Some of the standards are more official than others. The definition of a meter for example. The International Organization for Standardization (ISO) is an important contributor for the more official standards. They have developed more than 19.000 standards covering almost all forms and aspects of products and business [45]. They work to break down international trade barriers and to ensure quality.

De-facto standards are results from products and systems that have achieved a dominant position by public acceptance or market forces. An example is the QWERTY-layout used on keyboards. Even though it is reckoned as a less effective layout, the number of users has made it to the standard keyboard layout. The cost of switching from one layout to another layout is so expensive that a lock-in effect is seen. This has prevented other layouts for gaining market shares.

Other standards are consortium or community based standards which is seen in open source development. The World Wide Web Consortium develops protocols and guidelines that ensure long-term growth for the Web.

Common for traditional standards and ICT standards are the financial benefits. With traditional standards production cost is reduced, but for ICT increasing returns and positive feedback is instead seen [46]. Positive return

is the effect that occurs when value and profit increases for each product sold. With a marginal cost close to zero, it is often seen in the IT industry. The same applies for positive feedback. Positive feedback occurs when a product's or network value increases the more people that use or buy it. An example is Facebook: the more people that use Facebook, the more value it has. Positive feedback gives great market advantages and can also lead to lock-in (switch-costs are high). A problem with increasing returns and positive feedback is the creation of path-dependency, which means that following versions have to be backwards compatible. That might become a challenge in regard of standardization efforts.

2.4.2 Health Information Systems and Standardization

Communication is important in health information systems. Thus a common "language" is needed to be able to collaborate. However, the healthcare sector is huge and calls for large HIS. With standardizing getting more complexed and harder the larger the system, makes this a major challenge. Without standardization, communication of medical records are almost impossible. Data is recorded using different formats and structures which complicates sharing options and analysis. The same information might also be recorded multiple times and important data not recorded at all. The idea behind standardization is to find a "best practice", a standardized routine which can be distributed to all levels, so that "dialects" can be eradicated. In this way standardization can be achieved.

Constantly changing environment, increasing number of standards and the links between them, has resulted in a more complexed "world". Previous standards might conflict with new ones and the bureaucratic process is too extensive to take responsive actions [36]. This implies that standardization must be flexible [47]. With flexibility, Hanset et al (1996) discusses two different types of flexibility that both can help to address this problem. The first one is the flexibility in using a standard in a new way without doing any changes, *use flexibility*. The second, is how easy it is to modify the standard, *change flexibility*.

Developing Countries

It would have been very practical to just transfer all standards from industrialized countries to developing countries. Quality could have been ensured,

and time and resources saved. However, the differences in culture, resources access and knowledge, would not make this possible. Take the transition from paper based systems to electronic based systems as an example. In the industrialized countries they aim to replace all paper based systems with electronic systems. In developing countries the infrastructure is not capable to support such systems; power outage is a common problem, internet access is not prevalent, and equipment is expensive and require knowledge to use. Thus, electronic HIS has to co-exist with a paper-based solution, at least for a longer period.

Timmermans and Berg [48] looks at how a standard is shaped according to the involved stakeholders, artefacts and environment; the users are not slaves that simple acts on command - they will change, adapt, and avoid processes to optimize it to their local settings and use. This also state that it is not possible to reuse standards made for two systems which are operating in different environments. Timmermans and Berg argues that to ensure a working standard, it has to be adapted to the different local settings. They use the term *local universality* to describe how the balance between standardization and localisation can be achieved; the standard should be an outcome of a repeating process where the standard is shaped according to experience.

2.4.3 Strategies for developing standards

Many countries are in the process of standardizing their health information systems. Coiera [49] describes three different strategies that can be used in such a task: *top-down*, *bottom-up*, and *middle-out*. Examples are shown from three different countries using these strategies to develop a national standardized healthcare systems.

Top-down (UK) - a top-down strategy will from the beginning of the project try to define a solution that serves every healthcare facilities. This requires defined goals, extensive knowledge of the processes involved and dedication and strict control from the government. However, due the complexity in such a task and the number of stakeholders involved, makes management a slow and inefficient process. This impose huge challenges when it comes to be able to quickly and efficiently respond to changes. Local customization will also be a difficult task using this approach.

Bottom-up (USA) - this strategy use the existing organizations and systems to form the basis of the standard. There are none who is in control of developing the standard, unlike the top-down approach. The goal is still

the same. Local conditions and variations are taken into consideration when developing the standard. This makes it easier to react and adjust to changes, but it is also seen as the major drawback. When taken every variation and inequality into consideration it can be difficult to find a common platform and standards. However, the different service providers can meet to merge the different systems. Coiera hopes that these merges will be enough to eventually lead to a standardized national healthcare system.

Middle-out (Australia) - is an attempt to combine the best of the above mentioned strategies. The standard will still "evolve" but different actors are given different responsibilities based on their expertise. For the government, this mean that besides ensuring that the different actors are using the standard, they will not interfere in how they chooses to adhere to it. Thus, the standard that is derived, is not for the systems in itself, but how the different systems shall operate together creating a national system. This will enable local variations in addition to a flexible and cost effective development process.

2.4.4 Summary

Standardization provides state of the art specifications for services, products and good practices. The idea is to find a "best practice", a standardized routine which can be distributed to all levels. For ICT, ensuring communication and interoperability is the main objective. Thus a common communication ground can be set which ensures communication of medical records. The standard is defined through protocols, APIs and interfaces. Three different strategies can be used; top-down, bottom-up and middle-out.

2.5 Mobile development

Now, mobiles are found everywhere. In your pocket, handbag or even under your pillow. In India, it was not unlikely to have two phones. If the phone did not support dual sim, then off course you need two phones. But how does mobile phones differentiate from computers? What is important to consider when developing applications for mobile phones? Can mobiles improve healthcare? I will try to answer these questions in this section.

2.5.1 Developing for mobiles

The more convenient differences between computers and mobile phones are the size and weight. It is very easy to carry. The battery last longer, and it is much cheaper. There are of course phones that are more expensive than computers, and computers with longer lasting batteries. But to find computers that are lighter and easier to carry around is however more challenging.

With GSM and network connectivity, the advantages of phones' portability is being fully exploited. People stay connected wherever they are - even on flights. Mobile communication has unfettered us from our geographical boundaries and led to a cultural shift [50]; users are encouraged to constantly seek out new information and make connections with increasingly dispersed media content [51]. The users does not only expect their mobile device to provide functionality similar to their desktop, but also additional functionality such as location based services. To succeed gets more challenging for every application that is being launched.

I will look at some points that are important to be aware of when developing applications for mobile phones. I will start with the user-interface.

The screen is the primary interface for any digitised medium. Comparing the human eye with the human ear, the eye can easily receive information from multiple sources simultaneously, but to distinguish sounds is much more difficult. Thus, for a lager screen more information can be rendered simultaneously in a single context. How can the same information be given on a smaller screen?

A website not optimized for small screens can be aesthetically unpleasant, un-navigable, or even illegible. To succeed with mobile applications, an easy-to-use interface is critical [52]. Small screens and limited navigation, makes this a real challenge. However, there are some techniques which can be used.

Dialogue boxes or alerts are examples of elements that can easily be adapted to small screens. Scroll bars or something similar, can be used when the content is either longer or wider than the screen. A scroll bar can indicate the user's position in relation to the total content of the page. If the scroll bar is more or less proportional, it can also indicate the relation between the visible content and the total content on the page. This is an easy way to be "honest" with the user. Say the application is a form that needs to be filled out. Thus a scroll bar can indicate how much time the task will take, and show progression.

When it comes to data entry, providing input to small devices are difficult and requires a certain level of skill. For simple phones there are 3-4 letters per button. The default approach is to push that button two times if the required letter is positioned as number two, e.g. pushing b where b is found in the sequence abc. This results in a lot of buttons being pushed. T9 is a smarter approach. It predicts what word the user most likely will type, but in comparison with touch keyboards, only one alternative is shown at the time. The point is, typing on small keyboards can be a frustrating and time consuming process. Especially for touch screens it is easy to hit the wrong button, and thus increase the chance of errors. To prevent typing errors validation checks can be done, but there are only so much one can check.

There are measures that can be done to make the input process faster. One suggestion is to replace text fields with radio buttons or check lists wherever possible. Thus the amount of typing errors can be reduced and it is faster to write.

Another aspect which need to be taken into consideration is that mobile phones can be used in many different and changing environments; sitting, standing, walking, driving and so on. Thus an application for navigation while driving have different requirements than for walking. Hence the application should be adapted to its use.

Mobile phones have limited resources when it comes to computational power and memory capacity. Thus the following questions need to be answered: what data should be stored, how to get the data there and if required, how to make sure it is synchronized. The last question implies that data connectivity will be lost at some point. How should the application react, the data has to be managed locally in some way and what happens when the phones is reconnected? The context can play an important role in deciding the right choice.

For websites that are accessed with mobile phones, they should be optimized in such way that loading the page goes as smoothly as possible. This implies using images of lower resolution or maybe remove some of the content. It is important to have in mind that the quality of the data connection can vary a lot, thus loading a page not optimized for mobile phones can be a long frustrating process.

2.5.2 A mobile application

From 2008, over 55 billion applications have been downloaded from App Store (Apple) and Google Play, which are international online software stores for smart phones. In 2012 there where approximately 700.000 available applications (apps) in Google Play. During a period of 5 years the app market has exploded. The apps that exist are everything from games, health and workout apps, to social networking and travel apps. In Trondheim, an application called Mobillett was launched in 2011 as a substitute for cash payment when using public transport. The figure 2.3. By creating an account, payment can either be done directly through your mobile network operator or drawn from an amount transferred to the account. After the payment has been completed, the ticket's duration is nicely shown with a decreasing bar.

Mobillett is one of the more social beneficiary applications. Cash payment directly to the bus driver is one of the more time consuming payment options for public transportation; if not the exact amount is given the driver has to find the required change and wait for a paper receipt to be printed. By providing a substitute for the cash payment option, the time used at each (bus) stop can improve significantly. Since punctuality is one of the biggest challenges within the public transportation, this application can make it easier for the vehicles to be on time. In a social perspective the benefits from improved punctuality is everything from less pollution from idling, more attractive alternative to cars or prevent people from getting late to (important) appointments and such.

Figure 2.3: A snapshot of the Mobillett application (foto: WTW Software).

2.5.3 Mobile Health

Mobile-healt or mHealth is a sub-segment which has emerged from eHealth. The Foundation for the National Institutes of Health defines mHealth as "*the delivery of healthcare services via mobile communication devices*" [53]. Although mHealth has great value within industrialized countries, it is in the developing countries the field has really emerged. There are mainly two reasons behind this. First is the nature of the problems developing countries face with the healthcare service delivery: big populations, numerous diseases, lack of resources, poor infrastructure, and so on. The second factor is the expansion of mobile phone coverage in the developing world [5]. This implies that also in rural areas people will now have mobile phones together with a working infrastructure. This new opportunity has motivated to a lot of research and discussions.

The idea is that communication through mobile devices can improve the healthcare service. Mobile devices enables health workers to communicate health data in a more accurate and efficient way which will enhance the data quality. By being able to report from rural areas, decision-making and resource allocation will be based on more accurate information. A two-way communication between healthcare-worker and patient, and healthcare worker and whom they are reporting to, is also possible. Technology can also increase the efficiency among the healthcare workers as well, which can free resources that can be spent on patients instead.

A systematic review of healthcare applications in developing countries that uses Short Message Service (SMS) was published in 2012 [54]. They report that the majority of the applications satisfying their criteria focuses on HIV/AIDS and were located in India, South Africa and Kenya. The applications are mostly used for diseases prevention and surveillance. Concerns and potential barriers that has been reported for prevention interventions are language problems, SMS cost, anonymity, data security, high mobile phone turnover in the population and mobile network fluctuations. For disease surveillance, problems with cost, mobile network coverage, electricity access and high personnel turnover was experienced. However, most of the interventions were found to be feasible.

They conclude that their findings are promising for the use of SMS based reporting applications. *Text messaging seemed to improve the process of care and was well accepted by both healthcare works and the target population.* However, there is a lack of research towards the clinical outcomes of using such application. Thus further research is needed to investigate the effects

of mHealth in developing countries.

2.5.4 Summary

The research field on mobile phones, mobile development and mHealth is enormous. In this section I have only touched the surface of the available material. A more throughout review is beyond this project's scope.

As we have seen, development for mobile phones is quite different than for computers. The size of the screen makes usability extra challenging, and typing can be a cumbersome task. There are also important differences between developing applications for smart phones contra simple phones. Especially connectivity and available resources are important issues. This is important to keep in mind if developing mHealth applications. Currently, the research indicate that the use of mobile devices in the healthcare is promising, but it remains to see the medical outcomes of its use.

2.6 Management and Leadership

What makes a good leader? Throughout history, we have seen examples of great leaders: Genhgis Khan, Mahatma Gandhi, Jeanne d'arc, Ernesto "Che" Guevara, and Operah Winfrey. What quality is it that they all share? In this section I will first look at the difference between leadership and management, and what characterize good leadership. I will also give a short presentation of different leadership styles. At the end I will look at characteristics of fear-based leadership, and the effects it has on the followers.

2.6.1 Difference of Management and Leadership

The difference between leadership and management is about complexity and change [55]. While management is organizational structure and plans, leadership is about coping with change - showing the way when changes are needed. Thus leadership is about creating visions and strategies, and management to plan and organize them. Management is a complex task involving many processes and variables. Thus, a stable environment, few changes, will be the optimal environment. "The whole purpose of systems and structures is to help normal people who behave in normal ways to complete routine jobs successfully, day after day". Thus management and leadership have in some way

conflicting objectives. What happens when the same person is responsible for management and leadership?

> Management is doing things right; leadership is doing the right things - Peter F. Drucker

There exist no universal rule in how to lead every group, team or person. The suiting leadership style is depending not only on the person who is the leader, but also on followers, work setting, culture, public or private company, and not-for-profit or for profit companies. Leadership is no longer simply described as an individual characteristic. It is a complexed social-dynamic process. In *Leadership: Current Theories, Research, and Future Directions* [56] different leadership styles are reviewed:

Authentic leadership: a pattern of transparent and ethical leader behaviour that encourages openness in sharing information needed to make decisions while accepting followers' inputs.

Transformational leadership: leader behaviours that transform and inspire followers to perform beyond expectations while transcending self-interest for the good of the organization.

Transactional leadership: leadership largely based on the exchange of rewards contingent on performance.

New-genre leadership: leadership emphasizing charismatic leader behaviour, visionary, inspiring, ideological and moral values, as well as transformational leadership such as individualized attention, and intellectual stimulation.

Shared leadership: an emergent state where team members collectively lead each other.

These are just a handful. There exist many more, but it is a good place to start if trying to identify a leadership style. There exists a lot of research on each of the styles which can be used to improve the leadership, or to adapt another style. Each of the styles has its own drawbacks and advantages. The leadership style is important when it comes to running the organization or company effectively.

When it comes to the leader, the most important personal qualities are [57] [58]: **integrity** - one's actions should be honest and truthful/accurate. It is a concept of consistency in actions, values, methods, principles, expectations, and outcomes. **Vision** - a leader should have a clear idea of where to go and why. **Trust** - without trust the leader can not function. It is something that

can not be acquired, but must be earned. **Competence** - it is about understanding, making the right choices, and respond quickly and intelligently to changes. **Encouragement and motivation** - how to bring out the best in the followers. Successfully motivation ensures that people have the energy to overcome obstacle. Motivation and inspiration energize people, not by pushing them in the right direction as control mechanisms do.

There are many other qualities as well, but in every leader one, if not all, of the qualities are present.

2.6.2 Fear-based leadership

> Immediately the atmosphere changes. Tension hangs like a fog in the air. Everyone is hoping that the leader's gaze won't light on them. Is today going to be one where silky smiles and broad good humour will defuse the tension, or is it going to be one of those occasions when the gaze is a dagger, silence a threat and a question a blow? Everyone fears that the arbitrary axe of the leader's malignant attention will fall on them, for everyone knows that Maxwell is famous for picking out people and publicly humiliating them.

This is a citation from one who worked with Robert Maxwell (a Czech war hero who robbed his company's pension fund) [57]. We all know the type, but what happens to a workplace, a team or a single employee with this style of leadership?

There exists many different names and definitions on the form of leadership that is described above: Petty tyranny (1997), Abusive supervision (2000), Coercive power (2000), Social undermining (2002), Destructive leadership (2002), Tyrannical leadership (2007) and so on. Shyns and Schilling use the term destructive leadership and defines it as *a process in which over a longer period of time the activities, experience and/or relationships of an individual or the members of a group are repeatedly influenced by their supervisor in a way that is perceived as hostile and/or obstructive.*

Bies [59] identified the following manifestations of abusive supervision: public criticism, loud and angry tantrums, rudeness, inconsiderate actions and coercion. Other descriptions are speaking rudely to subordinates in order to elicit desired task performance and wilful hostility - publicly belittling subordinates in order to hurt their feelings. Hornstein [60] describes an abusive leader as *one whose primary objective is the control of others, and such*

control is achieved through methods that create fear and intimidation.

Schyns and Schilling [61] have done a literature review on the available research where they have summarized the effects of destructive leadership. The following points are based on their review:

- Leader-related concepts: followers shows resistance towards destructive leaders and also lower trust in the supervisor.
- Job-related concepts: destructive leadership is negatively related to job satisfaction, and motivation and dedication is likely difficult to obtain, especially for a longer period.
- Organization-related concepts: high turnover and the impression of low justice. Also a risk of counter-productive work behaviour.
- Individual follower-related concepts: increased stress, decreased well-being, and it is negatively related to performance.

In addition to mentioned points, Tepper [62] have also found that people who are less mobile experience the abusive supervision stronger. "Moreover, job satisfaction, life satisfaction, family-to-work conflict, depression, and emotional exhaustion where more pronounced for subordinates who had less job mobility." He explain the phenomena with that people who can quit will have a way of protecting themselves; They can escape from the abuse they are experiencing whenever they want - it is their choice of staying or not. For persons who can not quit, the feeling of abusive supervision can magnify because there is no option for them to protect themselves. Thus people who are less mobile might feel the abusive stronger.

2.6.3 Summary

The existing research on leadership and management is enormous. The topic has been of interest for thousands of years, and still there are a lot left to discover. This section only looks at a small part of the theories of leadership and management. There are so much more that could have been said, but a more thorough review will be beyond this projects' scope.

Chapter 3

Method

This chapter describes the research and data collection methods used in my empirical work, carried out during the stay in India. First follows an argumentation of selected research method, then description of data sources, and finally reflection on the quality of the collected data and methods used.

3.1 Research Approach

The research approaches can be mainly divided in two categories: qualitative and quantitative. Quantitative research methods aim to tests theories or explain social phenomena based on empirical investigation using a numerical approach. It is based on the assumption that statistical analysis of numerical data can be generalized to a larger population or represent strong scientific evidence. It started out as a research method in natural science, but have later been accepted in social science as well. Common methods are surveys, laboratory experiments and mathematical modelling.

Qualitative research methods have a long history from social science. The aim is to get an in-depth understanding of human behaviour and social phenomena. Questions like *what*, *how* and *why* are often tried to be answered. It is the reasons and purpose that are of interest. In the information system field there has been an increased interest in focusing on organizational and managerial aspects instead of technical issues. This has led to more qualitative research. Common research methods are case study, action research, ethnography and grounded theory.

Traditionally these methods were not possible to combine since the theories

which they are built upon is rather conflicting. However, there have been a change; instead of being contradicting approaches qualitative and quantitative methods are now seen as complementary approaches [63]. The choice of research approach is still important, and will be of significance when it comes how data is collected, analysed and evaluated. Each of the methods have its own strengths and weaknesses. The choice should be based on the objectives of the research.

I have chosen a qualitative approach, more specific an interpretive case study. This will provide insight and deeper understanding of the process involved and challenges faced when developing health information systems in low-resource settings.

3.1.1 Interpretive case study

Interpretive research is based on the assumption that our *knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools, and other artefacts*[64]. Positivism on the other hand, explains reality as something fixed and independent of social conditions and subjective interpretation [65]. Interpretive research in IS will try to understand how information systems influences and is influenced by the context [66]. The context is an important part in getting an in-depth understanding of challenges towards developing HIS in low-resource environments.

Case studies was first used in jurisprudence (law) but has become a common approach in IS research [67]. A case study looks at phenomena in a real-life setting; It can be anything from an event, activity, process, person or group of persons. Thus, an interpretive case study provides rich descriptions of practises, and it allows reaction to unforeseen events, and investigation of complexed situations. It is something that exists, evolves and changes over time. It happens only once and it is impossible to recreate.

The classic model is experiments where the surroundings are controlled, and specific factors are carefully changed one by one. Thus it is possible to evaluate how the research object is affected to different environmental changes. This process can be repeated until the desired result is obtained.

The main drawback of using interpretive case studies is generalization. The research is based on subjectiveness so the chance of biased results are very likely. However, in this study the aim is not to generalize. It is an attempt

to get understanding and insight of issues in a specific context. That is way an interpretive case study has been chosen.

3.1.2 Data access

In May 2012, conversation with the President of HISP India started to discuss the opportunity for me to work on one of their projects. During the autumn 2012, as a part of the *specialization project*, I went to India for three weeks to work with HISP. Since the time period was so short, the main objective was to get familiar with the organization, how they worked and the software they use. In the end of February I left once again to India but this time for two months. However, it was not until a week or so after I had arrived that it became clear that I would work on the school health project.

I left 28th of February and returned 24th of April.

3.2 Data collection methods

The data collection methods used in this research have primarily been observations, interview, questionnaires and document analysis. A short account of each of the methods together with description on how the data has been collected will be given below.

3.2.1 Observation

Data collected during observations can be categorized into three different types: observations during workshop, at the workplace and in project meetings.

Workshop

One big workshop was organized where all of the users together with the state programme officer, the head of the department of cardiology and members of HISP was invited. Out of 35 teachers, 10 participated. The head of the department of cardiology started by giving a presentation of the medical aspects of RF/RHD. It lasted for about 45 minutes, and the teachers were asking questions during this session. Afterwards, the chief implementer

presented the project, its objectives, and the process flow. This lasted for around 20 minutes. There were fewer questions during this part. A hands-on, step-by-step, demonstration of the application was then given. An emulator and projector was used to show the teachers how to register a student. The teachers did the same on their phones. We had installed the application on their phones during the medical presentation. This was the last session and went on for about one hour.

The members of HISP that participated was: Chief Implementer who had the responsibility for giving the presentation and demonstration. Project leader, senior health officer, intern, me, and both of the developers. In total we were 7 people from HISP.

Workplace

I took an active part in the team, and interacted with a number of people on a daily basis. The core team consisted of 5 people, but usually there were one or two who worked on something else. E.g. at the end of my stay, I was the only person left in Shimla from the team. The team was divided in "implementers" and "developers". The implementers worked on requirement gathering and documentation, testing and deployment. It is a two-story office with an open space solution. Usually, the developers are situated in the first floor and the implementers in the ground floor. When the team members were working on the project, we sat next to each other in the first floor. The project leader sat in the ground floor. This made it easy to observe what the others where working on.

There was one issue that made observation some what challenging. Many of the conversations were done in Hindi, which I do not understand. However, a lot can be understood by facial expressions and voice pitch.

I also tried to document what had happened each day by taking notes. In the beginning it worked pretty well, and extensive notes were taken. After the days became more busier it was easier to forget or not find the time. Thus they could be written for several days at a time. This increase the chance of missing important details.

Project meetings

There where two meetings with stakeholders outside HISP. One was with the state programme officer, and the second with the head of the department of

cardiology. During both of the meetings recording was done, and transcribed afterwards. The meetings lasted for approximately one hour. The meeting with the school health programme, the chief implementer, developer, intern and me attended. Questions was prepared and printed out. With the head of the department of cardiology only the chief implementer, intern and I attended. Preparation was done but questions were not printed out this time, only kept in a notebook.

3.2.2 Interview

There were only one formal interview which was conducted. I chose to use a semi-structured interview to be able to discuss new ideas or issues that could be brought up by the interviewees. I prepared some questions to make sure that the wanted topics were covered. I had planned to tape the interview, but somehow I forgot. Thus I had to take notes instead. Since the interviewees were probably not that good in English, I had one of the interns at the office with me to help translate. She had not worked on the project before, so I gave her an introduction to the project and its purpose before we went. This was to ensure that she understood the context of what we were discussing, so that confusions or misinterpretations could be avoided. At this time there were no one else working on the project in Shimla beside me, otherwise it would have been better to have someone who is familiar with the project to translate. The interviewees' English turned out to be not that good, so it was essential that the intern could come along.

However, the interview did not go exactly as planned. Instead of interviewing 5 users separately, I interviewed three of them together. So it became a semi-structured group interview instead. The reason for this was due some unforeseen events and that the intern could only be there for 30-45 minutes. The interview was still very valuable, and helped to clear out confusions.

3.2.3 Questionnaire

A questionnaire was designed with the main purpose to capture the user's mobile qualifications and motivation towards the project. It was handed out during one (out of two) school trainings and at the workshop. The number of respondents was 27 which is to few to achieve any statistically quantifiable data, but it gave some indications of who the users are.

3.2.4 Documents

Most of the documents within this project have been made during the implementation process. The use case document was one of the few documents which was made before I joined the project, but it has been revised since. Other documents are test documents (script, bug report), one invitation letter (to the workshop), minutes from meetings, user manual, FAQ. In addition data has also been gained through email and chatting. Data that concerns events that happened after I left India, has been provided through chatting.

The table 3.1 summarise the different data collection methods used and how many times it was conducted.

Summary of data collection methods used	
Workshop	1
Trainings	2
Project meetings with stakeholders outside HISP	2
Interview	1
Questionnaire (number of respondents)	27

Table 3.1: The table presentss a summary of the different data collection methods used. The number on the right indicates how many times each if the activities have been conducted

3.3 Scope and Limitations

This research was conducted during my in India, from 27th of February to 24th of April. Besides two days in Delhi, I spent rest of the time in Shimla. I took part in the development and implementation of a mobile application that are used by teachers to report suspected cases of RHD. 5 government schools in the state capital Shimla, Himachal Pradesh, in India are participating in the pilot project. The project started in January. 1st of May the pilot project was launched in the participating schools. The project is planned to run for one year. I left India before the pilot period started which means that only the implementation and developing processes has been taken into consideration for this research.

The RF/RHD project is the only project which is included in this research. Due time limitation, I have not focused on the technical part of the devel-

opment. I have also not evaluated any outcomes of the project since this information has not been available yet.

3.4 My role

I did not know until a couple of days after I had arrived in Shimla that I would work on the RF/RHD project. Before I left, me and my supervisor had discussed a potential task, but for this project, it has been difficult to foresee how things would turn out. When I joined the project, they were in the middle of discussing a use case document. I was asked if I could help out with the development, and I said yes. However, the developer who was in charge told me that due time limit, it was best that he did it alone. Since I was familiarized with the system, it would have required some help from him. If I had known that I was supposed to work on this project at an earlier stage, I could have done more preparations and thus contributed more on the development part.

My work was thus mostly on the implementation part of the project, where I worked together with the chief implementer and an intern. The chief implementer was often busy with other projects, thus she allocated tasks to me and the intern. The tasks consisted of preparations and conduction of different meetings, workshops and trainings, documentation of such events, and testing. Participating in discussions was also an important part of my role. It seemed that too little attention was paid towards the users, so I tried to take some responsibility towards that aspect of the project. The other implementers had very few comments on how the application should be developed even towards the usability aspect of it. I tried to highlight some of the drawbacks the solution that had been chosen would bring upon the users. I suggested a solution that would improve these drawbacks. The developer agreed with me, but it was not enough time to implement such a solution at that time. The application would have not been finished by the time of the project start.

Having a technical background proved to be valuable also during the implementation process. The chief implementer and the intern had some times difficulties to understand how the technical part of the process worked, which is quite understandable. However, I was able to explain it to them which prevented confusions and misunderstandings. When it is the implementers who is responsible for the contact between HISP and the users, it is important that they understand how the process works and are able to answer

any questions. Even though I was not able to help out on the coding part, I hope that my contributions was still valuable. However, looking back, I could have contributed more if only the circumstances had been clearer at an earlier stage.

3.5 Reflections

Klein and Myers have developed a set of principles for conducting and evaluating interpretive field research [68]. The principles are meant to help researchers to identify where choices that has been made, could have affect the project. A summary and description of all the principles are found in the appendix A.1. The principles are an outcome of the question of how quality can be assessed. It is derived from the fields of anthropology, phenomenology and hermeneutics.

1. The Fundamental Principle of the Hermeneutic Circle

> *This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.*

When I left Norway, I had only a vague notion of what my task would be. When I arrived in Delhi, I was asked if I could help them solve some challenges that they were facing. In Shimla, I was asked to do something else. It has taken some time to fully understand the context of this project. By interacting with the other project members, observing and take part in discussions, the context, system and its challenges has gradually become clearer. Coming form another country, have also imposed challenges towards understanding the cultural differences, norms and my place in the organization. By participating in meetings, asking questions, and interact with the users, have given me a clearer understanding towards these aspects. Without understanding these parts, the context, system, cultural differences, I could not have understood the whole they form.

3. The Principle of Interaction Between the Researchers and the Subjects

> *Requires critical reflection on how the research materials (or "data") were socially constructed through interaction between the researchers and participants)*

The main weakness concerning material gained trough interactions is the language spoken. Neither I nor the others I interacted with spoke our mother tongues when we communicate. This led to communication problems. Trainings, the workshop, meetings with different stakeholders have all, at different degrees, been spoken in Hindi. Especially the trainings and the workshop were mostly done in Hindi. I asked the chief implementer and the intern afterwards these activities, if they could tell me the essence of what have been discussed, and what questions that had been raised. This means that I can only interpret the situation based on the sum of others' interpretations. This increases the chance of misinterpretation and introduces an extra level of bias.

My appearance as a foreigner has likely affected how others have interacted with me. I am not only a foreigner within the organization, but my appearance immediately reveals my rather non-local origins. In the beginning, I often got questions from various people asking who I was and my role in HISP. The most common assumption was that I was a new intern, which is not very far fetched. I did know some of them from my last visit, which hopefully made my present less intruding. However, it did take some time before we were comfortable with each other within the project. At the trainings and the workshop I was referred to as *baahari* - "the foreigner".

There are reason to believe that the people I interacted with had made their own assumptions about me and my role, which can have influenced our interaction. During the trainings and the interview I deliberately wear Indian clothes to appear less of a stranger. The response I got was positive. Nevertheless, information given to me could still have been adjusted according to their presumptions about me, either deliberately or unknowingly.

6. The Principle of Multiple Interpretations

> Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study, similar to multiple witness accounts even if all tell it as the saw it.

Different data collection methods have been used which decrease the chance of misinterpretation [69]. If data collected using different methods indicating the same results (triangulation) it is likely that the right interpretations have been made. However, with only one interview and workshops and trainings with "missing" discussions, the amount of data gathered from different sources that indicates the same results could have been stronger. E.g. by having more interviews where the same questions were asked, the triangula-

tion effect could have been enhanced. However, the aim of this research is not to generalize.

Chapter 4

Case Background

In this chapter I will try to give some background information about India, the Indian healthcare service and the Indian school system. I will also give an introduction to the Health Information Systems Programme and the software they have developed. The software has been used in the development of this system.

4.1 India

The republic of India is situated in South Asia with borders to Pakistan in the west, Nepal, China and Bhutan in the north and Bangladesh, China and Myanmar in the east. Close to the southern point is Sri Lanka. The capital is New Delhi, which is situated north in the country. India is divided into 28 different states each ruled by a governor appointed for a 5-year term by the federal president. The states have primary control over education, health, police, and local government. There are also seven Indian union territories, one of them is Delhi, which are sub-national administrative divisions ruled directly by the federal government [70] [71].

India is well known for its population which is over 1.2 billions (2012) making it the second most populated country in the world. The population comprises a number of different ethnic groups, languages and religions making it a divers and colourful country. Hindu (80%) is the most common religion followed by Islam (14%). Official languages are English and Hindi (40%), but over thousands of different languages and dialects are used. Many of these languages are so different from each other that Indians have trouble to

understand each other.

The climate varies from tropical monsoon in south to temperate in north. The terrain is everything from flat rolling plains along the Ganges, to deserts in west and the Himalayan mountains in the north. Thus India resembles more of a continent than a country. This also brings different challenges when it comes to the healthcare. Tropical areas face different types of diseases (dengue fever, parasites, infections, dangerous animals) then the hilly areas, and there are often huge differences from state to state. Some states have a high amount of educated persons others struggles with illiteracy. Some states are also more corrupt than others which creates another type of problems.

From the late 1990ies India have had an astonishing rapidly economic growth, partially due an upsurge in the Information Technology (IT) industry but also strong growth in the production industry. Liberal economic politics and increased foreign investments have also played important roles. Outsourcing of ICT services and software is a huge exportable. Thus, it is likely that India will remain a major player in the IT industry for years to come.

However, the economic growth have mainly been driven by the internal market which have led to a steadily growing middle class. The internal growth potential is enormous, but for the country's poorest more problems have arisen: Subsidises and funding have been reduced and food prices increased. Figure 4.1 illustrates India's GDP from January 1985 to April 2013.

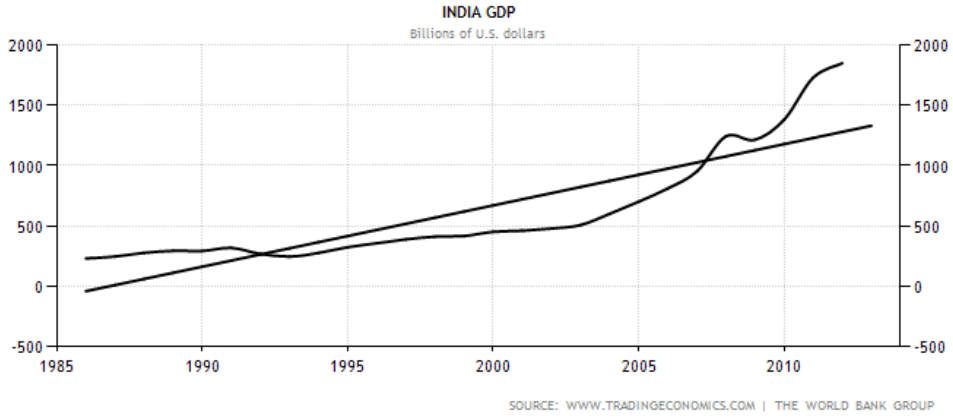

Figure 4.1: India's GDP from January 1985 to April 2013 showed in billion US Dollars. The straight line indicates the trend.

4.1.1 Health care service

The healthcare service in India is quite different from Norway. To understand the requirements for a HIS it is important to have an understanding of how the healthcare system works. The healthcare service is organized as a tree-structure with The ministry of Health and Family Welfare at the top. The ministry of Health and Family Welfare is further divided into - Department of Health and Family Welfare, Department of Ayush, Department of Health Research and Department of AIDS Control. Each state has its own department which is controlled by the Ministry. The department of Health and Family Welfare is responsible for awareness campaigns, immunization campaigns, preventive medicine, and public health.

The healthcare service is further divided into states, districts and blocks. A state consists of many districts where districts have many blocks. The service provided is divided into three levels: primary, secondary and tertiary. Sub Centre (SC) and Primary Health Centre (PHC) are the most fundamental facilities providing healthcare in the rural areas. Thus they are providing at the primary level. Private hospitals and healthcare facilities are also common. They are organized, however, independent from the public system. Figure 4.2 illustrates the healthcare hierarchy.

Sub-Centre

The Sub-centre is the first contact point with the primary healthcare system in a community. It provide services such as immunization, antenatal/postnatal care, treatment of common childhood diseases, family planning services and counselling. In addition, the centre also provides drugs for minor ailments such as diarrhoea, fever, worm infestation etc. The centre should be staffed by one female healthcare worker, commonly known as Auxiliary Nurse Midwife (ANM) and one male healthcare worker, commonly known as Multi Purpose Worker. In addition the centre will have an Accredited Social Health Activist (ASHA) per each 1000 capita, which will serve as a link between a village and a SC. The SC facilities are small and primitive as it is seen from figure 4.3. Thus their main task will be promotive actions. A lot of their work is done "out in the field" by visiting households instead of receiving patients. For the maternal healthcare programme the ASHA will know if any of the women in her village is pregnant and report to the ANM. The ASHA will also notify the ANM if someone needs to be checked upon. Thus she is the eyes and ears for the ANM. In this way they are able to

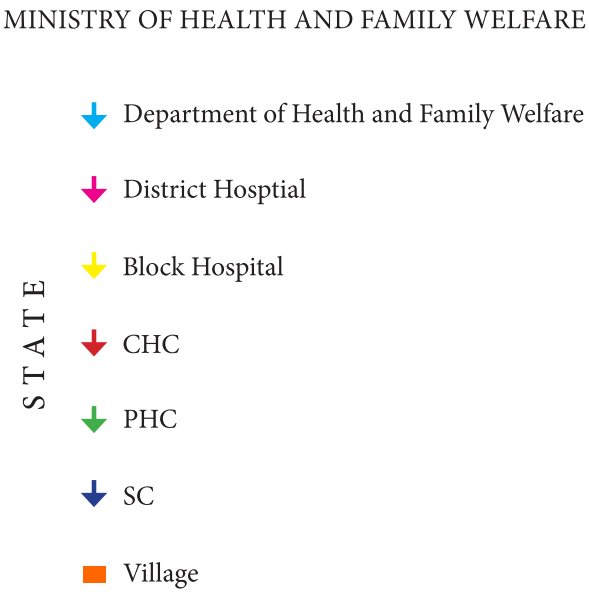

Figure 4.2: Illustration of the healthcare hierarchy with the state department on top.

attend more people.

Figure 4.3: A sub centre in Shimla, Himachal Pradesh

Primary Health Centre

Primary Health Centre (PHC) is the next higher level after SC. With 4-6 beds the facility works as a referral unit for around 6 SCs. A qualified medical doctor will be available. The medical doctor can also refer cases to higher level facilities if needed. The PHC is open 24 hours for emergencies. The centre has also a small medication stock, containing only the most necessary drugs. The staff will be around 15-18 including a Medical Officer, Pharmacist, Nurse-midwife, Laboratory Technician and different healthcare workers. Their main task will be preventive actions. Figure 4.4 shows a PHC in Himachal Pradesh.

Community Health Centre

The Community Health Centre (CHC) is also administrated by the National Rural Health Mission, as are PHCs and SCs. The CHC serve at the sec-

Figure 4.4: A primary health centre in Shimla, Himachal Pradesh

ondary healthcare level, with around 30 beds covering an area of 80.000-120.000 people. The main tasks are preventive actions. The CHC work as both a treatment centre and a referral unit to district hospitals. The CHC have different specialist in the fields of anaesthesia, public health, surgery, medicine, obstetrics, gynaecology and paediatrics.

Sub-District/Sub-Divisional Hospitals

A district might be divided into two or three sub-districts. In total there are 1200 sub-district hospitals in India. The amount of beds in these hospitals range from 31 to 100 beds. There are approximately one sub-district hospital per 500.000-600.000 capita. It work as a referral unit for block level hospitals like CHCs. It has an important role in providing emergency obstetrics care and neonatal care. It further acts as a link between SC, PHC, CHC and the districts.

District hospitals

A state consists of different districts where each district have one or maybe two district hospitals. The amount of beds will range from 75 to 500 depending on size, terrain and population of the district. In addition to provide normal hospital services, the district hospitals are also responsible for handle epidemic and disaster management. It should also facilitate training of healthcare workers at different levels.

Figure 4.5 summarize the different health facilities, and gives an estimation of the number of beds, healthcare workers and patients at each facility.

Health Programmes

The practice where everyone is assigned a general practitioner, as we are familiar with, is not applicable for the Indian health service. In addition, the healthcare facilities are characterized as much more primitive then what we are used to. This means that equipment like computers are not found at the primary level, which results in other types of challenges when it comes to recording of medical data. Another difference which is also important to be aware of is the lack of social security number. See 4.1.2 for more information. This create extreme challenges when it comes to follow ups and involvement of different healthcare facilities.

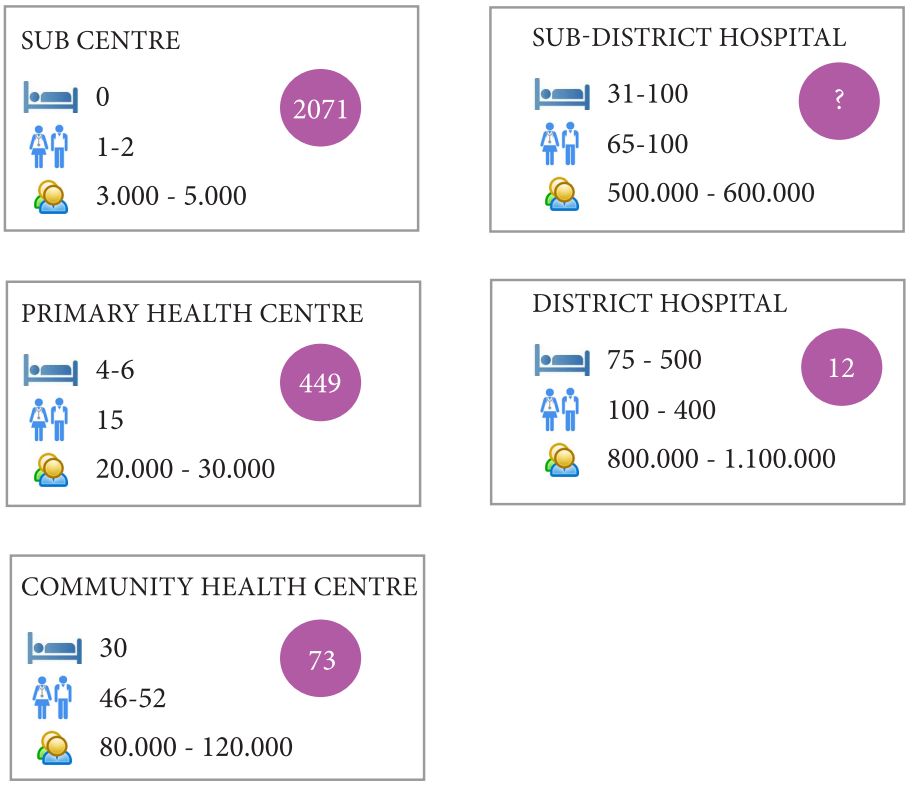

Figure 4.5: Shows number of beds, staff and coverage at the different health-care facility levels. The number in the circle is the amount of the respected facilities in HP [72].

Another aspect in the Indian healthcare service which separates it from the Norwegian is the use of different healthcare programmes. There are programmes for school children, cancer, cardiovascular diseases, maternal healthcare, leprosy and many others. These programmes have been initiated because the healthcare service in general is not good enough to tackle all the healthcare challenges the country is facing. Diseases that are particularly prevalent, takes many lives, or where preventive measures can save many lives, a health programme designated for one or more of these challenges can be initiated. Health programmes are often found in developing countries. For some programmes own facilities have been built and new positions have been initiated.

All health facilities and programmes need to contain patient registers, keep track of treatment, write referrals, capture treatment outcome and so on. This is mostly done on paper and reported to a higher level on a monthly basis. At the top level the information is analysed and used to develop strategies and evaluate the health status in the state/country. However, the healthcare workers are usually overworked which results in poor quality of the captured data. Papers are also disappearing which leads to incomplete records. All in all the healthcare service face huge challenges.

National Rural Health Mission

The national rural health mission (NRHM) is a health programme initiated to improve healthcare delivery in rural areas. Thus the programme has a special focus for 18 states (including HP). A number of new mechanism for healthcare delivery has been proposed, including training local residents as Accredited Social Health Activist (ASHA)s, as mentioned above. The mission also aims to improve hygiene and sanitation infrastructure, improve monitoring and planning. Some of the state goals are [73]:

- Reduce Maternal Mortality Ratio to <100 per 100.000 live births
- Reduce Infant (less then 1 year) Mortality Ratio to <27 per 1000 live births
- Reduce Neonatal Mortality Rate to <18 per 1000 live births (death during the first 28 days)
- Reduction in Annual Malaria incidence to <1/1000 population
- Elimination of Leprosy in all districts

A mother and child tracking system has been launched in 2011 to reach out and ensure proper care for women and children during and after pregnancy. Information is collected to track the mother and child by name, address and telephone. The mother and healthcare workers can report through SMS and receive alerts for follow ups. The mother can also request any data they have captured on her or the child to see which services she has received and not. Call centres have also been established to provide any support regarding data capturing. As far as I can see, the project seems to be succeeding. The aim is to cover the whole country from public to private healthcare facilities [74].

During the mission the health funding has increased. Noted economists Ajay Mahal and Bibek Debroy have called it "the most ambitious rural health initiative ever" [75]. However, there have been some large corruption scandals which lead to the murder of two apex health officials [76].

4.1.2 Unique Identification Authority of India

The Unique Identification Authority of India (UIDAI)) is working on providing every resident a unique 12 digit number [77]. It will primarily be used as the basis for efficient delivery of welfare services, but also for effective monitoring of various programs and schemes. The project started in 2006 when the first UID concept was discussed. The first number would be issued between August 2010 and February 2011, and for April 2013 the total number is 319.299.591. Over five years, the Authority plans to issue 600 million UIDs. The numbers will be issued through various 'registrar' agencies across the country. The UID number shall be verified and authenticate in an online cost-effective manner.

Aadhaar is the brand name of the UID, and means foundation or support. The ID number is linked to the resident's demographic and biometric information, which will be used to identify a person anywhere in India. This will also grant access to different benefits and services. The biometric data which is captured are: fingerprints, scan of iris, and camera (which will be used for face detection). This means that the youngest children must re-register at an age of 5. Before turning 5, their UID will be based on demographic information and facial photography linked to their parent's UID. The biometrics will be updated again when they turn 15. As it can be understood, the process of providing a country with over 1.2 billion residents with UIDs by capture these biometric data will be a long and complicated process. Security is also extremely complicated.

Particulars	Required	In position
Sub-Centre	1128	2071
Primary Health Centre	186	449
Community Health Centre	46	73
Multipurpose Worker/ANM	2520	2496
Doctor at PHCs	449	407
Nurse/Midwife	960	1062

Table 4.1: The figure indicates the status of the healthcare service for HP in 2008 [72].

To get an Aadhaar one has to visit any authorized Aadhaar enrolment centre anywhere in India with some kind of identity and address proof. There is a list of different documents which are approved. It is also enough for family members to use the family head identification papers. After providing the necessary documents, a form must be filled before the biometric scans are captured. An acknowledgement slip with temporary enrolment number and other details captured during enrolment is given. The enrolment number can be used to check the status on the application. When this stage is done, the data given will go through different security checks. This process will take 60-90 days or longer.

4.1.3 Himachal Pradesh

Himachal Pradesh (HP) is situated on the north-western footsteps of the Himalayan mountain range. See figure 4.6 for map. With elevation ranging from around 350 to over 6.800 meters above sea level results in a diverse climate: Hot dry areas in the south to cold alpine and glacial climate in the north. Snowfall is seen on 2200 meters an above from around November to March. The state is divided into 12 different districts where Shimla is the state capital. The total population is 6.8 million. The economy of Himachal Pradesh is based mainly on agriculture and food processing [78], but the landscape and weather conditions makes it challenging. Hindi is the official language [79].

When it comes to the healthcare situation in HP it is considered to be one of the better in India. This can be seen from the table 4.1. For all of the three healthcare facilities, SC, PHC and CHC, HP has over the required number. That is also the case for nurses and midwives.

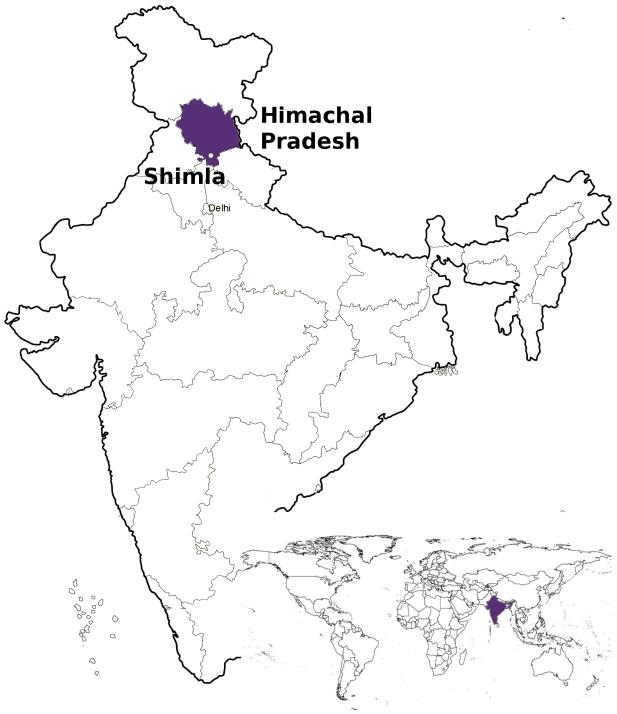

Figure 4.6: From the map you can see Delhi furthest south, Himachal Pradesh (violet), Shimla (the white dot) and India in a worldwide perspective.

For the unique identification project - Aadhaar, figure 4.7 illustrates the coverage for HP. They have achieved almost 80 % coverage, and some have estimated that a coverage of 95 % will be reached within the end of 2013. The male/female ratio is also fairly uniform. For 2012-2013, it has been decided that the scholarship for school students will be transferred through Aadhaar based direct cash transfer scheme. So every student has to apply with their Aadhaar number to receive scholarship. This is a good initiative to get more people interested in getting Aadhaar. If one person in the household must get Aadhaar, it is likely to believe that the rest of the household will come along.

4.1.4 Shimla

Shimla, formerly known as Simla, is the state capital of Himachal Pradesh. Shimla is situated south west in HP and lies 2200 meters above sea level. The populations is above 800.000 which makes it a small city compared to the rest of India. In 1864 it became the summer capital by the British Raj. Every summer they moved the administration up to Shimla to escape the burning heat in the low-lands until the independence in 1947. Then Shimla became the capital of the neighbouring state, Punjab. Later it became the capital of HP. The literacy level in Shimla is on average 84.55 but seen gender wise - male and female - 90.73 and 77.80 respectively. Over 75 % of the population lives in rural areas [80].

4.1.5 The school system

The school system in India use a 10 + 2 model [81]. The children starts when they are 6. The first ten years is divided into four levels: lower primary (1-4), upper primary (5-6), high (7-10) and higher secondary (1 and 2). Students have to learn a common curriculum (except for regional changes in mother tongue) till the end of high school. Some specialization can be done at the higher secondary level. This is quite similar to the Norwegian education system. From 3-5 years of age, children can go to nursery, lower kindergarten and upper kindergarten. At this stage student is given knowledge about school life and is taught to read and write some basic words.

The school education policies and programs are suggested at the national level by the Government of India. However, the state have a lot of freedom in implementing the programs. Policies are announced at the national level

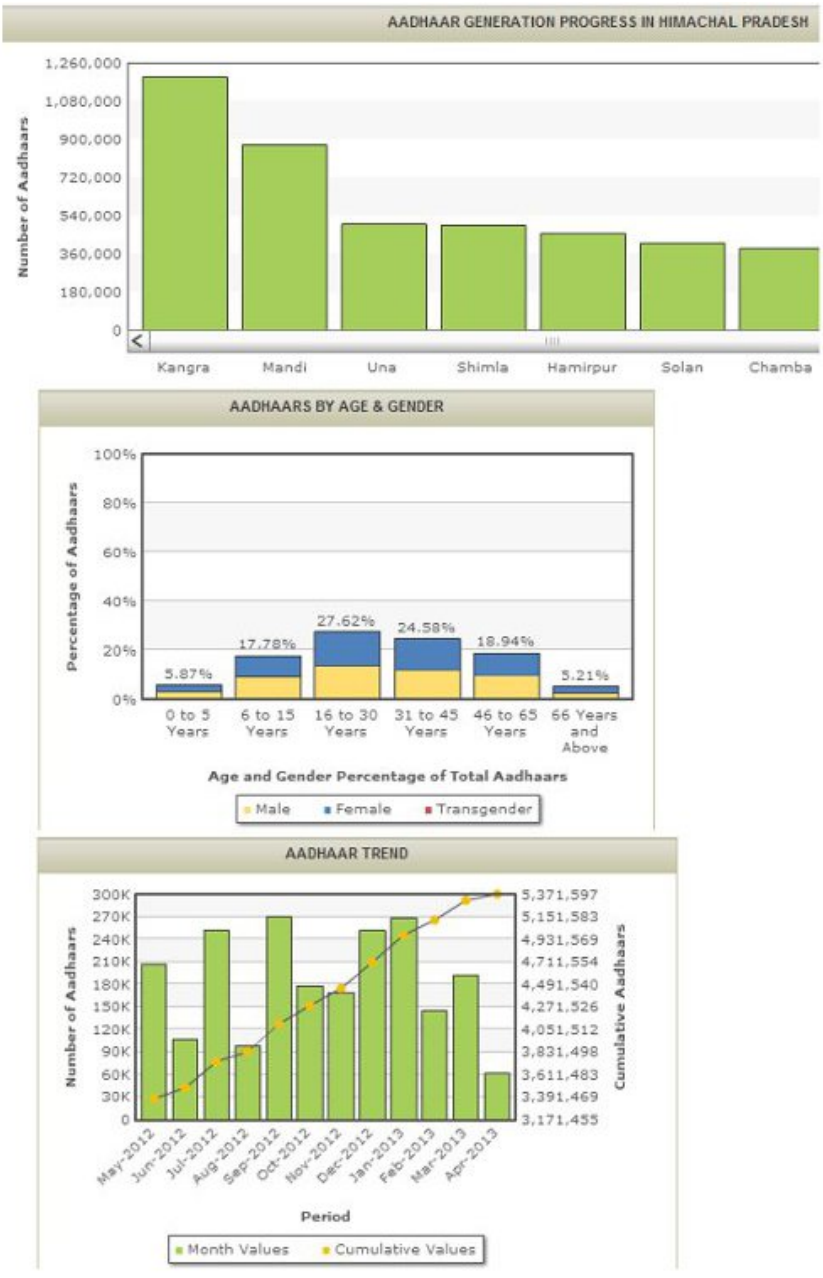

Figure 4.7: The figure illustrates the Aadhaar progress for HP [1].

periodically. There are mainly three streams in school education in India - Central Board of Secondary Education, Indian certificate of secondary education and state schools. The first two are coordinated at the national level.

According to the Constitution of India, elementary education is a fundamental right of children in the age group of 6-14 years. However, the school system is facing problems regarding students who does not fulfil their education. At least half of all students from rural area drop out before completing school. The government has rolled out many plans to increase the percentage of elementary education: 'Sarva Siksha Abhiyan (focus on girls' education), District Primary Education Program (increase number of facilities), Operation Blackboard (resources like black boards), and Mid Day Meal (free lunch).

National Service Scheme (NSS) - is a central sponsored scheme which was introduced at different universities from 1969. The aim was to *arouse the social consciousness of the students and to provide them with opportunity to work with people in the villages and slums, and to expose them to the realities of life*. Now the programme is also found for students at the 10+2 grade. The NSS is lead by a programme officer at each school which have the responsibility to conduct the scheme. This implies organising, education, co-coordinating, supervising and administrating the scheme. A Programme Coordinator has the responsibility of guiding the programme officer and volunteers in planning NSS activities. The programme coordinator will execute all administrative and policy directives of the Government and the State Government.

School health programme

The school health programme is under the NRHM, and focuses on effective integration of health concerns through decentralized management at district [82]. Sanitation, hygiene, nutrition, safe drinking water, gender and social concern are some of the health aspects in the programme. The programme covers both government and private schools. It is the only public sector programme with directly focus on school children. Its main focus is to address the health needs of children, both physical and mental, and in addition, provide nutrition interventions, yoga facilities and counselling.

There have been made a national guidance for states who have or is planning to implement the programme. Since the states can customize the programme

relatively freely, many different types of school programmes is seen. The main areas are: Anaemia, malnutrition, immunisation, de-worming, distribution of Iron-Folate tablets, visual acuity, hearing problems, dental check up, common skin conditions, heart defects, physical disabilities, learning disorders, behaviour problems, counselling services and mid day meals.

4.2 Health Information Systems Programme

HISP, the Health Information Systems Program was initiated in South Africa in 1994/1995 by researchers from local and Norwegian universities [83]. The aim of the system was to support post-apartheid decentralised health structures.

During the apartheid there was great inequity between "blacks" and "whites". The segregation was also seen in the residential areas - sometimes black people were even forced to move (like district six in cape town). This inequity also affected the healthcare service. White people got good medical care, and black people lived in poor conditions, was more exposed to diseases and received poor medical care. Thus, after the apartheid the need for equity was pressing. To establish equity one needs to ensure that the right measures are taken. To be able to do that, information is needed. For the healthcare service this meant standardized national health data and HISP (Health Information Systems Program). Standardized national health data provides a solid foundation for further improvement of the healthcare service by illustrating the current situation. However, it does not guarantee any actions.

HISP started development of the District Health Information System (DHIS) using a bottom-up design approach with focus on high end user control and establishment of local empowerment. In 1999/2000 it became the national standard in South Africa and was enrolled out to all district and provinces. Since the initiation it expanded from the pilot projects in Cape Town to a global South-South-North network active in over 30 countries [84]. The network consist of universities, health authorities and NGOs from different countries [83]. NORAD provide the core support and development is coordinated by the University of Oslo.

HISP's aim became to improve healthcare systems in developing countries. Their vision is:

"Development and implementation of sustainable and integrated

health information systems that empower communities, healthcare workers and decision makers to improve the coverage, quality and efficiency of health services."

4.2.1 Modules

HISP has developed two systems called DHIS and DHIS2. The latter one being an upgrade from the first. The systems are tools *for collection, validation, analysis, and presentation of aggregate statistical data, tailored (but not limited) to integrated health information management activities* [85]. The aim is to provide information like vaccination coverage, amount of HIV/AIDS patients under treatment, or disease outbreaks, to be able to do necessary preventions or allocate resources more efficiently.

District Health Information System

DHIS was developed in compliance with the HISP start up in South Africa. It is based on Microsoft technology, Microsoft Access. Microsoft Access was the first mass-market database program for Windows and came with the office suite. Before the 2010 version it only worked on windows computers limiting HISP not to benefit from free OS as Linux. Further DHIS used Excel and Visual Basic for user interaction. The problem with this system was that even though the technology being used was open source, to run it required MS Windows and MS Office which cost money [86]. To succeed with implementation of systems in developing countries where resources are limited and money short, start up and usage costs needs to be at a minimum. This together with the appearance of new and more powerful open source framework, was the main motivation behind porting the whole application to Java, becoming DHIS2.

DHIS2

The implementation of DHIS2 started in 2004, and the first version was released in 2008. It uses free open source Java frameworks like Spring, Hibernate, Maven and JUnit. It is a stand alone modular web-based software package which is database and operating system independent. This gives great implementation flexibility and opens for possibilities to, for example

use the Raspberry Pi as a computer (costs around 250 NOK). The user interface is also flexible considering that no programming is needed to design content. DHIS2 consist mainly of two modules, one for aggregation data and one for patient data. See `http://dhis2.org/demo/` for a demonstration.

Aggregation module

DHIS2 is mainly a tool for presentation and collection of aggregated data. The aggregated data are numeric representations of different diseases like number of incidence of tuberculosis, malaria or HIV/AIDS, number of births, and number of deaths and so on. The data is generated from daily routines where specific forms are requested to be filled out from the government. The data is used to evaluate health information systems, derive strategies for improvement and more efficient resource allocation. The performance of the health system can in this way be measured. The aggregation module generates excel sheets containing the aggregated data which are sent as reports to district or national level. The reports are either paper forms or electronic forms. Diagrams, maps and different presentation of the data is also functionality provided. The aggregation module is the most used, and thus best supported and tested.

Patient system module

When a woman is pregnant she is offered at least three antenatal care (ANC) visits. An aggregated report will show for example a case of 50 pregnant women where 20 women received three ANC visits, 10 women received none ANC visits, and 3 deaths. From this data it is not possible to ascertain that one of the women that died, delivered at home or how many ANC visits she got. To evaluate the quality of the service provided and where measures need to be taken, patient specific data is needed. This means that information of each person must be maintained as an individual case. The patient system, or further addressed as the tracker module (or tracker system), is developed to support this type of functionality. It uses many of the aggregation module's functionality and thus servers as an expansion of DHIS2. However, the tracker module is newer and less used. Still, many issues are experienced.

For this study I have only focused on the tracker part of DHIS2. The tracker system has mainly converted existing paper forms, used in different health

programmes, to electronic forms with some additional features. The following points are the main features provided in the tracker system for health programmes:

- **Administrating meta data** - person attributes, person attribute groups, identifier types, health programmes, validation etc.
- **Person registration** - register new person, update person data, set relationship, enrol person into programme
- **Data entry** - record individual treatment data
- **Reports** - individual and linking tracker system with aggregation system
- **Activity plans** - automatic generated time schedules given to healthcare workers showing who to follow up when

The tracker process starts with patient registration where personal details are entered. A check is done to see if the person is already registered. This functionality is, however, not very useful since persons are not registered with social security numbers. The information which is recorded does not guarantee uniqueness: name, birth date (which can be accurate or approximated), contact number (not required) and can thus not be used to check for duplicates. Contact number is unique in it self but is not treated as unique (in the system) and can thus not be used to check for duplicates. Programmes which affects young children will probably use one of the parent's number. Then a sister or brother can also be registered with the same number. For programmes which only includes adult, contact number could be used to check for duplicates.

After a person is registered he/she can be enrolled into a programme. A programme contains one or more stages where in each of the stages data is entered. The data depends on which programme you are enrolled in, as does the frequency. Usually it is done on a monthly basis. Some programmes also provides activity plans with details of the coming patient visits. The plans are automatic generated and helps the healthcare workers with administration and providing care. Reports are generated from the entered data and sent to higher level for evaluation. Figure 4.8 shows a typical tracker process.

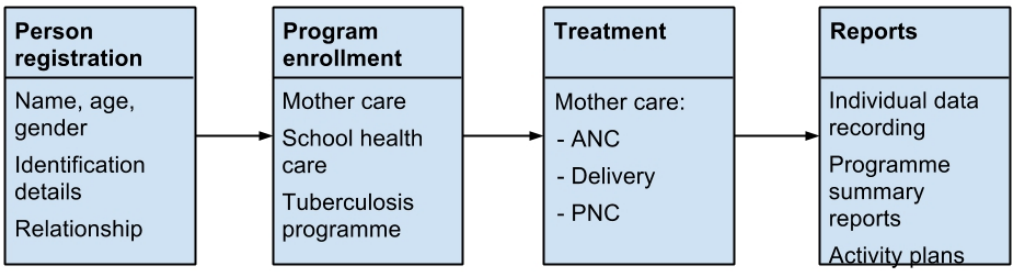

Figure 4.8: The figure illustrates a typical tracker process.

Mobile application

The most recently part in DHIS2 is mobile applications for registering data. There is a lot of optimism around this technology; Mobile phones are much more common than computers, and Indians often have more than one. They are easy to carry around, cheap and they are not dependent on internet connection to be able to communicate. Still, it has its limitation, especially when it comes to usability.

Currently there are three main mobile solutions for DHIS2: data entry through a browser, a Java 2 Micro Edition application with GPRS/3G and a Java 2 Micro Edition application with SMS. A smart phone customized version for the website have also been developed but does currently not support the tracker module.

In many of the programmes where mobile applications are used the state have supported healthcare workers with phones and sim cards. This is an important motivation factor to make sure the healthcare workers use the application.

Programmes

The first time I went to India to work with HISP I looked at 8 different programmes implemented in the Tracker. They are: Revised National Tuberculosis Control Programme, School Health Programme, National Leprosy Eradication Programme, Nutritional Rehabilitation Centre programme, Mother care programme, Cardiovascular Disease programme, Acute Coronary Syndrome programme and Cancer Control Programme. These programmes have been implemented in different states, where some of them in HP. It also varies how far they have been used.

For the cancer programme, healthcare workers and medical students visits every household in the state of Punjab where they capturing patient specific data of persons in the household who have had cancer or shows symptoms of it. The tracker module has been used in this programme. However, it was never tested before the programme was implemented, so they are now experiencing a lot of trouble with the reporting. The problems are duplication of patients, inconsistent reports and problems with the generating reports.

Chapter 5

Case

In this chapter I will describe the objectives of the project and how it has been conducted. A detailed description of the process flow is given together with the system development method used. Different activities as meetings, trainings and so on will be explained in detail. This chapter will give a clear understanding of how the project has evolved.

5.1 School health programme in Himachal Pradesh

The health department in Himachal Pradesh wishes to enhance collaboration between schools, the health department and hospitals/health facilities. Currently the situation can best be described as "Silo" structured. The health department is one silo, a hospital another and a school the third. Each of the silos are organized in their own way with different communication protocols, interests and agendas. However, even though they are different they share problems. If a student get sick it does not only affect the hospital, but also the school. Thus, they should be able to work together. The way they are organized now hampers the collaboration. By tearing down the silo boundaries enhanced cooperation can hopefully be achieved. Thus a school health programme has been initiated with these intentions (2011 for Himachal Pradesh).

The school health programme consists of a yearly "full body" screening and monthly delivery of iron tablets. The screening is organized by the state programme officer at the ministry of Health and Family Welfare. Medical camps are set up close to or in different schools where the children will be

checked for different diseases common among school children (anaemia, malnutrition, de-worming cure, visual acuity, hearing problems, dental check up, different skin conditions, heart defects, physical disabilities, learning disorders, and behaviour problems). Theoretically, the team consists of a female and a male doctor, nurse, dentist, psychologist, and pharmacist. Everyone is not always attending, especially the female doctor. Thus, examination of girls can be problematic.

The teachers are not responsible for capturing any data. The same goes for the iron tablets they are distributing. It is only the medical team who will write reports from the camp.

To improve the school health programme, increased frequency of screenings is a good initiative. However, the medical camps are an expensive affair, thus involving teachers might be a more feasible solution. With some training, the teachers can be very valuable in detecting symptoms; They are spending a lot of time with the student on a daily basis so changes in behaviour, appearance and learning capabilities will be easier for them to detect than a 2 minutes session with a doctor. The teachers can also inform about malnutrition, hygiene or other relevant information which can serve as preventive measures. If expanding the school health programme to give teachers more responsibilities, they should also report the cases they are discovering. Both for the child's insurance, but also to be able to evaluate the process and document the students health.

To ensure that the reporting is done efficiently, the use of mobile phones have been suggested. Thus, a trial project where teachers report suspected cases of rheumatic heart diseases through mobile phones have been initiated.

HISP has been involved to provide such a mobile application. It is important that the solution that is made easily can be adopted to different diseases. However, it is important to keep in mind that if to succeed it does not matter how good the application is, if the teachers are not motivated to use it. Thus the plan is to start with 5 schools and one disease (rheumatic heart disease). After an evaluation more schools can be included. If it turn out to be a success, then it can even be introduced in other states as well.

5.2 Children with Rheumatic Heart Disease or Rheumatic Fever

Rheumatic fever is an inflammatory disease that develops 2-3 weeks after inadequately treatment of group A streptococcus. The rheumatic fever is most common for children between 5 and 15, but it can also affect adults and younger children. The symptoms are sore throat and fever. If not treated it can lead to Rheumatic Heart Disease (RHD) which is one of the most dreaded complications after rheumatic fever. This can happen even up to 5/6 months after signs of RF is seen. The symptoms for RHD are *joint pain*, *breathlessness* and *abnormal movements*. RHD can cause permanent heart damage including heart failure and damaged valves. Treatment can reduce tissue damage from inflammation, lessen the pain and prevent the recurrence of the fever, but it is a complicated and expensive procedure.

Screening schoolchildren is seen as an effective preventive initiative. By providing teachers with reporting tools, training in detection of the symptoms, and information about the disease, they can help indirectly with diagnosing and treatment. This will help build and strengthen institutions in detection and treatment of the disease. Considering that the treatment is very costly and the condition is very server, even life threatening, it can save a lot of resources and lives. To make this programme feasible, it will initially be complained based.

The role of HISP is to provide teachers with a simple mobile application they can use for reporting suspicious cases. The application is a jar-file which can run on every phone that have Java installed and is bluetooth enabled. Thus cheap phones can be used. The reports will be sent as text messages which is a cheaper alternative to internet based communication. The expenses will be covered by the department of health and family welfare.

Figure 5.1 shows the process flow of the programme. First the child or parent of the child, will complain to the teacher of having any of the three symptoms: joint pain, breathlessness and abnormal movements. If the teacher is convinced that the child have any one of the three symptoms, he/she will register the student in the application. Next, the parents will be notified via a text message sent from DHIS2 to take the child to a heart specialist in Shimla, Indira Gandhi Medical College Hospital (IGMC).

The teacher will get notified by a text message when he/she needs to follow up the child to see if the child have been to the hospital or not. If the child have received treatment at the hospital the teacher will capture the outcome.

If not, the teacher needs to tell the student once more to go to the hospital, and a reminder text message is sent to the parents (through DHIS2). After 2 weeks the teacher needs to repeat the procedure. If the student still have not sought help then the procedure is repeated only once more.

If the child complains about sore throat and fever which might have lasted for around 2 weeks (the teacher can also check for tonsillitis), the parents will be notified to take the child to any doctor. Then after 2 weeks, 4 weeks and 4-6 months the teacher will ask the child if he/she has any of the three symptoms (breathlessness, joint pain and abnormal movements of arms). This is the period where the child can develop RHD. If the child experience any of the three symptoms during these three follow ups, the student will be asked to seek help at the IGMC and the same procedures as mentioned above will follow.

5.2.1 Roles

There have been different roles and persons who have contributed in the development and implementation of the RF/RHD programme. For the HISP-team, all of the contributors were situated in the Shimla office. This has made collaboration and discussions more efficient and easy to organize. The office has two floors, where the implementers and developers were seated on one floor, and the project leader on the second. For participants outside HISP it has been the head of the department of cardiology who was behind the initiative and state programme officer in HP.

The HISP-team:

- **Project Leader** - even though the term project leader have never officially been used during this project, based on the task this person have been responsible for, I have nevertheless chosen to address this person with it. The tasks this person has been responsible for is to have the overall responsibility for the project, responsibility allocation within the team, deciding deadlines, attend meetings, and communication with the stakeholders outside the company. The problem with doing this, is that the project leader title suggests more responsibility attached to it than the person actually had.
- **Developer** - there have been two developers working on this project, where one of them have had the main responsibility for the development. The other have contributed some on the server side, and when the other developer was in Delhi.

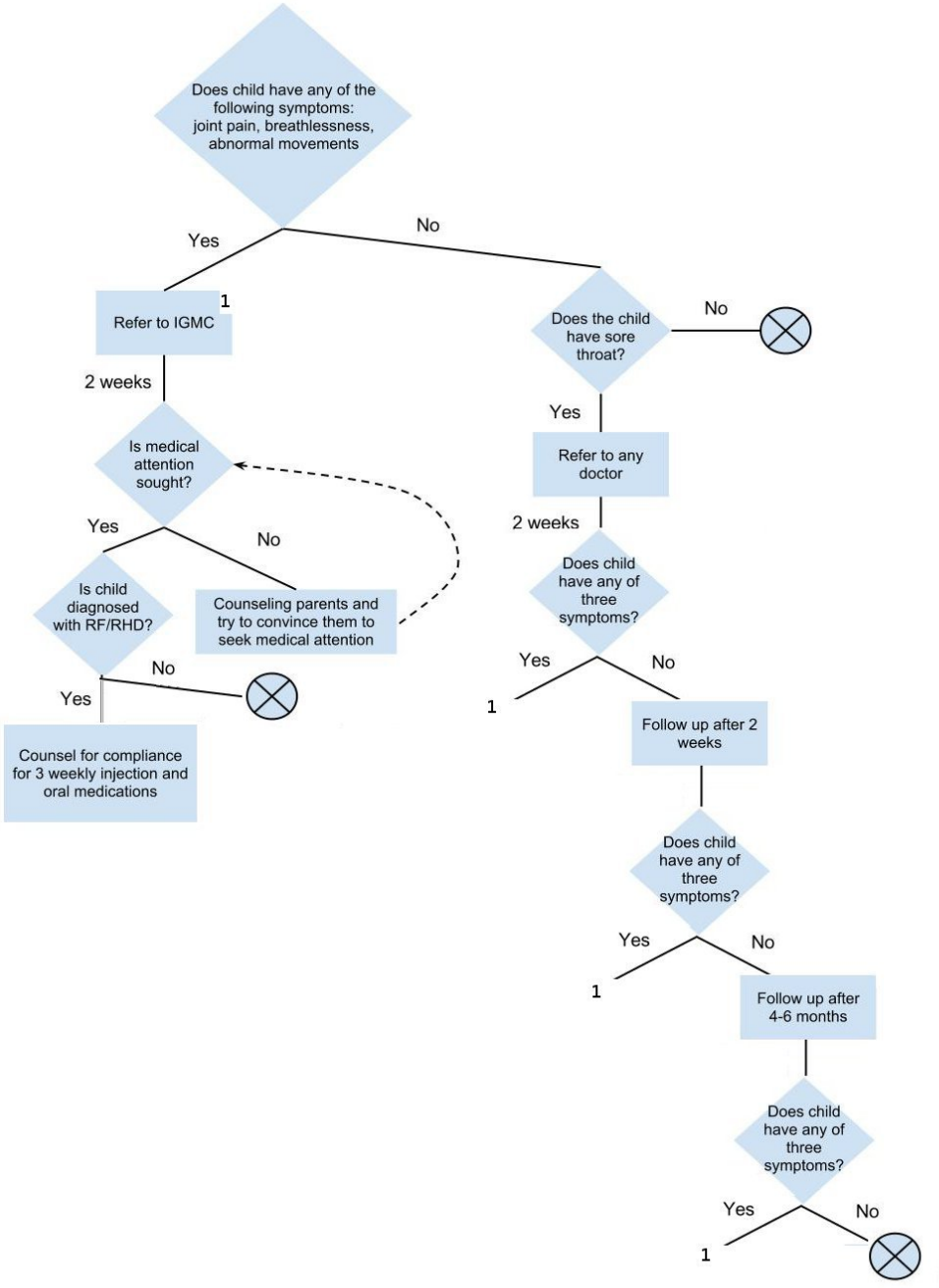

Figure 5.1: The figure illustrates the Rheumatic Fever and Rheumatic Heart Disease process flow. The circle with a cross in it means that the process stops here. The "1" number means that the process is continuing from "Refer to IGMC".

- **Chief Implementer** - allocates tasks between the implementers and is responsible for making sure the needed tasks are carried out. In addition the chief implementer also have some responsibility towards organize meetings with teachers and the other stakeholders. During the time I worked on the project the chief implementer was also responsible for two other programmes. This meant that most of the tasks was allocated to the implementers.

- **Implementer** - in total 3 - 4 different implementers have been involved at some point. However, after I arrived there were only two working on it. Their main task have been requirements gathering, documentation and testing. One of the implementers finished the internship during the project leaving only one implementer (me). There were no plans on whom would take over our roles when I left.

The main stakeholders for this application is:

- **The head of the department of cardiology** - is the man behind the project. The annual incidence of rheumatic fever in India is 100-200 times greater than what is observed in developed countries. Combined with the expenses of the treatment, there is great interest in establish preventive actions to reduce these numbers. By using modern technology and involvement of teachers he hopes to reduce the number of incidents and thus free resources.

- **State programme officer** - is responsible for the school health programme for HP. She is working for the department of health and family welfare, and is the key person when it comes to the implementation of the programme at the schools. A letter sent from her illustrates her role " ... They (HISP-team) may kindly be allowed to carry out their work in the above mentioned schools for the greater betterment of the health of the students."

- **The user** - the teachers are the ones who will do the reporting. It is important that the application is easy to use and not time consuming since this programme will come in addition to their existing workload and their gain will be minimum.

- **School students** - they are the main beneficiaries for this programme by receiving preventive measures.

- **Parents** - the parents will also receive two major benefits: the well-being of their children and financial. If their child get sick with RHD the treatment is very expensive. Since few Indians have health in-

surance such a procedure might be to expensive for their family to overcome. Preventive measures, in comparison, is far less expensive. They will receive text messages which informs them what to do, but it is important to remember that some of the parents might not be able to read or check their text messages. Instead, the parents can receive a call with a pre-recorded message.

- **HISP** - if this pilot-project succeeds it can give HISP an important role for the school health programme and cardiovascular diseases. The head of the department of cardiology is very interested in the opportunity to use mobile technology as reporting tools for other projects as well.

5.2.2 Process

The Rheumatic Heart Disease and Rheumatic Fever programme was initiated by the head of the Department of Cardiology in Shimla. A meeting between HISP, the cardiologist, teachers and the health department was held in January. A Cancer programme implemented by HISP was shown to demonstrate how such a programme could be conducted. After the meeting the doctor sent requirements to the HISP team which developed the application. When the application was ready to be tested the doctor visited HISP's office to see the results. He was not satisfied and provided new requirements. The development of the second prototype started in the beginning of March. A requirement specification document was made to illustrate the new requirements and process flow. After two weeks a meeting between HISP, the cardiologist and the health department was held. The new application was demonstrated and a date for the prototype workshop was set.

During the process of conducting the new requirement specification document many questions were raised. The most important question was how to use unique identifiers and still keep the mobile application user-friendly. More explicit, make an application where the teacher does not need to keep a separate list where he/she maps the IDs to students. The solution which was proposed to solve this was to extensive to implement within the time limit of the prototype workshop. Thus a simplified solution was chosen which ensure UIDs but is not very user friendly. The plan was to start implementing the proposed solution after the pilot workshop, but it still remains to see if it will be done.

After the requirements were settled, development of the application started. While the developer coded, the implementers started on making the pro-

gramme in DHIS2. This is where the instances, data elements, forms, and programmes are created which defines the elements in the database. This is done in a drag and drop manner using the DHIS2's Graphical User Interface (GUI).

After the user interface and some logic was developed, a mobile was used to test the functionality. Since the implementers sat right next to the developer it was easy to communicate problems verbally. However, it is valuable to document the bugs, and keep track of which have been solved. Thus a document on google docs was made and used to keep track of the bugs. Test protocols, test scripts and user manual were also made.

An important issue was discovered at this time - the application did not support smart phones. We had only assumed that this would work fine, but we were wrong. There were to little time left before the application had to be ready, and there were still functionality which was not supported. Thus, there were no time to implement an application that supported smart phones as well. After a discussion we agreed that since smart phones can access web pages, the website will always be a solution. Thus, we should wait and see how many of the teachers did use a smart phone, and thus be able to make a choice of whether implementing a new solution or just support the website.

The day before the workshop the application finally supported SMS sending. This day was used to test registration - *is the server providing the SMS with UID after a registration is done*, *are the patients who is registered found in the web-application*, and *are the right prompts shown at the right time.* After solving any issues with the features, the rest of the day was used for preparation for the workshop.

A meeting with the state programme officer was held the day before the workshop. The application was showed and some issues discussed. The state programme officer is working for the department of health and family welfare, and is responsible for the school health programme. Thus she has the authority to make sure that the project is put into practice. The state programme officer is also responsible for maintaining reports from the school and forward it to the national level.

The week after the workshop was Easter and Holi (three day festival most known for its colours), thus little work was done on the project. The week after, the project leader was gone for three. The training session for the five participating schools started this week. Two trainings was conducted and a meeting with the head of the department of cardiology was held. At the end of the week one of the intern implementers finished her internship, and thus

left the project. The following week there were only two people working on the project, the chief implementer and me. The developer was still in Delhi.

The training of the three last schools was planned to be conducted the week after the two first was conducted. Due some family issues, the chief implementer had to leave from Tuesday to Thursday. Thus only one of the three trainings was planned to be conducted (on the Friday). When the Friday came, after we had printed out all the required documents, she cancelled the training due some other urgent tasks she had to do. She was also gone from 15th to 27th of April to do mobile trainings for another programme. Thus the three last trainings was planned to be conducted in the end of April. However, when May started the schools was busy with admission, thus it was difficult to arrange trainings. One of the three remaining trainings was conducted two weeks later.

While the chief implementer was gone for the mobile trainings for another project, and the developer was in Delhi, I had an interview at one of the schools who had participated in the training. The interview was very valuable and gave insight on how the project would be conducted. The interview was held on my last day in Shimla. The day after, I went to Delhi and had a discussion with the developer regarding standardization and customization. This was also quite helpful.

Figure 5.2 illustrates the timeline for the project where the most important details are shown. The coloured lines illustrates at what time the different project members where in Shimla.

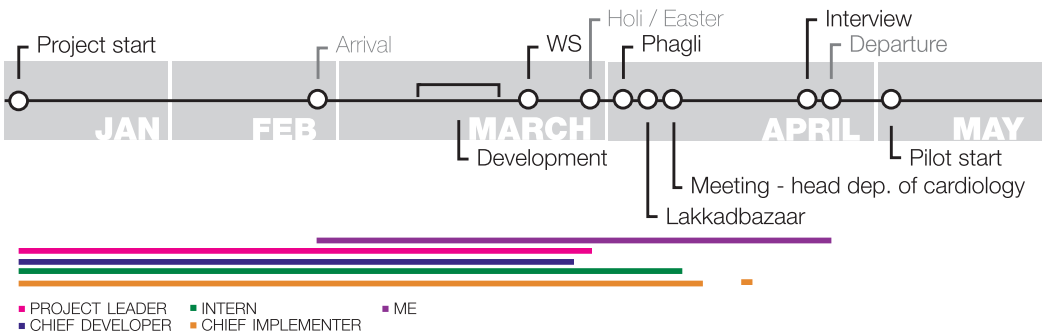

Figure 5.2: The figure illustrates the timeline of the project where the most important details are shown. The coloured lines illustrates at what time the project members where in Shimla.

5.2.3 System development method

For this project there has been no consciously use of any specific methodology, in the way I have experienced it. The process can be described more as an ad hoc type; Tasks that needs to be done have been assigned ongoing and if discussions are required, the involving parts will just take the discussion in a "there and then" manner. This way of organizing projects time spent on meetings and planning is saved. However, this does not automatically mean that the project will take less time to complete. For example, we experienced double work when there were no agreement on how the graphical elements and navigation should look like. The developing part was done simultaneously as the finalization of the requirements specification document. This lead to the following situation:

In the requirement specification document the following was written:

1. Child registration
   (a) New Child Registration
   (b) Edit Existing record
2. Follow up

The way it was done in the application:

1. Register new student
2. Update student details
3. RHD stages
4. Update stage information
5. Settings

Similar situations happened for the prompts that should be shown, the text messages that should be sent and so on. The reason to why these situations occurred, in the way I see it, is that there have been no discussions or plans in how to actually implement the different features. There have been discussions on what features that are needed and how the process flow should work, but very few discussions on how to achieve the features. Like the case with UID versus usability. If that discussion have been done much earlier, we might have been able to implement a good solution from the start. It is important at some point to discuss details in the application. Otherwise drawbacks and

problems will be discovered at a later time when it might not be possible or to expensive to change. This is where planning and organizing are important. Even though time was very precious for the developing phase, it might have cost the project much more by developing a solution that could have been better. Even though it seems like one is saving time by not planning and organize, it might even save the project a lot.

There have also been none documents which have illustrated the progression in the project, list of remaining tasks or deadlines. The day the application was demonstrated for the first time for the health department and the cardiologist, I thought the whole week that the meeting was the prototype workshop with the teachers. That was the information I had received from the project members. So when the day came, I asked when are we going and so on. The developer said that he was not finished and he thought that the meeting was next week. He had asked for the deadline to be postponed whenever he had the opportunity to ask. He had never got the postponement confirmed, but it seemed that he was in the impression of that he had managed to postpone the date. "The project leader never gave me a conformation on the meeting yesterday, so I do not think we are going". Thus the developer concluded that the meeting would be some time next week as he had requested. The other project members was not sure. So, when it was time to go, the project leader came up to ask if the developer was ready. He was not, but managed to install the application on the phone and then they went in a hurry.

Having documents which illustrates progression, remaining tasks, and deadlines, can help avoiding similar scenarios to occur. These documents would make it easier for the project leader and the other project members to keep track of the development, and to know what deadlines are coming up. The information will also be valuable when it comes to making plans and allocate resources. There are also a motivator factor in deadlines. Thus a bit of project planning would have been good for this project, and it is possible to achieve without increasing the workload significantly. The way it works now, if say I finish a task, I have no other option then to ask the chief implementer for a new task. If she is not available, then I need to figure out something else to do. Instead I could just have checked a list of the remaining tasks and picked one.

I am not sure why these documents have not been made. It might be priorities - something came in the way or was more important. Or it may be a question of who's responsibility it is: the project leader, the chief implementer or the group as a whole? Thus clarifying this might result in someone taking the

initiative to make the documents. Or maybe the project scope was considered to be too small to achieve enough benefit from doing it. Either way, I believe it would have been beneficiary for this project, and routine processes is more likely to go faster the next time one has to do it.

5.2.4 Architectural description

The system consists of mainly four parts: mobile (client), modem, DHIS2 server and a database. However, the DHIS2 server can be accessed through a web interface, which let any browsers access it. Since the mobile application is of main interest, little attention has been paid towards the use of the web interface. Figure 5.3 illustrates the application's architecture.

Mobile (client) - the application is installed on the teachers' phones. It is used to report suspected cases of RF/RHD, and follow up the registered cases. A student is registered by entering his/hers personal details in the registration form found in the application. When the required details are filled in the report is sent via SMS to the DHIS2 server. A text message containing the students UID is received in the phone's inbox, and not in the application. When a user wants to report follow up details, the student's UID has to be entered together with the wanted information. Again the data is sent as a text message to the DHIS server. The first time the application is used a phone number has to be entered in the *settings* option. This is to provide the number the text messages are sent to, which in this case is the modem's.

Modem - is the component which makes it possible to communicate through the SMS. It is connect to the DHIS server.

DHIS2 server - is responsible for retrieving, updating and store information in the database. It also process the data in the text messages received via the modem. It generates UID when a new student is registered, and sends it back to the teacher who registered the student. It also checks once a day among the registered students if there is someone who's follow up is due within two days. If such persons are found, the parents and the teachers connected to the student is notified with a text message. The server will be run at the IGMC.

Database - this is where the data is stored.

The communication between the client and server is through the SMS. However, the server is only able to send text messages to the clients inbox and

not to the application itself. Thus it is a one way communication between the client's application and the server, and the server and the client's inbox. When first installing the application a phone number has to be entered which decides where the text messages are sent. In this case to the modem connected to the DHIS2. When the text message is received the server will either update or create new entries in the database. If needed, a confirmation message will also be sent back.

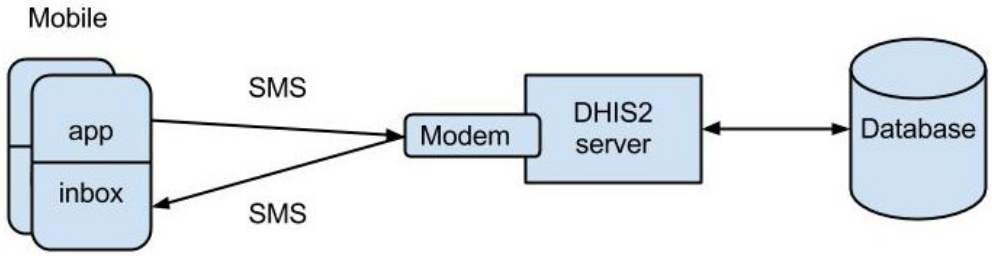

Figure 5.3: The figure illustrates the application's architecture on a high end level.

The features in the application is: Register a new student, Update student details, Stages (5 different stages) and Update Stage. Whenever a new stage or update is done, the teacher must enter the student's unique ID. The UID is sent to the teacher as a text message which is received in the teacher's inbox. This means that the teacher has to write the UID somewhere, while he/she is opening the application and navigates to the right form. Prompts, short messages, are shown in the application for confirming actions or notify if some data field are missing or entered incorrectly.

5.2.5 Prototype workshop

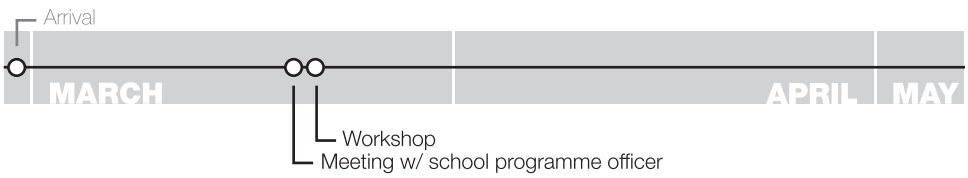

Figure 5.4

The first prototype test was conducted Saturday 23rd of March. Seven representatives from HISP (including project leader, senior health officer, chief implementer, intern, me and both of the developers) where attending together with 10 teachers (NSS coordinators) and the head of the department of cardiology and the state programme officer. The timing was set to 11.00 am but was started around 11.45. An attendance sheet where mobile brand together with name and contact number of the teachers was captured. The application was installed on the teacher's personal phones, and how many who were successfully installed was captured. The workshop started with a thorough introduction to rheumatic fever and rheumatic heart disease given by the head of the department of cardiology. The symptoms were carefully described with the aim to provide the NSS coordinators with enough information to identify suspected cases. Next a presentation of the mobile application was given where the different use cases were presented together with the objectives of the programme. The workshop ended with a hands on demonstration of the application. An emulator was used to describe the application step-wise while the NSS coordinators could perform the same steps on their phones. While the chief implementer held the demonstration, the other HISP members provided assistance when needed. At the end, a questionnaire was given to the NSS coordinators to capture mobile experience, knowledge around RF/RHD and motivation factors for conducting the application. The questionnaire can be found in the appendix.

We were only able to successfully install the application on four phones (out of 10). We knew that the application did not support smart phones, but we were unsure how many of the teachers would have a smart phone. Smart phones can use a website solution thus it is not critical. It turned out that only one NSS coordinator had a smart phone. The other 5 phones was actually simple phones which was not able to run the jar-file or phones without bluetooth. This was unexpected but for the prototype workshop we lent out testing phones so everyone was able to participate.

An observation I did during the prototype workshop was that some of the teachers were not comfortable using the mobile keyboard. My guess is that they only use the mobile phone for calls and do not send SMS. Thus, in order to use the RF/RHD application they also need to get comfortable in typing on the phone as well. This can prove to be challenging.

The overall aim for the workshop was to give an introduction to RF/RHD and the application. Thus the next step was to visit the 5 schools which are participating and give a more through demonstration.

5.2.6 School pilot training - Phagli

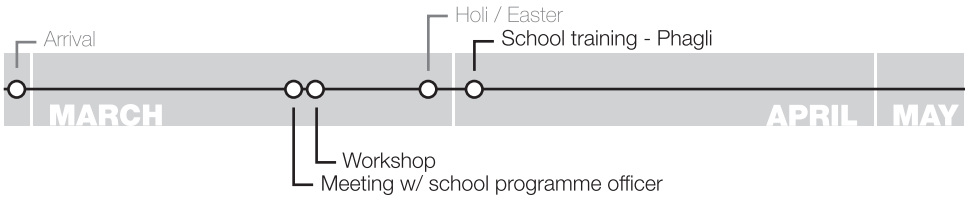

Figure 5.5

One and a half week after the initial workshop the chief implementer, the implementer and I went to the first of the five schools. 19 teachers participated on the pilot training. The training was organized by one of the school's National Social Scheme (NSS) coordinator. A NSS coordinator is responsible for among many other things, the school health programme and will thus be the coordinator for the RH/RHD programme. He suggested that the teachers should report to him or the other NSS coordinator (there are usually two NSS coordinators at each school) when a child was showing symptoms of either RF or RHD. Thus, there will only be two people responsible for sending and receiving SMS. The NSS coordinators will hopefully help reminding the teachers of conducting the programme.

Since only two people will be responsible for reporting, we asked if he would prefer a computer based solution instead of SMS. He said that he would do it by SMS even though the school had a computer lab and he had a laptop back home. If there are many cases for the coordinators to report, he might change opinion.

All in all we thought the training went well. We were able to install the application successfully on 14 phones which, percentage, was a huge improvement from the prototype workshop. The problems we experienced was still the same: smart phones (only 1), phones without bluetooth and ae Samsung model which is not able to run the jar-file. We did not know that the NSS coordinators was going to be the only teachers that would send the text messages, so we needed to change the focus in the presentation: what RF/RHD is and what are the symptoms. We decided that we would install the application on as many phones we were able to because it is difficult to organized these meetings. If any changes on who is sending the SMS will happen, the teachers would at least have the application installed.

5.2.7 School pilot training - Lakkadbazaar

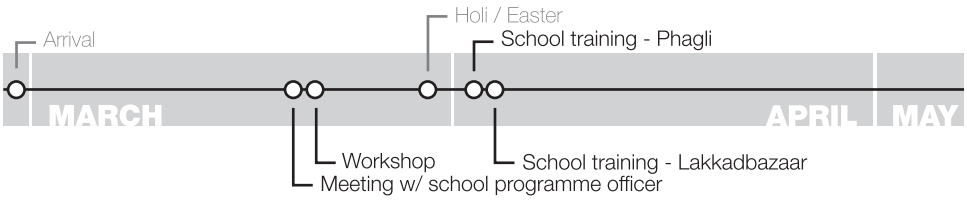

Figure 5.6

On the way to the school training the we (the same who went to Phagli) had a discussion concerning who was suppose to do the reporting. It was not clear to us if whether the NSS coordinators was the only ones who were suppose to use the application, as we were told at Phagli, or that the class teachers should report as well. We had not heard anything about the NSS coordinators doing the reporting. Thus, we agreed to install the application on every teacher's phones just in case the teachers was supposed to do reporting after all. Otherwise, a new training had to be arranged.

Before the training started we had a discussion with the NSS coordinator for that school. It appeared that there were only one NSS coordinator for a school with 500 students. She said that she would have the responsibility for the programme and coordinate everything, but in the end she finish by saying: *.. but I will not send the text messages. She will (points at another teacher).* This teacher explains that she is a chemistry teacher and have a lot to do with preparation of her subject, but she could help out in sending the text messages. It still remains to see who will actually be doing the reporting.

The training followed the same procedure as the last one, but for this group there was more disturbance (like chitchatting) from the teachers. Many teachers also left the training before it was finished. They might had classed to attend, because just after we finished a class came into the room. The impression I got was that the end of the presentation was a bit hurried (talking was done in Hindi so I can not say for sure). An interesting detail however, is that after the training we had tea and biscuits with the principal, and she told us that her nephew had suffered from RF/RHD. Hopefully, this can lead to an extra motivation for conducting this programme, with the right pressure from the administration.

Questions which was asked during the training was: **what is the difference between viral fever and rheumatic fever? How can you tell the**

School	Teachers	Successfully installed	Students
Phagli	19	14	450
Lakkadbazaar	15	5	500
Portmore	25	5	?
Total	59	24	?

Table 5.1: The table summarize the number of teachers attending the trainings (including NSS coordinators), and how many had the application installed successfully on their phones. The number of total students at each school is also shown.

difference? Can you explain what is meant by abnormal movements of arms? The chief implementer tried to explain it as well as she could without having a medical background. Later these questions was asked to the head of the department of cardiology so that we had an answer ready if anybody else would ask.

5.2.8 School pilot training - Chotta Shimla, Portmore and Boileauganj

The pilot training for these three schools was set to the end of April. I had left India by that time. The training at Portmore was done 17th of May. The chief implementer told me that the two last schools would recieve the trainings at the beginning of June. I have not been able to confirm this within the time provided. The figure 5.1 summarize the number of teachers attending the trainings (including NSS coordinators), and the number of successfully installations. Total number of students at each of the schools are also shown except for the last school which the chief implementer did not know.

Material used in training sessions

For the prototype workshop and training sessions at the schools different material was handed out. They are explained below.

- Questionnaire - to identify teachers knowledge around RF/RHD, their mobile qualifications and motivation.
- SOP - standard operational procedure. This document gives a detailed explanation on how to install and use the application.

- FAQ - frequently asked questions. The document contains questions and answers which we believe will arise during the use of the application. Thus it can reduce the need of technical support, but also provide contact information if the answers are incomplete or not sufficient.
- Feedback - the form contains a couple of questions regarding how the training session was conducted - if there are any improvements which can be done.

Questionnaire, FAQ and feedback form is found in the appendix.

5.2.9 Meeting with the Head of the Department of Cardiology

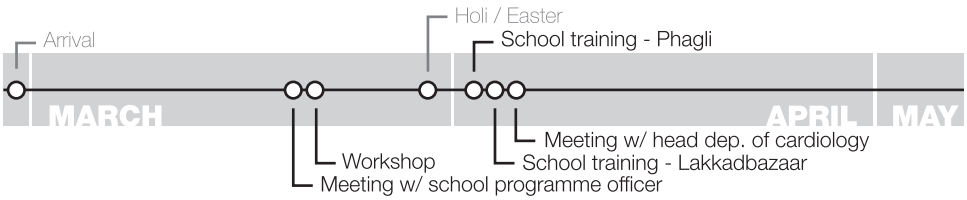

Figure 5.7

After the second training we had a long discussion about who should do the reporting. A list was made of pros and cons of letting the NSS coordinators do the reporting or the class teachers. We stared with the NSS coordinators. The drawbacks by them using the application is that they do not have the same personal realtionsship with the students as the teachers have. The amount of students at the schools are between 400 to 500 students. There are only 1-2 NSS coordinators at each school. Thus they have to track down one student among 500 and get the needed information from him/her. The students can also be afraid of telling the teacher or the NSS coordinator about his/hers symptoms. They do not know what the consequences are, if the treatment will hurt or maybe the parents will get mad at them. It is difficult to predict how comfortable the students will be in "complaining" to the teacher. The NSS coordinators are not seeing the student on a day to day basis. They can only rely on what the teacher or student is telling them. There are different things that can happen when a student is detected with symptoms 1 - the student can be sent to the NSS coordinator so that the coordinator can get all the details needed directly from the student. Then it depends on the student to actually go and visit the coordinator. 2 - the

teacher can record all the needed details from the student and then pass this on to the NSS coordinator, either as a written note, verbally or through a third person. Either way, it is double reporting. In addition the question of motivation to conduct the project is also present. There are also a chance that the application should be improved to suite the NSS coordinators better.

As we can see there are a lot of drawbacks. Thus, we thought of giving the parents more responsibility. Instead of having to go through class teachers and/or students to get information for follow-ups, the communication could be done directly towards the parents. They will know whether their child have sought medical attention or not, and is thus capably to answer every questions concerned for the follow-up. By doing this the parents will have more responsibility towards their child's health instead of the teacher. They will also see their child on a daily basis thus be able to tell if changes in their health has occurred. It can also help to make sure that the parents take their children's health seriously. In the end, it is the health of their children which is at risk. The problem is how to communicate with the parents. Not every parent can read, thus communicating in writing can be difficult. Calls will be a more expensive solution and time consuming for the NSS coordinators, and thus not that feasible.

The positive aspect with letting the NSS coordinators do the reporting, is that they might be more motivated towards conducting these types of project considering their role in the school. It is more a task for their position than a teacher's.

When it comes to letting the teachers do the reporting the major drawback is the question of motivation. However, considering that they see the students on a daily basis, the cost of detecting students and do the follow up is minimal compared to the NSS coordinators and medical personnel. The project is also complained based which means that the teachers does not have to ask every student within a given time interval if they experience these symptoms. Only a small remainder will be sufficient. It might also be less frightening for the student to only be involved with the class teacher whom they know and can (hopefully) trust.

Since the major drawback with using teachers is the question of their motivation, we thought of what options there are to make sure that as little motivation as possible is required. We drew the assumption that motivation is closely related to the time needed to be spent on the application. Thus, we focused on how the teachers could spend less time on the project. By giving the follow-up responsibility to medical students, the teachers only have to do the registration - filling out one form. By doing this the medical responsibil-

NSS coordinator:	**NSS coordinators & parents**
- too many students	- too many students
- get student reg info	- get student reg info
- do follow ups	- expensive
- double reporting	+ responsibility
- feasibility	+ involvement of parents
+ motivation	+ do follow ups
Teachers	**Teachers & medical students**
- motivation	- expenses for follow up
+ get student reg info	- feasibility
+ follow up	+ motivation
+ feasibility	+ get student reg info
+ less threatening for students	+ responsibility 1

Table 5.2: Pros and cons listed for the different reporting options.

ity is no longer the teachers', but in fact a medical institution's. Students are often interested in getting real experience which can make them interested in taking responsibility for the programme.

In table 5.2 the pros and cons are listed for each of the options. We agreed that the last option, let the teacher's register the students, but give the follow-up responsibility to medical students would be the best solution. Thus the chief implementer called the head of the department of cardiology to arrange a meeting where we could purpose our suggestion.

After having the proposal presented, the head of the department of cardiology replied the following: Involvement of medical students is not possible (translated from Hindi). Thereafter he changed the topic of the discussion, leaving no room for arguments. During the meeting several other issues were discussed including funding. There will be a funding of 300 rupees per month per school. The funding will be coordinated by the NSS coordinator. A text message cost approximately 0.80 Indian rupees. There will be sent around 4 text messages per registered student during a month. Some money is expected to be used on calls: either technical support or to parents. An estimate of 10 rupees per students leaves 30 student to be registered per month. This should be enough money for the pilot project. After three months an evaluation will be done thus a statement of the expenditures can be prepared.

During the meeting new requirements was requested. One were a list of

all the students where colours are used to indicate their health status; Red for students who has pending follow ups, green for students who has no overdue follow ups, and yellow can be used to distinguish between how critical the overdue is (days or weeks). The list should be automatically updated whenever changes occurs. Thus it will serve as real time monitoring.

For now, to get this information from DHIS2 one needs to generate a summary report each time someone wants to check for updates. Or click into each person registered in the programme and check whether there is a need for follow up or not. After consulting the Oslo team it has been decided that the development of the real time monitoring will be done either in Delhi or Shimla.

The second requirement was alerts. That is a functionality which give a notification whenever a new student has a pending follow up. This functionality is currently not supported in DHIS2, but will likely be developed together with the colour-list.

The third requirement was towards security. *"There should be a login functionality in the mobile application to prevent unauthorized persons to send data"*. Originally we had decided that the level of security was good enough. However, there is a solution which is quite straight forward to implement, so after the trial a discussion can be held concerning this requirement. It will be to troublesome to install a new version of the application at this time, that is why it is best to wait after the trial. The proposed solution is to make the user enter a x-digit pin code whenever he/she wants to access the application. The users will choose the pin code themselves.

For future requirements, it was desired to also installed the application on the children's parents' phones, but only for those who is diagnosed with RF/RHD. Then the parents are responsible for providing information about their child's treatment. The installation will be done at the IGMC when the child is diagnosed. The last requirement, also in a future perspective, is to install a similar application on medical officers' and patients' phones so that the patients and any kind of medical officer can directly update patient information through the application. This must be discussed in more detail.

5.2.10 Interview

On my last day in Shimla I was finally able to organize an interview at one of the schools (Lakkardbazaar). One of the intern who knew Hindi came along, so she could help me communicate. The interviewees was not so

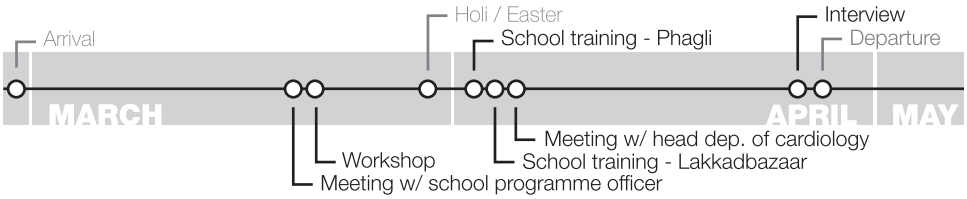

Figure 5.8

good in English so it was very helpful to have her with me. The intern had not worked on the project before, so I gave her a brief introduction to the project and application before we went. The plan was to interview five of the teachers who would do the reporting. However, during the conversation with the NSS coordinator she told us that she and one of the other teachers (Chemistry teacher) would be the ones in charge of the programme. Thus the NSS coordinator and the chemistry teacher together with one teacher was interviewed. They were all interviewed together.

I started the interview by explaining who I was and why I wanted to talk to them. I tried to emphasize that it was important for us to know their thoughts and opinions so that improvements, either towards the application or the process, could be done. I also explained that it was not a test or evaluation of their efforts. After these formalities, I asked what they thought about the project. The answer I got was: ‘‘*The idea is good or fantastic. It will really be good for the students*”. I asked what they thought would be the biggest challenges or obstacles for conducting the project. They answered the following: *Obstacle, no, but the parents need to be involved with the treatment. They will not take it seriously enough*”. They did not mention the challenges for them to conduct the project.

The conversion then turned to how they were planning to conduct the project, what roles they had and responsibility. They would have the main responsibility for the project and thus they would to the reporting as well. But only the NSS coordinator had the application on her phone. The chemistry teacher had a smart phone. They told me that they would share on the phone that worked, and the chemistry teacher would show the NSS coordinator how to use it: *“No problem, no problem, she [chemistry teacher] will show me what to do, and we will share”.* If they needed help they would ask other teachers to help them: *“People help each other here”*. Further, and this they emphasized a lot, was that they did not have the authority to demand other teachers to get involved, only the principle could do that.

When it came to their workload and the time they had on this project they said they were busy with different things, but they assured me that they would do their best - *"In fact, we can start tomorrow"*. They agreed that they would talk to the principle so that they could use the morning assembly to inform the students and teachers. Then they would visit every class and give a more throughout description of RF/RHD and its symptoms, and what the students should do if they experienced any of the symptoms. They would try their best to motivate the teachers, and remind them of the project.

At the end I asked if there were something that could be improved or should have been done differently, they pointed out that a class teacher from 6th to 10th class should have been present at the workshop. The NSS coordinator and the chemistry teacher did not know the students in these classes that well. Thus it would have been better to have a person who knows them and them him/her responsible for the reporting for these classes. It would have been easier for the students to contact this person if they knew him/her, and for the person to do follow-ups.

When it comes to the follow-up process they assured me that it would not be a problem for them to identify a student. They knew everyone. There are 500 students in this school so I am not completely convinced. Paper forms were also not a problem, they were used to those. Considering improvements, we agreed that it would be better to continue the discussion after the trial was over. Then they would have used the application more, and have experienced how well the other process around the project had turned out.

5.2.11 Further plans

The pilot project started 1st of May for the five schools who had received training. The pilot project will keep on for 3 months before an evaluation will be done. After that it will run for 9 months leaving one year of pilot testing. The first three months the pilot project is running, is in the low season of sore throat. Thus, it is likely there will not be so many real cases for the teachers to handle. By continue the pilot project throughout the winter season, more cases will be seen and the application and conduction of it will be better tested. After the year is completed decisions of including other schools will be made. To include additional diseases will likely take some more time to discuss.

Chapter 6

Discussion

In this chapter I will discuss some of the challenges faced throughout the implementation and developing process trying to answer the research questions. I will start by giving some characteristics of the communication in the project, before looking at some of the consequences projects operating in low-resource settings imposes. This concerns how the requirement specification was achieved, level of user-involvement and robustness. At the end suggestions for improvements are given.

6.1 Arenas of communication

Communication is an important part in our every day life. With all the communication exercise we get each day, it should make us really good at it. But is this the case, and how good where we to communicate in the RF/RHD project? In this section the different forms and arenas of communication used within the project will be discussed.

Face to face

Most of the communication was done face to face since the core team was situated in Shimla. The working environment was however quite different from what I am used to. I experienced that shouting and yelling from superiors to subordinates was a common way to communicate, both on phone and face to face. For me this felt very unpleasant and awkward. I got the impression

from the employees that this was not a common practice for Indian companies. My experience from the Delhi office also underpinned the statement - there were rarely any shouting. During a work feedback evaluation, one of the developer said that he wished a more peaceful work environment. It seems that there is a desire among the co-workers for a less shouting environment.

Among the team members it was quite different. The atmosphere was good and relaxed. We were usually seated next to each other so it was easy to collaborate. Sometimes the chief implementer sat downstairs, usually working on another project, but then she called for us if there were any issues.

The problem with communicating face to face was the language barrier. When someone was unable to communicate what they wanted, they shifted to Hindi. This happened usually when there where many people involved in the conversation. Important issues were discussed but I was not able to understand what they were saying. This was very frustrating and I was afraid I missed out important points. It also makes you feel left out which is not a good feeling.

Among the team members it was usually the chief implementer who struggled with English. Whenever we had trouble to communicate with each other, the intern translated either to English or Hindi. It was very valuable to have her there. Without her things would have been much more difficult.

6.1.1 Email and Chat

Email was mostly used as a tool to send different documents among the HISP team - requirement documents, tests scripts, reports, minutes and so on. It was also used to communicate with project members outside HISP - the head of the department of cardiology, the state programme officer, and the principles at the five schools. However, when organizing meetings with these stakeholder, mobile phones were used instead. Gtalk (chat client in gmail) was used to give short instructions when the team was not sitting together.

The emails that was sent was mostly from one of the implementers to the project leader providing her with documents to keep her updated on the project. However, there were only one document which was sent the other way - that was the invitation to the pilot workshop. No minutes was made from meetings which only the project leader attended. Thus it was difficult to keep track of how the situation developed. You just had to believe that if some important information was discussed then it would reach you.

Gtalk - chat which is provided in Gmail, was used to give short messages. When the chief implementer left for mobile trainings for another project, it was used to keep her updated and to organize the interviews with teachers. It was also used to communicate with the developer when he was in Delhi. It is a less formal way to communicate than email. It resembles more like a conversation.

6.1.2 Teleconference

A Skype meeting was held with the leader of the DHIS2 development who is situated in Delhi. He provided valuable information in how to implemented the application on DHIS2. He also did a quality check on the implementation concept. He told us that the original way we had planned to implement the application was not advised since it had not been tested (multiple event with registration). Thus multiple *single event with registration* was chosen instead.

6.1.3 Redmine

Redmine is an *open source project management web application* [87] used to enhance collaboration. It supports wikis, forums, roadmaps, bug/issue tracking, documents and file management among other things. The most used features for this project was *issues*, *documents* and *files*. Only the requirements that have been requested after the implementation started is found here. Thus a complete list of all requirements is not existing. For the bug report, a Google document was initially made to report bugs and indicate the priority level (low, medium, high). After the document was finished the bugs were copied to Redmine. None of the bugs on Redmine have been marked as solved even though I know that some of the bugs/issues have been fixed.

The documents that are found on Redmine have first been made in Google docs before they were uploaded. The same for the bug report. It might seem that Google Apps could be a suiting option, but it cost 300 NOK per person per year (it is free for education and government actors). For a Norwegian company, this is a small prize to pay, but I am not familiar with HISP's/HISP India's financial status. Thus an evaluation must be done to see if it is an appropriate investment. However, it would be a good tool for collaboration and especially among teams which are geographically dispersed. Redmine could still be used to assign issues (bugs, new requirements etc.), but the

documents would be created and stored on Google drive instead. Redmine appears to be the only common file storage which is used. Every file that needs to be read must first be downloaded. Collaboration on the same file is also not supported. For Google Apps, a local folder is created on the desktop which is synchronized to a cloud storage. This makes it easy to read and write files, and collaboration on the same file is also supported. Thus Google Apps would serve as a better file storage option than Redmine.

6.2 Requirement specification

Requirement specifications include both functional and non-functional requirements. It is a complete description of the behaviour of a system based on the different stakeholders' needs. To derive the requirements a clear and thorough understanding of the product is needed. If the requirements are incomplete, it can be critical towards increased expenses and the use of the system. In worst case it can lead to project failure. During this project we have experienced some issues towards a full understanding of the requirements. I will discuss some of the issues below.

6.2.1 The school health programme

An important part of understanding the requirements is to understand the existing school health programme; How it is conducted and how the RF/RHD programme will fit in. The teacher's motivation is an important part of this. In a conversation with the project leader, where I tried to express my concern towards challenges around the teacher's motivation, I was explained how the school health programme works: "The teachers are keeping huge paper forms where they quarterly fill out health details of different diseases for each students. A yearly report is made from the forms. They have to keep track of the paper form, and sometimes even do follow ups. However, they are experiencing problems with forms being incomplete or lost. Thus, a mobile based reporting system will make it easier to record and report. This should give some motivation towards using the application.

The problem was, during the meeting with the state programme officer (she is responsible for the school health programme) another description was given: "Once a year a team of health personnel travels to schools where they check the students for different diseases and give prescriptions and referrals whenever needed". On the question *what is the teacher's role [in this programme]?*

the following answer was given: "The teacher's role is only to help facilitating the medical camp, and not report. The medical doctors will write a report which is sent to me". We also asked if there were any health programmes where the teachers had to capture data. She told us that they just recently had started a programme where the teachers will distribute iron tablets, and capture the amount of delivered tablets and report to the NSS coordinator. Since the project had just started, there were no feedback or evaluation available. This could however been very interesting to know and be valuable for this project.

The state programme officer's explanation of the school health programme was consistent with what we were told by the NSS coordinators at the two schools we had trainings. Thus, the RF/RHD programme will not improve an existing process, but instead be an additional process the teachers will have to spend time on. This makes the teachers' motivation for using the application even more important.

The schools are run differently from private to government, and between states. It is likely that some schools have a practice consistent with the project leader's description. However, it was not discovered until the day before the workshop that this was not the case for the schools involved in this project. How can we get a throughout understanding of the requirements if we do not know how the school health programme works? This could have been avoided with increased user-involvement.

6.2.2 Teachers vs NSS coordinators

The application have always been developed with the class teachers as the users in mind, but after the first training we (chief implementer, implementer and I) were all confused. The NSS coordinator at the school said that the teachers would report to him, and then he would send the text messages. Thus we started to wonder about who was really suppose to do the reporting - NSS coordinators or class teachers. Since only the NSS coordinators was attending at the workshop, the question was raised - was it known from the beginning that only NSS coordinators was suppose to do the reporting? If this was so, why did we not know about this, and why spend a lot of time teaching class teachers how to use an application they were not supposed to use? Instead we should have a closer session with the two NSS coordinators and make sure they fully understood the application.

Knowing who the primary users are, is a prerequisite for understanding

the requirements. How can one successfully develop an application without knowing the users' needs, tasks, preferences and so on? If in fact the teachers were *not* the primary users, we would not only develop an possibly unsuitable application, but in addition spend resources tailoring the application to someone else.

Before the second training, which was the day after, we (chief implementer, implementer and me) had a huge discussion regarding this issue. I pointed out that there would be new challenges if the NSS coordinators should do the reporting - how would the NSS coordinator identify the right student among 500 to do follow ups? Only which class year the student is attending was captured. For each class year there are different classes - 6a, 6b, 6c and so on. Thus this should be captured as well as teacher's name and teacher's contact number. The main advantages of the application we had developed, was to take advantage of the close teacher-student relationship. This advantage would become a challenge instead. So we decided to install the application on every teachers' phones and continue with the original plan, and have a more throughout discussion when we came back. After looking at pros and cons for both solutions, see table 5.2 - NSS coordinators vs teachers, we agreed that letting the teachers report would be the best solution

What we discovered later, during the interview with the NSS coordinator, was that since only NSS coordinators attended the pilot workshop, the perception from the teachers was that the NSS coordinators was responsible for this project, and not them. In the invitation letter, sent from the state programme officer to each principle at the five schools, it said the following: *(...) You are kindly requested to nominate 5 teachers for the same; including NSS co-ordinators from above mention Schools for a one-day workshop (...).* However, the message to the teachers must have not been clear enough. There should have been around 25-35 person participating, but only 10 came. The programme state officer had expressed some concern regarding the appearance of the teachers, but I am not sure if there were anything else she could have done. If the teachers had been at the workshop more people would had felt responsibility towards conducting the project. This should be kept in mind for the evaluation.

One might believe that even though the teachers did not come to the workshop, they could still do the reporting after attending the training session. But the real problem is that we have made an assumption of who the users are without involving them. One problem have been that the importance of the NSS coordinator role have been discovered too late. None of the other project members were familiar with this title and could explain what the role

entailed. Inadequate knowledge and no user involvement have been the two important reasons to why this situation happened. Instead we have made the assumption that we could decide how the reporting should be done, which again leads to the design-actuality gap (2.2.3). The application should have been developed with both the NSS coordinator and the class teachers as users. Hopefully, the consequences will not be too severe.

6.2.3 Leadership style

As mentioned earlier there were a lot of screaming and shouting from superior to subordinate. This does not need to mean anything other than a way of giving messages. However, when we experienced the confusion around the teacher - NSS coordinator issue, I suggested that we should ask the project leader to get a clarification. By discussing the issue with the project leader it would have been possible to identify where the misunderstanding had happened, and what could be done to prevent the situation from happening again. However, we did not consult the project leader because we were afraid of getting yelled at for being confused.

If we had talked to the project leader, we could have clarified the confusion or, at least, have a discussion on what would be the best approach to solving it. Maybe the project leader would had some relevant information that had not been passed to the team, under the assumption that the team already knew or that it was not relevant. It seems that screaming and shouting have affected the productivity. The confusion occurred the 4th of April, and the interview was not until the 22nd. 18 days went by without actually clarifying the issue.

When the project leader was out of office, the senior health officer was in charge. During these periods I observed a change in leadership style. The senior health officer would, during these periods, exert a more "bossy" behaviour, especially towards the interns. The senior health officer would stand behind their back and carefully watch what they were doing. Questions like "what have you done today?", "What are you doing now?" and "Why have you not finished yet?" were asked frequently. I would not be surprised if this leads to negative feelings towards the management. According to Tepper [62], feeling of abusive supervision can magnify for persons who have less job-mobility. [1] The same would likely apply to other negative feelings

[1] Mobility in this sense is defined as a person's ability to change job or move from a social group or class.

towards management, even though it is not a case of "abusive supervision" as such. The interns are still working on their master degree; they need to be deployed in a company for a certain period of time, thus their mobility is very limited. The employees have more mobility, but it might be difficult to get a new job, which makes them less mobile as well.

The consequences of negative feelings towards the management can be: lower trust in the leader, less job satisfaction, motivation and dedication, and high turn over. All of these consequences will affect projects negatively, and thus should be taken seriously. E.g. high turn over is particularly costly in terms of knowledge transfer. Considering Tepper's findings and the employees and interns level of mobility, one should pay close attention for any signs that can indicate that this is the case. Since this project is operating within a low-resource setting, these consequences will be even more critical.

From section 2.2 we know that many of the information systems in developing countries are failing. However, there are one story of a project that succeeded. The two most important reasons to that was leadership and innovative organization structures. One of the qualities in good leaders is being able to motivate and encourage their followers. To reduce the chance of failure, more encouragement and motivation can be an effective measure for this project. When being motivated it is easier to preform better which can increase the productivity in the project and company.

6.3 Management

There have been some situations which have lead to other projects being prioritized over this. The most explicit situation was the day me and the chief implementer was going to the third school training. After all the print outs was ready and the school session should have started in 10 minutes (we were still at the office), the chief implementer cancelled it. Some minutes before she had been told to work on another project by the senior health officer, and thus she had to cancel it. There might be some cultural differences when it comes to the acceptance of cancelling appointments in a last minute manner, but in Norway it is generally not well accepted. The last week in Shimla the chief implementer was again set to work on another project. She left for a 10 days mobile training around the district. When she came back there were only three days left before the pilot should have started. Two weeks after, the trainings was still not held because the teachers were to busy with admission.

I have to emphasize that I do not know how things are organized or the status for the other projects. I only know the consequences for this project by postponing the trainings. That is three out of five schools did not receive the training within the date they were promised. This mean that three schools could not start reporting when the project was intended to start. The postponing made it even more difficult to arrange the remaining trainings due admission work. I am not sure in what degree the admission issue could have been foreseen, but the consequence still remains. Also, both me and the intern had left the project when the three trainings remained. The chief implementer was the only person left who could do the trainings. It is not possible to do the trainings alone, so someone has to come along with her. That can lead to consequences for other projects. In addition extra time is needed to make sure the person is familiar with the project and its tasks. It would have been more efficient to use me and/or the intern.

The reason to these situations can be anything from planning, lack of knowledge or priorities. However, if this project should be able to succeed, it is important that the needed resources are provided and well managed. There were no plans distributed to everyone in the office indicating what projects that was running, who was assigned which project and for how long. There where also no plans of who should replace me and the intern when we left, as I and the chief implementer knew of. Particularly for companies that are understaffed good management is important, but maybe also more challenging. The companies are more vulnerable towards changes since empowerment can not be increased or shifted whenever needed. But, it should not require much time to make a plan like that and distribute it to everyone.

6.4 User-involvement

Good usability makes the application easier to use, it is more satisfying to use it and it supports the user's tasks. Hence, it is important when it comes develop successful applications. To achieve good usability the key is high user-involvement (see 2.3). In this project the users are the class teachers and NSS coordinators.

Ideally, the development should have been done iteratively where after each iteration users should have been involved to provide feedback. This was not done, and the degree of user involvement was rather low.

The teachers and NSS coordinators are the users of the application which

have been made. They do not use it because they think it is an awesome application or because it satisfies their need. It is requested of them. This means that there are no competitors - no one who put pressure on having the best features or being the easiest to use. Especially under time pressure usability can be neglected; User-involvement is an expensive activity, and it takes time to plan, arrange and conduct.

When the success of the project is determined on whether the application is used or not, usability is however quite important. Teachers in India are no different from teachers in other countries. They have a tight schedule and a lot of work. By forcing them to spend time on this application it should be as efficient as possible to use. Otherwise the chance of the teachers not using the application would increase.

There have been one role missing in this project - the designer. The person who always thinks about the user first. When in a hurry it is easy to forget the user. It is only your tasks which is in focus. If it is nobody's task to think of the user, then naturally, the user could easier be forgotten. This seems to be the case for our project. Before I joined I do not think the user was given much thought, or at least how to develop an application which was suitable for the user. The only time the user had been involved was during a meeting in the very beginning of the project. The NSS coordinators was asked if they thought it was possible to conduct such a project. They answered yes and the project started (January).

The project members had more than two months to develop an userfriendly solution. One solution was made during this period, but due to new requirements they had to start over with a clean slate. At the time I joined the project, they were discussing the new requirements. A use case document had been made and I was asked to read through it and give feedback. I came up with 15 points which needed to be clarified or discussed. Most of them was important issue regarding the use of the application like (question regarding a use case): *what should the teacher do with the id? Why does the teacher need the id now? Is she suppose to store it somewhere?*. Some of the issues was not resolved until much later. Like how to conduct the screening of the students.

During the meeting with the state programme officer (the day before the workshop), it was discovered that the project was complained based and not screening based. During the meeting we asked the following question: what is the frequency of the screenings? She answered: *Your pilot is what, complained based? (...) The teacher will tell the student if they have sore throat or one of the other symptoms they should report to him/her. Screening*

means that you will see all the children. This is an essential requirement which we did not know of or was not aware of until then. During this process the teachers was not involved at all. It was not until the first workshop they got involved.

During the workshop there were no invitation for discussing the application or the process. The focus was on the medical aspects of Rheumatic Heart Disease and a throughout demonstration of the application. Instead of installing the application on every phone, we should have had a dialogue around how to conduct the programme, and asked for feedback on the application. This was a good opportunity to get valuable information from the NSS Coordinators, especially since it is difficult to arrange meetings where everyone is participating. I am not sure why a discussion was not held, because we had talked about it the day before the workshop. It might have been due not sufficient planning, or to much time was used on the medical presentation and the demonstration, so it was difficult to hold the NSS coordinators' attention. But it might also have something to do with the project leader yelling at the chief implementer, who was responsible for holding the presentation, just before it was her time to speak. Maybe she just wanted to get it over with as fast as possible. Either way, we missed a golden opportunity.

For the school training sessions I attended, we only had a small discussion with the NSS coordinator(s) who was responsible for coordinating the meeting. At this point it was too late to do any changes on the application, thus the important part was the teachers motivation and how they planned to conduct the project. These discussions lead to the confusing around the teacher - NSS coordinator issue. This illustrate that we should had started a dialogue with the teachers earlier. Most of the confusion was clarified after the interview I had with the two NSS coordinators.

It was easier said than done to arrange the interview. Since I do not know Hindi and the quality of the English which is spoken varies a lot, it is some times challenging for me to communicate. Thus the chief implementer agreed to help me organize an interview. At this time she was gone on a field trip for another project, thus the communication between us was quite difficult. I had to ask for updates and the reply was slow and often " she [NSS coordinator at the school] is not picking her phone". Below is a excerpt from one of the talks we had. The interview had been settled on Wednesday but some issue had arisen:

Event though it was difficult to arrange, it would not have been possible for me to do it by myself. Which was quite frustrating since the timing was bad. I should have made sure to organize the interviews much sooner, or at

16:41 Me: [intern/Hindi interpreter] is not in shimla tomorrow any suggestion to what i should do? do you think we can postponed it [interview] to thursday? then [intern] will be back and she can join me :) can you call [NSS coordinator] and ask? :)

17:00 CI: cancelled

Me: and moved?

17:01 CI: I calld [NSS coordinator] nd canceld

17:05 Me: why? did u ask if we could have it on thursday?

CI: yeah fynn. u cn tell me wen u want to go

Me: im saying can we postponed it to thursdayg. thursday* any timings are fine with me and [intern]

CI: yeah I told to her will fix date by tomrrw. so u cnfrmd me tomrw

Me: why not now?

CI: thn will call

Me: now?

17:07 CI: plzz fix timings nd day by [intern] also

Me: yes i have talked to her and she can come with me on thursday at any time

CI: okhy thn on thurs at wat tym

Me: whatever suites the teachers

CI: okk

Me: but early is best

17:10 Me: let me know when you have confirmed it with [NSS coordinator] :) so i can tell the details to [intern]

54 minutes later

18:05 Me: you have the timing?

18:06 CI: ingvild she dint pick my call

least before the chief implementer left. I realized to late that the remaining trainings would not happen before after I had left.

The interview was conducted on the day before I left to Delhi (two days before I went back home). Then me and the intern (translator) had travelled to the school two days before to find out that the NSS coordinator was not able to meet us. The intern could only stay for around 30 - 45 minutes before she needed to go back to the office. Thus the plan was to start with one teacher and see how it went. If their English was ok then I could carry on after she was gone. Otherwise, we could return the day after. The NSS coordinators was the persons who was helping us coordinate the interview. We soon discovered that they were in charge of conducting the project thus it was more valuable to talk to them than a teacher.

The interview was the first real involvement of the users. It helped to clarify the confusion we had, and we also got some feedback on how the workshop was conducted. However, they did not have any opinions or suggestions towards the application or how the programme should be conducted. Considering that it requires some experience to answer these questions, and the programme has not started yet, they will hopefully have stronger opinion at a later time. Since an evaluation is planned after three months this will be a good opportunity to conduct new interviews.

To summarize, the user involvement have been very less during this project even though it is an important aspect of achieving good usability. User involvement has not been prioritized which means that we have not received any feedback on the application that has been developed. It has also led to unnecessary amount of time used to trying to understand the requirements and the project scope. Especially much time has been used to discuss how the project would/should be conducted at the schools. A lot of confusion could have been avoided if the user had been involved at an early stage. However, an evaluation will be done after the project have run for three months where the teacher will have much more feedback regarding the application and the conduction of the project.

6.5 Level of usability

There are no question around the importance of good usability in this project. However, the solution which was made did not reflect that perception. It requires the person who use the application to maintain a separate paper

sheet where the UID is mapped to a person containing enough details so that it is possible to identify him/her. If the sheet is lost there are no other ways to identify the student without calling HISP and make them do a database query. There are other ways this could have been solved without the need of the paper sheet. If the application instead had kept a list over all the students who needed a follow up with personal details shown (name, age, fathers name), then the person could have been identified without consolidate the paper sheet. After choosing a person on the list the right form would appear. After completing and sending the form, the person would be removed from the list. This solution would prevent the teachers to worrying about UIDs. All communication would also be done between the application and the modem, not the inbox. Now, the application can only send text messages to the modem and not receive text messages from it. This means that the text messages with UID is sent to the phone's inbox and not to the application. Simple phones run easier out of memory which means that receiving many text messages could be a frustrating process where one need to constantly delete messages.

A lot of the HIS today struggles with replacing paper based systems with electronic systems as discussed in 2.1. For this project we have the opportunity to start a HIS project without an existing paper based system. Thus all the positive effects with embedded paper routines can be more or less ignored. However, we have not seized this opportunity. Once again a big paper format is needed. On a positive note, the paper does not contain any reporting data, only contact information. Thus, every data that is captured will be stored electronically.

Developing applications for simple phones is quite different from smart phones. The screen is even smaller and navigation is more time consuming. The actions which can be performed is restricted to writing, wiping and navigation. Copy paste is not supported only up-down/left-right navigation. Typing however, can be done faster than on touch screens where it is easy to hit the wrong letters. Performing tasks on simple phones is time consuming and clumsy. The user's actions are restricted and it is difficult to navigate between screens. Thus, applications on phones should be as simple as possible. Check-boxes/radio buttons should for example be used instead of text fields wherever suitable, and as little information as possible should be required to write.

For this application check-boxes/radio buttons are used wherever suitable. The number of data elements in the different forms are also kept to a minimum. The most time consuming form to complete is to register a new

student. This is only required to do once except when the information is wrong and a correction is needed. Otherwise the forms should be easy to complete (but we have not got feedback on this). The navigation is also fairly simple see figure 6.1. At the maximum, the navigation goes only three levels down.

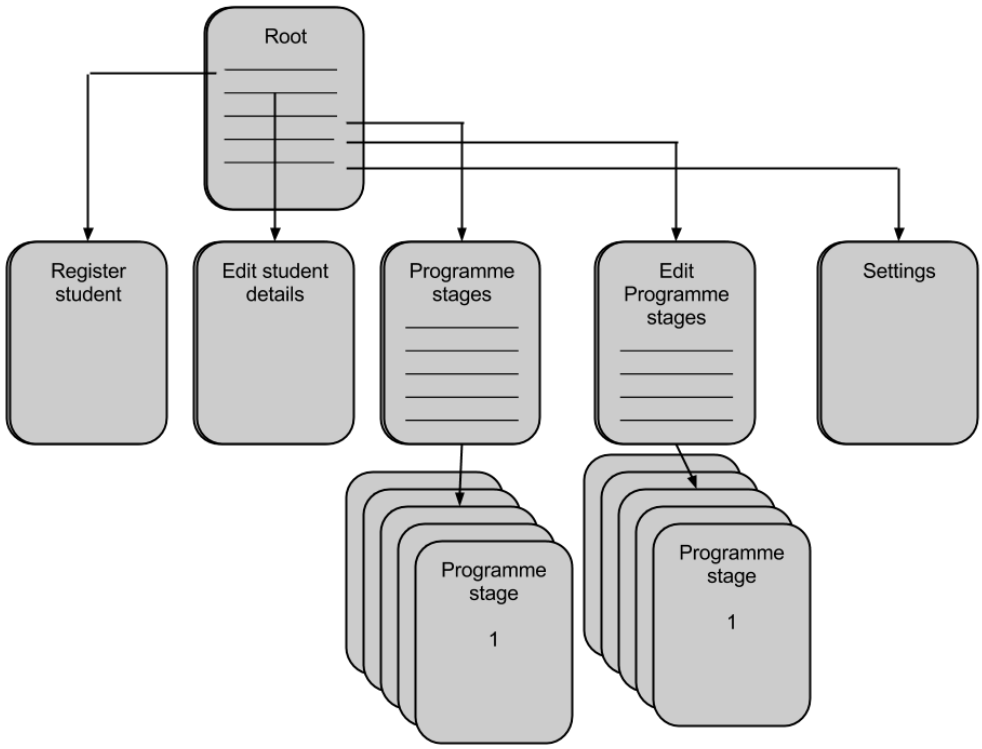

Figure 6.1: The image illustrates the navigation structure for the application. As we can see from the image, at the maximum the navigation goes only three levels down. This helps making it simple and easy to use.

The forms indicates which data elements that are required to answer by using a * symbol at the end of the text. If the user tries to send an incomplete form, the user will get a notification saying "Fill all fields marked with *". There are also checks on students and father's name (character length), class and age (numeric and range), and contact number (numeric and 10 digits). If these fields are not filled out correctly, a notification is given where the concerning field is mentioned and a description of the problem. This ensures good user feedback which is an important aspect of good usability.

The design part of the application is kept minimalistic. Text fields are used for describing every data element, no icons are used. The colours are mostly

black and white except a blue colour which is used to mark the heading and which action that are possible. A typical form design have been tried to be designed which the users can easily recognize. See figure 6.2 for an example.

Figure 6.2: The image illustrate some of the screens in the application. A typical form design is recognisable.

6.6 Robustness

One of the definitions of robustness is *the ability to maintain flexibility in a future which cannot be predicted or foreseen with any degree of certainty* [88]. It is about changes and how the system reacts to it. Thus it is an important quality for projects where it is likely that changes will occur. For this project, the application will probably not be used in the same way and in the same setting. There are five different schools which are participating and there are no official guidelines in how they should conduct the project. The responsibility between NSS coordinators and the teachers will most likely be different as well. To increase the chance of succeeding one should strive to make the project as robust as possible. How can robustness be achieved?

6.6.1 Process robustness

Process robustness is how well the process regarding the use of the application will handle changes. The most important part in this process are the teachers and NSS coordinators together with the students. What will happen if the NSS coordinator don't have time to use the application, or the modem is not working so they can't report? The outcome of these scenarios will determine the level of robustness.

What do the teachers actually gain for using the application? In *Groupware and social dynamics* [89] Grudin looks at 8 different challenges when developing groupware (software used to enhance collaboration between users). One challenge he points out is that the software which is developed should be beneficiary for every user. To often software requires additional work of users who does not receive any benefit from it. This often results in software not being used which again leads to project failure. A typical example is sending voice recordings instead of textual emails. For the sender it is very convenient - talking is faster than writing and emotions can easily be expressed. For the listener however, it is more troublesome. The recording is slower to take in and it is not easily scanned or reviewed. Thus writing a reply would require the recording to be listen to many times before it can be certain that all questions are answered. The author asks when it is acceptable to burden the listeners in that way. He answer with the following: *If the role is changed equally, if the speaker is disabled (unable to type) or that the speaker is of higher status. But in general, the disparity in effort and benefit works against acceptance in many situations.*

Even though the application we have developed is not typical groupware, the same challenge applies. Why would the teachers use a lot of time and effort on an application they do not receive any benefit from? Thus, an effort should be done to make sure that the teachers receives more benefit from using the application. Initially, the only benefit they received was the well-being of the students. But is this enough? Among the stakeholders, it is the parents and student together with the health department who receive the most benefit. The treatment of RHD is extremely costly, both for the hospital and the parents. Most people in India do not have medical insurance which means that they have to pay for the treatment themselves. Preventive measures is far less expensive and can thus save the families economy, if not to mention the student's life. The additional work the parents and the medical personnel have to do to provide preventive treatment, is minimum, if any. All the work is on the teachers.

It will be very interesting to see the feedback from the teachers after the trial is over. To provide more benefit to the user, one should investigate the NSS coordinator's role to find out what exactly it is. Maybe there are something which can be done with the application or a free SMS package can help with, which can serve as an additional benefit? How can their motivation be increased? Measures which have been taken is to make sure that they do not need to pay for the text messages or calls when using the application. A monthly amount of 300 Indian rupees (one text message costs around 0.80 rupees) is provided for each school. Will this be enough?

If they gain benefit from using the application or feel that the application is very important for the students, it can help to tackle changes. If someone who is responsible for reporting looses his/her phone, then either the person can continue as normal or try to solve the issue. With the right motivation, it might be enough to make sure that the person chooses to fix the issue. Thus the motivation is the key.

Our biggest fear is that the NSS coordinators and teachers do not have time to use the application. Another approach, can be to lessen the additional workload and distribute it to other stakeholders. A solution involving medical students connected to the IGMC was suggested. It would reduce the teacher's responsibility and past it on to the health sector. For this solution the teachers would only register the student and all follow up responsibility is given to the medical students. When the suggestion was presented to the head of the department of cardiology a categorical *no* was given. This part was done in Hindi so I am not sure how the proposal was done. It might be worth to try to convince the cardiologist one more time and make sure he understands the full intention behind the idea. This solution would had strengthened the project and minimized the risk of failure. The allocation of responsibility would have been more rightful; The medical aspect would be the hospital responsibility. I think a teacher could easily question why he/she is responsible for the students health when he/she is only a teacher. By including medical students one would achieve redundancy which strengthens the robustness. With two institutions it would also put more pressure on using the application.

In the end, all comes down to the teachers' motivation. In the questionnaire we handed out, we asked *Do you think using mobile application will increase your workload?*. The result we got is shown in figure 6.3. The results are fare from representative, but as we can see there are varying opinions among the 27 teachers and NSS coordinators we have asked.

To cope with problems occurring when using the application a "Frequently

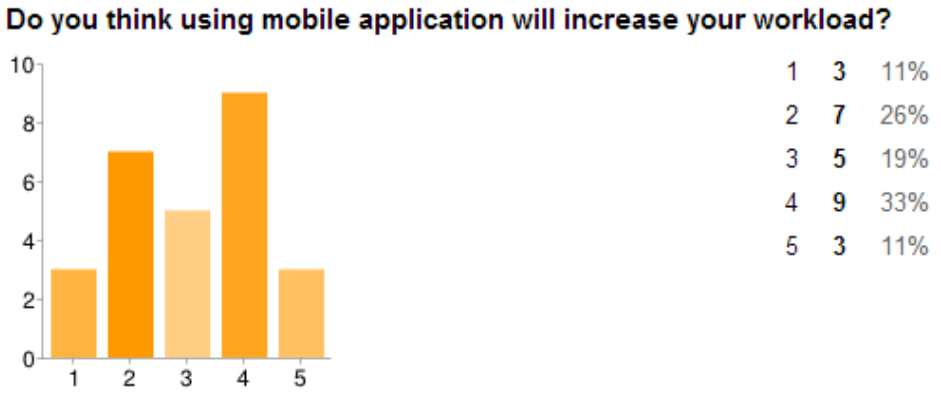

Figure 6.3: The figure shows what 27 of the NSS coordinators and teachers answered on the question: "do you think using mobile application will increase your workload"? 1 is strongly agree and 5 is strongly disagree.

Asked Questions"-document have been prepared. We have made the questions and answers based on the situations we expect to happen. A contact number to the chief implementer is also provided so they have someone to reach if they don't find a solution. We hope that this will help to cope with changes towards the use of the application. Most likely some questions are missing. Thus the document should be updated whenever a missing question is discovered, and be distributed.

6.6.2 Product robustness

Another important aspect of robustness is how the *product* reacts to changes. There are two important issues I would like to address. The first is if/when a new version of the application must be deployed. The expenses of distributing the version will be high since it most likely has to be done in person. The internet connection at the schools is most likely quite unstable, and in addition it requires someone technical enough to transfer the file from a computer to all the required phones. If such a person is not working there, HISP could train one to do this, but either way the distribution will still be expensive in the sense of time consumption. For smart phones however, it is easily done through the different application markets. The prerequisite is that the phone needs to have internet access. Then the application will either update itself automatically or they will get notified and by pushing a single button they will have the new version.

The second issue is smart phones. With increasing use of smart phones the need to support it will be more crucial. Currently this is a weakness towards robustness. However, the website can be used but there have been given no trainings on the area, and it is not optimized for mobiles.

Hopefully, since the application is quite simple, few changes are needed, but it might be dangerous to rely on that. There are few options towards improved distribution of newer versions for simple phones. For this project there are only five schools involved, thus one person can manage to travel to all of the schools. Should the project expand to include more schools a strategy on how to distribute new versions should be agreed upon. For the smart phone issue, we realized too late that the application was not compatible with their operating systems. Supporting smart phones should be a priority for further development.

6.7 Standardization

The concept of standardization is simple: similar things are cheaper to produce than different things. It is about efficiency, leverage of resources, and sharing and exchanging information across multiple local settings and systems. Companies like HISP India, who experience challenges as understaffing, limited resources and equipment, will particularly benefit from developing standardized systems. Not to forget the importance of establishing standardized processes and communications protocols when developing HIS. Considering that one of the long-term goals for this project is to be able to expand the project to other schools and included additional diseases. The question is, what forms of standardization can facilitate this type of generalization?

The main goal for this project, is to see if it is possible to use a mobile based health reporting tool in schools, used by teachers. If it proves to be possible, then the project can be expanded to include additional diseases. By accomplish a fine line between standardization and customization, the additional diseases can be implemented in a effective manner. However, it seemed that this part of the requirements had more or less been forgotten. When I addressed the issue, there were only approximately one week left to develop such an application. This was not feasible to accomplish. In addition, the developer had stated pretty clear that he did not believe that the teachers would have time to use the application. He was also in Delhi working on another project after the application had been developed. Thus

it was difficult to do anything towards this part of the requirements.

The day before I went back to Norway, I had a discussion with the developer regarding his opinions on the architecture that has been developed, with special concern towards the standardization and generalization aspects. He told me that a template was used when developing the graphical user interface (GUI). The template contains buttons, text fields and other types of GUI components which can easily be used for different applications. There are also a setup for use of menu screen and navigation to multiple pages. For GUIs, there will always be some customization from project to project, so it seems reasonable to use a template. J2ME Polish is used on the client side.

The server side presented more challenges. The server side consists mainly of two modules: DHIS2 and a modem. The challenge is how to import the SMS received in the modem and into DHIS2. For this task, a new solution was required. In the old solution the messages were stored for approximately 5 minutes before they were imported into DHIS2. This lead to storage problems when many text messages was received. In the new solution, the text messages are read from the modem immediately. The content of the text messages are stored in an XML format which is read by DHIS2. For each new project a small customization of this format is needed.

The developer finds the level of standardization of the server side as fairly good. There must be some customization done when it comes to importing the xml-file since it will contain different data elements from project to project. The only problem is the quality on the new solution which was developed. The concept have been improved, but a re-factoring of the code should be done to ensure better quality. Due time limit, the implementation was done in a hurry.

On the client side the use of templates make the solution balanced between standardization and customization. There will always be changes on the GUI from project to project thus the use of templates is an effective way to save time. This is illustrated with the short developing time usedt: *"around a week on the mobile app on and off and about a week on the server side dhis part"* (estimated by the developer).

The problem is that smart phones are not supported. A cross platform tool which works for smart phones as well as java phones, or a template only smart phones which will be additional to the existing J2ME, should be developed. To only use the J2ME solution for future projects will not be sustainable.

Another issue towards standardization and generalization is that the team in India has made their own customization of DHIS2. There is a team in

Oslo and Vietnam who works on the "global" version of DHIS2. However, in India they have had requirements which the global solution have not support and thus implemented them. This could potentially be a great risk towards generalization and standardization. If the two versions of DHIS2 becomes too different, they have to be merged at some point if they are to benefit from each other. This can potentially be very expensive. However, both the teams are aware of the situation, and as long as they keep a good dialogue, hopefully, it will enhance the system and not the opposite.

Back to the question, *what forms of standardization can facilitate this type of generalization?* A bottom up approach has been advised in several papers concerning standards in the healthcare [90]. By using a bottom up approach standards are "evolved" throughout the development and implementation process, instead of being enforced. Thus it will be easier to adjust to local processes, and there are room for improvements. It is a more step-by-step approach which will make the transition less risky. Large and abrupt changes often comes with unwanted effects, like Ahus experienced.

A bottom up approach is well suited for this project. Even though there have been done little towards generalizing the system yet, the project is planned to run for a year which gives room for the needed "evolvement". However, close attention and good collaboration with the users are needed to be able to discover the changes that is required. Only by analysing how the application is used, makes it possible to optimize the work-flow.

One important thing that should not be forgotten is the Aadhaar project (social security number). It might prove very valuable to replace the UID which is used now, with the Aadhaar-number. This will enable communication of health data across multiple systems. Any treatments that are funded by the health department will be based on this number. Thus, the child can seek funding automatically through the application if the Aadhaar-number is used. As we can see, this opens a lot of new possibilities.

6.8 Improvements

6.8.1 Increased user involvement

Users should have been included in the development process from the beginning. Particularly involved in discussion of the concept and how to conduct the project. Instead, an application have been developed based on our as-

sumptions on how we think it will be best conducted. This can easily lead to a design-actually gap (see 2.2.3) which again can increase the chance of failure. The recommended approach to avoid this gap is to use an iterative developing approach. Even though this approach have not been used, it is not too late. The project is planning to last for a year, so there are many opportunities for user involvement and improvements. After the project has run for three months it is planned to have an evaluation. This is an opportunity where the users should be involved so it is possible to get feedback. Based on the feedback, changes can be done in both the application and how the project is being conducted.

There are many ways to conduct the evaluation - questionnaires, workshops, interviews, observations and so on. The expense in terms of resources are everything from complexed workshops to simple questionnaires. Thus, there are no excuses for not involving the user. There will be an option suiting every budget. For this project, it is important to facilitate a discussion. Thus workshop and/or interviews are best suited. It is easier to get an in-depth understanding of the issues they are experiencing, and solutions can be purposed and discussed accordingly. They same goes for the development of the smart phone solution - one should try to get as much user involvement as possible during the process. At least it should be tested on a person, preferable one of the users but any person is better than none [42]. It could be wise to wait with the development until after the evaluation if bigger changes are required.

If successfully exploited, in the end, the user involvement can be at such a level that the actuality-gap is minimized. On another note, how likely is it that the user-involvement will be improved, when there are no excuse for not doing it, and still it is not done? My assumption is that the importance of user-involvement have just been forgotten. By reminding them, everything will be solved. But it does not seem to be that simple.

Even though the caste system has been abolished, a lot of the mentality is still left. I can only speculate, but this might have something to do with the low user involvement. When the hierarchy is important inside an organization, it is likely to be even more important between institutions; Who is allowed to talk to whom, and through which channels. If information has to go through the management on each institution it will take time to reach the “bottom” (of the hierarchy). If it is important for the “bottoms” to interact, how should this be done? Or who can decide that it is in fact important? I do not have any good solutions towards these challenges. It is up to HISP to solve it if this is the case.

6.8.2 Project planning and methodology

Confusion can characterize the communication in this project. There have been a gap between the team-members and the project leader. This gap should be narrowed. By introducing some common guidelines in how to keep all project members up to date, this could be achieved. Like daily or weekly stand-up meetings (from the scrum methodology) where all project members are gathered to have a status update. Any questions can be raised and progression or other relevant issues can be discussed. This should not be to difficult to arrange, considering that all team-members is situated in Shimla. The only problem is when someone is out of office, but then a Skype meeting can be held instead, or a short email could be sent. The problem now is that planning and deadlines are all done verbally. Thus it might be difficult to foresee if this deadline is definite or just an approximation. Dates can also be forgotten when just agreed upon verbally. If the stand-up meeting is not feasible then even a simple email can improve the situation.

If each project should impose daily or weekly stand up meetings and the project manager shall attend all, it is conceivable that this solution is not feasible after all. The problem have been communication between team-members and the project leader, and not within the team. Thus, by "promoting" the chief implementer she could have the responsibility to make sure that both the team and the project leader is kept updated. A fixed weekday or two where the two of them have a "meeting" could be a starting point. It is important that even though it does not feel that anything new has happened, the meeting at that fixed day should still be held. It is easy to forget or neglect things.

Planning is an important part of management 2.6. When I was trying to organize the interview with the school teachers I was depending on having a translator with me. At that time there were only one intern who spoke Hindi left at the office, so she was the only person who could come with me. She told me the day before we left, that she might have to go to a hospital to do some research. Hence she might not be able to stay that long with me, but this she would not know before the same day. On that day she was told by the senior health officer that she had to go to the hospital. Another employee would come along to help, thus she needed to come back to the office so they could travel together. When we returned after the interview she was told by the senior health officer that she could manage the work alone, thus the guy did not come with her after all. The interview was being rushed because she only had approximately 30-45 minutes with me before she had

to go back. If she had known when she left the office that the other guy was not coming after all, we could at least have another 30 minutes extra due saved travelling.

This illustrates the need of better management. First of all, one should know whether one is leaving for field work before the same day. Field trips require preparations if to be done properly. If working on more than one project, it can also turn out to be very unfortunate for the other project(s). Second, one should know who is coming with you or not. The available resources are an important aspect when planning and conducting field trips. By being told that the extra resource you were planning on is withdrawn just minutes before you are leaving, will affect the organization and conduction of the field trip. In the worst case the field trip or research would not be possible to carry out.

6.8.3 Technology

The biggest challenges for this project is how to support as many phones as possible. Out of 59 mobiles (only three of the schools are accounted) we where able to successfully install the application on 24. This gives 40% coverage which has to be improved. In India most people uses simple mobile phones, but there exists so many different brands and models which have been developed in a time range of 10-12 years which makes it almost impossible to support every kind. The system requirements are bluetooth enabled phones and being able to run Java applications. By using the Java 2 Micro Edition (J2ME) one can develop such applications. For simple phones, we experienced when installing the application, that some phones did not have bluetooth, others where unable to locate the file after transferring it and some could not install the jar-file. Thus the success rate of installing the application was rather low. How I see it, it will be very difficult to fix these problems, except for buying them new phones. Hopefully it will solve itself by people replacing the oldest models. The focus should be directed towards smart phones instead.

When the technology was chosen there were no research done on the alternatives to J2ME Polish. The developer had used the tool before and was familiar with the technology. The smart phone issue was not fully discovered before after the "choice" was made. It was not really a choice between different technologies. Since the development of the application did not start until it was only approximately one week left, any other options than the technology the developer was familiar with was left out.

For companies to stay competitive, adoption of new technology is crucial. If HISP India is not able to support smart phones, what future are they developing for? The team in Oslo is working on customizing the website for mobiles, but currently it does not support the tracker module. In addition, reporting through text messages will still be cheaper than internet based. Thus a smart phone solution which is text message based should be developed to make the application as feasible as possible.

There exist so many tools and developing kits for mobile applications where each have its own advantages and drawbacks. To find the right one can be a time consuming and challenging task. Thus time and research should be invested. It can be very costly if the wrong choice is made. The optimal solution will be to make it possible to design the application on DHIS2, and then export it to the different mobile operating systems. Then everyone can make a mobile application regardless technical background. This will be a step towards enhanced standardization which can save time and resources for future projects. It can even be critical for HISP's future.

Another issue which is important not to forget, is that typing on computers are much faster than on mobile phones. With cheaper hardware and improved infrastructure, laptops and tablets will be more and more common in developing countries. A Google Chromebook for example costs only 199 USD $ which is cheaper than many smart phones. Thus desktop solutions will be more relevant for projects where the user stay more put (as teachers), and tablets for both moving and not moving users. The DHIS2-website is serving this purpose. A lighter version of the site have been developed to support areas which have poor connectivity, and it also support offline mode. If the reporting can be done through Wi-Fi/Ethernet which is already paid for, the reporting costs can be kept at a minimum. If having an application that is synchronized for all devices (mobile, tablet, desktop) the users can choose which device they want to use at any time. It is important to remember that even though the project is typical mobile-based, desktop or tablet solutions might also be relevant. However, the user-interface must be simple and very easy to use. In my opinion, after using DHIS2 for 2-3 months, it has a lot of potential regarding improvement of usability (I still find it confusing to use). Poorly designed applications or websites can easily lead to great support and training expenses. The importance of good usability should not be neglected.

Chapter 7

Conclusion

During the two months I worked on the project, an application that let teachers report suspected cases of Rheumatic Heart Disease and Rheumatic Fever has been developed. Two schools have also received trainings in how to use the application and detect symptoms. The remaining three schools have all received the training within the beginning of June, only a month behind schedule. The chief implementer could also inform me that reports have started to come, and a case of RHD has already been detected. Seemingly, the project has been a success thus far. However, it remains to see to what extent it will succeed in the long run.

Despite the broad acceptance of the usability principles, user-involvement has almost been non-existent. This has been the leading cause of most problems faced during the project. Even though the project is operating within a low resource setting, there are many options of cheap user-involvement activities. The resources saved by not involving users, usually has to be paid back with interest at a later stage. Thus, there are rarely any excuses for not involving the users. This might indicate other underlying organizational problems. In either case, if the problems are not addressed, the chance of late and expensive changes is likely.

Expanding the project to other schools and including additional diseases, have always been the long-term objective for this project. Robustness and standardization are critical aspects towards achieving this. Currently, there are no means to distribute new versions of the mobile application, besides visiting every school. If hundred of schools are participating, this will not be a feasible solution. It will demand resources that this project does not have. A solution that increase the project's resource utilization has to be derived.

With the increasing use of smart phones, it is becoming crucial to support these devices as well. Time should be invested to ensure that the implemented solution is reusable. I.e. future projects can benefit from the effort put into this project. Reusability can be achieved through standardization and the development of general, customizable solutions. Reusing existing solutions can impose great advantages for projects operating in low-resource settings.

As we have seen, there are a lot of potential towards exploiting the project's resources to its fullest. Enhancing standardization and robustness are the key elements in such a process. Considering that this is a one-year trial, the prospect of achieving enhanced resource utilization looks promising. However, increased user-involvement is needed to be able to derive the right standards and to fully understand the project's scope. Only then improved robustness can be achieved. For this project we have seen typical user-involvement activities like workshops and trainings, but during this sessions there were usually only a one-way communication from HISP to the users. Discussions, opinions, or suggestions from the users have not been encourage. For further research, it would be very valuable to investigate the possible reasons. Have usability just been forgotten, or are there any deeper underlying causes?

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Appendix A

Appendix

	TRADITIONAL TESTING	LOST-OUR-LEASE TESTING
Number of users per test	Usually eight or more to justify the set-up costs	Three or four
Recruiting effort	Select carefully to match target audience	Grab some people. Almost anybody who uses the Web will do
Where to test	A usability lab, with an observation room and a one-way mirror	Any office or conference room
Who does the testing	An experienced usability professional	Any reasonably patient human being
Advance planning	Tests have to be scheduled weeks in advance to reserve a usability lab and allow time for recruiting	Tests can be dine almost any time, with little advance scheduling
Preparation	Draft, discuss, and revise a test protocol	Decide what you're going to show
What/when do you test	Unless you have a huge budget, put all your eggs in one basket and test once when the site is nearly complete	Run small tests continually throughout the development process
Cost	$5.000 to $15.000 (or more)	$300 (a $50 to $100 stipend for each user) or less
What happens afterwards	A 20-page written report appears a week later, then the development team meets to decide what changes to make	The development team (and interested stakeholders) debrief over lunch the same day

Table A.1: The table illustrate how user testing can be done in different ways in regard of expenses. The table is from [42]

1. **The Fundamental Principle of the Hermeneutic Circle**
   This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.

   Example: Lee's (1994) study of information richness in e-mail communications. It iterates between the separate message fragments of individual e-mail participants as parts and the global context that determines the full meanings of the separate messages to interpret the message exchange as a whole.

2. **The Principle of Contextualization**
   Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.

   Example: After discussing the historical forces that led to Fiat establishing a new assembly plant, Ciborra et al. (1996) show how old Fordist production concepts still had a significant influence despite radical changes in work organization and operations.

3. **The Principle of Interaction Between the Researchers and the Subjects**
   Requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants.

   Example: Trauth (1997) explains how her understanding improved as she became self-conscious and started to question her own assumptions.

4. **The Principle of Abstraction and Generalization**
   Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.

   Example: Monteiro and Hanseth's (1996) findings are discussed in relation to Latour's actor-network theory.

5. **The Principle of Dialogical Reasoning**
   Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.

   Example: Lee (1991) describes how Nardulli (1978) came to revise his preconceptions of the role of case load pressure as a central concept in the study of criminal courts several times.

6. **The Principle of Multiple Interpretations**
   Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.

   Example: Levine and Rossmore's (1993) account of the conflicting expectations for the Threshold system in the Bremerton Inc. case.

7. **The Principle of Suspicion**
   Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

   Example: Forester (1992) looks at the facetious figures of speech used by city planning staff to negotiate the problem of data acquisition.

Figure A.1: Klein and Myers principles for interpretive field research.

Rheumatic Heart Disease Surveillance Mobile Application Training

Training Evaluation Form

Date: 3th April, 2013

Please complete the evaluation for today's training session – your feedback is valuable to us and is appreciated.

Criteria	**Strongly Agree 4**	**Agree 3**	**Disagree 2**	**Strongly Disagree 1**	**Don't know 0**
Training was effective					
Instructor was prepared					
Length of training was sufficient					
Content was well organized					
Questions were encouraged					
Instructions were clear and understandable					
Training met my expectations					
Materials provided were helpful					

General comments:

_____

Thank you for taking the time to help us improve our training

Figure A.2: The feedback form used during school training sessions

RHEUMATIC FEVER/RHEUMATIC HEART DISEASE Surveillance Program
Declaration: This survey is purely for Research and Academic purposes only

1.0 **Respondent Details**	
1.1 NAME	
1.2 NAME OF THE SCHOOL	
1.3 AGE	1. 18-25 years 2. 26-35 years 3. 36-45 years 4. 46-55 years 5. 56-65 years 6. over 65 years
1.4 Which class do you supervise?	

2.0 Knowledge and awareness	**Tick the appropriate box**
1. Have you heard about RF/RHD?	Yes No
2. Do you know what causes it?	Yes No
3. Can you spot the signs and symptoms of RF/RHD?	Yes No
4. Which age group is most affected	Yes No
5. Do you know how to take preventive measures for RF/RHD?	Yes No
6. Have you ever come across someone suffering from RF/RHD?	Yes No
7. Do you know about the treatment for RF/RHD?	Yes No

1.1 **Basic Computer Awareness:**

1. Do you think IT applications are useful in Health programs?	Yes No
2. Have you ever heard of Health information System?	Yes No

RHEUMATIC FEVER/RHEUMATIC HEART DISEASE Surveillance Program
Declaration: This survey is purely for Research and Academic purposes only

3. What do you use your mobile phone for? (you can tick more than one)	1. Making and receiving calls 2. Sending and receiving sms 3. Sending /receiving mails 4. Surfing the internet 5. Play games

4.0 Knowledge about DHIS mobile:

1. Can the use of Mobile application for tracking the RF/RHD increase the efficiency of controlling RHD?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
2. Can the use of Mobile help in prompt reporting of RHD cases?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

5.0 Attitude towards mobile Application:

1. Do you think the use of Mobile Application will make you feel more competent?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
2. Do you think using mobile application will increase your workload?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
3. Do you think you will find it easy to use mobile application for tracking RF/RHD?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
4. Do you think use of mobile application will help in identifying the RF/RHD cases more effectively?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

RHEUMATIC FEVER/RHEUMATIC HEART DISEASE Surveillance Program
Declaration: This survey is purely for Research and Academic purposes only

6.0 Behavior towards Mobile application:

1. Do you think you will find it easy to use the mobile application for tracking RF/RHD	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
2. Do you think use of mobile application will help in identifying the RF/RHD cases more effectively?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree
3. Can mobile application help in assuring quality (Preventing duplication of data)?	1. Strongly agree 2. Agree 3. Neutral 4. Disagree 5. Strongly disagree

RHEUMATIC FEVER/RHEUMATIC HEART DISEASE Surveillance Program - Frequently Asked Questions

Contact information:
xxxxxxxxxx
xxxxxxxxxx

RF/RHD

What is RF/RHD?

Rheumatic fever (RF) is an inflammatory disease that develops 2-3 weeks after inadequately treatment of group A streptococcus. The rheumatic fever is most common for children between 5 and 15, but it can also affect adults and younger children. The symptoms are sore throat and fever. If not treated it can lead to Rheumatic Heart Disease (RHD) which is one of the most dreaded complications after rheumatic fever. This can happen even up to 5/6 months after signs of RF is seen. RHD can cause permanent heart damage including heart failure and damaged valves. The treatment can reduce tissue damage from inflammation, lessen the pain and prevent the recurrence of the fever.

What are the symptoms of RHD?

The symptoms for RHD are joint pain, breathlessness and abnormal movements.

Application

How to open the application?

Turn on your mobile, go to “Menu” and locate the “Games” folder. It can be a folder in “Applications” or a seperate folder. Open the folder. Here you should see either a folder called RHD surveillance” or the application called “RHD”. If you find the folder called “RHD surveillance” open it and then open the application “RHD”.

If you can’t find the application called RHD in the Games folder contact xxxxxxxxxx

I get an error message when trying to start the application. What should I do?

Please write down the error message and contact xxxxxxxx for assistance.

What is the server number I shall enter in settings?

xxxxxxxxxx

Student registration

This is where you register a new student. After the registration is complete you should receive a

UID. You need to store this together with enough student details to map the UID with student.

What is education block code?
It is the code of the education block your school belongs to.

What is school code?
It is your school's code.

What should I enter under student's name?
If the student have a last name then enter: Firstname Lastname. If the student only have a first name then enter: Firstname. Small letters are recommended.

Why do I get the warning: Student's name must have at least 3 charachters?
A student name can not be shorter than 3 charachters

What should I enter under father's name?
If the student's father have a last name then enter: Firstname Lastname. If the student only have a first name then enter: Firstname.

Why do I get the warning: Father's name must have at least 2 charachters?
A student name can not be shorter than 2 charachters

Why do I get a warning about the student's age?
The student's age can only be in the range from 3-20 years.

What should I enter under class?
The student's class number.

Why do I get a warning about the student's class?
The student's class can only be in the range from 0-12.

Who's contact number shall I enter?
Enter phone number to one of the student's parents.

Why do I get a warning regarding contact number?
Make sure the contact number contains 10 digits

What does "Fill all fields marked with *" mean?
It means that you have one or more fields that are not answered.

Update student details

This is where you can update the student's details if the current information is wrong. Make sure

you have the student's UID and enter all the details (even though they are correct).

RHD Stages

This is where you find the different stages that needs to be completed. You need the student's unique ID to complete the forms. Stage RHD and RF 1-3 should only be completed if you have received a SMS which tells you to do it.

Update stage information

If you have done a mistake in one of the forms that have been sent, this is where you can update a form wich contains errors. You need the student's UID and enter all the details (even the ones that were correct).

SMS

Not received SMS with UID after registered a student?
Please contact xxxxxxx for assistance.

I don't know which student who belongs to this UID?
Please contact xxxxxxx for assistance.

What does the SMS "Data for invalid stage" mean?
If you try to complete a stage before the previous stage have been conducted, this error message will be sent to you. The data will not be stored. So if you send the form RF2 before RF1 has been completed, then you will receive this sms. You should wait for a SMS telling you that it is now time to complete RF1 for student X. The details entered in the RF1 form will decided weather you need to complete RF2 or not. You will be notifed with one SMS if it is time to complete RF2.

Text message sending failed?
Check that you have service. Check that the server number is correctly entered. If that does not work, check that your sim card is working properly and try again. If it still does not work contact us

No letters appear when typing in the text field?
If your phone has a computer like keypad you need to activate the keypad for smaller phones. You might be able to do this by pressing the bottom-left corner button while you press the letters you want to write.

What is UID/Unique ID?
It is a identification number which will identify the student. No student have the same number (unique).