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Cross-border software development of health information system

A case study on project between India and Pakistan based on open source software

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Abstract

Global software development is a phenomenon that is receiving considerable interest from researchers during past two decades. Several challenges have been identified and approaches to deal with these challenges have been developed. Typically, western companies outsource their projects to countries where costs are lower and skilled professionals are easily available. Majority of these projects are developed for commercial purposes. However, software development projects between India and Pakistan involving open source software for public health information systems have never been explored earlier. Therefore, this is particularly a very relevant and important area of research which I have tried to explore through this thesis.

This thesis will address the following research questions.

1. What are the challenges in cross-border software development for open source public health information systems?

2. What are some approaches to address these challenges?

These questions are empirically examined in the context of cross-border software development between India and Pakistan. The project involves development of a health information system based on open source software.

The results show that the complexities of contextual factors are closely connected to several challenges. A problem in conveying and understanding context specific requirements over distance creates delays in the development process but can be mitigated through face-to-face meetings. Also, differences in cultural values and expectations result in conflicts, but could be mitigated by negotiated culture. Moreover, due to the distributed working environment, communication between stakeholders was also found to be a challenge, but online means of communication and meeting face-to-face helped resolve the problem to a certain degree.

To summarize, although linguistic similarities and working within similar time zones are clear benefits of cross-border software development, the importance of face-to-face meetings cannot be done away with.

Acknowledgment

I thank all, who in one way or another contributed in the completion of this thesis. First of all, I am very thankful to our God who gave me strengthen and ability to do work.

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Finally, I must express my very profound thanks to my family members. My father who has been an inspiration in my life, my mother who always prayed for me, my husband who supported and guided me, my kids for supporting me spiritually, my brother and my all sisters especially Hina Sabir who joined me during my field visit in Karachi, Pakistan.

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Table of contents

List of figures

List of tables

Abbreviations

AJK	Azad Jammu and Kashmir
AM	Area Manager
BHU	Basic Health Units
CBSD	Cross-border Software Development
CE	Community Educator
DEO	Data Entry Operators
DHIS	District Health Information System
DHIS2	District Health Information Software - version 2
DHQH	District Headquarters Hospitals
DoH	Department of Health
FATA	Federally Administrated Tribal Areas
GoP	Government of Pakistan
GSD	Global Software Development
HIS	Health Information System
HISP	Health Information System Program
HMIS	Health Management Information System
HSP	Health Service Provider
IHIA	Integrated Health Information Architectures
IPC	Inter Person Communication

IS	Information System
LGO	Local Government Ordinance
MAWRA	Married Women in Reproductive Age
MCHC	Maternal and Child Health Centers
MIS	Management Information System
MoH	Ministry of Health
NHIRC	National Health Information Resource Centre
NHSRC	National Health Services, Regulation and Coordination
NPM	National Program Manager
OPD	Out Patient Department
OSS	Open Source Software
RHU	Rural Health Units
SD	Software Development
SSF	Supportive Supervision Form
UC	Union Councils
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VP	Vertical Program

1 Introduction

Global Software Development (GSD) is now a mainstream phenomenon in the world of software development, which has been explored by several researchers during the past two decades. Through GSD, well-established customers from western countries are outsourcing their IT projects to countries where costs are relatively lower (Sahay, Nicholson et al. 2003), and where exists a large pool of skilled professionals available (Herbsleb and Moitra 2001). While a great variety of IT projects can be developed in GSD arrangements (Ebert 2011), a primary focus has been on development for proprietary purposes. Further, most GSD work has involved projects for commercial purposes. However, research about Open Source Software (OSS) for public settings in GSD is clearly lacking.

OSS usually involves large user groups as customers and a large community of developers as suppliers (Feller and Fitzgerald 2002) and is developed within a global environment. The Health Information System Programme (HISP) is a research network coordinated from the Department of Informatics, University of Oslo, Norway, and which is engaged in the development of a global product (DHIS2 – District Health Information Software) involving a global community. HISP is a global network that has been working to strengthen public Health Information Systems (HIS) in developing countries since the mid-nineties (Braa and Sahay 2013), and the network seeks to strengthen public health systems. The HISP network comprises of a large community of developers from different countries such as Norway, South Africa and India. The HIS of developing countries are often very large, complex, user dependent and context specific (Braa and Sahay 2012). Therefore, they need special considerations in terms of understanding requirements when developed in the context of developing countries by using OSS technologies.

HISP network nodes are spread out worldwide and HISP-India is considered one of the biggest and oldest nodes in this network. Pakistan is another developing country in the South Asian region which has a weak health system (Jalal 2014) and also their supporting HIS (WHO 2007). India and Pakistan share a border but software development between these two countries which involves OSS for public HIS have not been explored earlier both in practice and research. Therefore, this is particularly a very relevant and important area of research which I have tried to explore through this thesis.

Cross-border software development (CBSD) between India and Pakistan would be very interesting to study because both countries have had a series of wars and ongoing conflicts since their partition in 1947 (Ganguly 2013) despite sharing a common border and various cultural similarities.

1.1 Research questions

I have chosen the following research questions to study in this thesis.

1. What are the challenges in cross-border software development for open source public health information systems?

3. What are some approaches to address these challenges?

Research in the area of CBSD is clearly limited in existing literature. Previous research in GSD has identified several challenges (Mockus and Herbsleb 2001) and also several approaches to deal with these challenges (Ebert 2011). Most frequent challenges observed are related to distance (Herbsleb, Mockus et al. 2001), cross-cultures (Krishna, Sahay et al. 2004) communication (Herbsleb and Mockus 2003) and the understanding of requirements (Damian 2007). These challenges are explored in this thesis in the context of India-Pakistan collaborative GSD. Existing research also indicates that the effects of these challenges can vary with different business models adopted for the project (Prikladnicki, Audy et al. 2007). Nearshoring is one such business model. Outsourcing IT projects to a low cost country that is relatively close in distance or time zone or in both is called nearshoring (Carmel and Abbott 2007). Preceding research on GSD claimed nearshoring to be more beneficial in terms of alleviating temporal and cultural distance (Carmel and Agarwal 2001). However, subsequent research has revealed that nearshoring in practice may not be as significant as previously assumed (Markov, Wiener et al. 2011) despite being based on proximity of linguistic, temporal, geographical and cultural closeness within countries (Abbott 2004). Hence, nearshoring particularly is an interesting phenomenon. Throughout this thesis my analysis of GSD is based on a nearshoring business model.

1.2 Research context

The research questions posed in this thesis are empirically examined in the context of an ongoing project for development of HIS application between India and Pakistan based on the open source DHIS2 platform.

The District Health Information Software version-2 (DHIS2) is an Open Source Software (OSS), which works as a tool for collection, validation, analysis and presentation of aggregated statistical and also event based data, required for the design and development of a HIS. DHIS2 is being developed by the Department of Informatics (IFI), University of Oslo (UIO) and its global partners, with Oslo having the responsibility for developing the core functionalities of DHIS2.

HISP-India is a NGO, which is the developer in the project studied and has been working over the last 15 years in the area of public HISs in India and also in other countries in the Asian region. HISP-India's development team is responsible for customizing the DHIS2 according to the context specific needs and for the provision of capacity building and support services to the customers.

GS-Pak, an organization from Pakistan is the customer of this project. This non-profit organization (NGO) is providing family planning services through various kinds of entities such as health facilities, medical practitioners, NGOs and others. Previously, GS-Pak was using an in-house software application but decided to replace that with one based on the DHIS2 platform. Through this new application, the organization seeks to monitor the activities of their different entities to support their improved planning and management. To accomplish this task, GS-Pak contracted HISP-India.

The empirical study, in addition to various Skype discussions with both partners, also involved a one month field visit during June-July 2016, in Pakistan. To gain the full understanding of the context it was also necessary to get an insight of the practices of the HISP-India team. To accomplish this task, I contacted HISP-India several times, by using online means of communication. I also had the opportunity to have a few face to face discussions with senior members of HISP India when they were in Oslo.

1.3 Chapter overview

After providing a brief introduction to the aims of the thesis in this chapter, in *Chapter 2 – Background* , I will describe different aspects of the context (of Pakistan), including its population, administrative division, structure and levels of health care system, and details of the different health care providers. The cross-border relationship of Pakistan with its neighboring countries will also be presented to get a better understanding of the context of the project selected for this thesis. Since this thesis is based on a study of the development of HIS application for Pakistan, I will also discuss the existing HIS in Pakistan and the challenges associated with them.

Chapter 3 – Research approach introduces the philosophical foundations and research methods selected for this thesis. The main source of data collection was interviews, user observations and these details will be presented in data collection section. The techniques used for data analysis will be presented in this chapter along with an overview of the themes and main findings.

Chapter 4 – Theoretical background presents the literature used as a body of knowledge for this thesis. This chapter is divided in four sections. The first section will present the CBSD term in the light of GSD, its different business models and its relationship with nearshoring. The second section presents OSS and the different public HIS developed by using OSS technologies. The third and fourth sections will discuss different challenges and approaches to deal with these challenges in GSD generally and in a nearshoring context specifically.

Chapter 5 – Cross-border software development between GS-Pak and HISP-India provides an overview of the case study and is divided into three sections. This case study involves GS-Pak as a customer of the project and HISP-India as the supplier, and both of them will be presented in separate sections. The project itself which is undertaken in CBSD setting will also be described in detail in the third section.

Chapter 6 – Analysis embodies the main themes identified from the case study with the help of examples. The themes identified relate to context, requirements, culture, communications and different expectations.

Chapter 7 – Discussion answers the research questions selected for this thesis. Additionally, I will discuss my contributions to the existing body of knowledge by comparing the findings with the literature presented in chapter 4. Moreover, I will discuss my contributions to practice based on the case study and my analysis.

Chapter 8 – Conclusion summarizes the discussion of research questions and main findings.

2 Background

In this chapter, a brief overview of the research context (Pakistan) will be presented.

Pakistan's population has been significantly increasing in the past few decades and the organization under study was established to control this extra-ordinary growth in best possible ways. The administrative division and structure of health care system in Pakistan is quite complex and different in certain way from other developing countries. Health care provided at different levels by different health care providers makes the context of Pakistan socially and institutionally even more complex. All these aspects of the context have affected the project under study and therefore, an overview of these aspects will be given in this chapter, which will help in understanding the ensuing complexities. Apart from all these aspects, some historical events of Pakistan have also affected nature of the relationship with its neighboring countries. Since, this project is based on CBSD; an overview of cross border relationship will also be presented. Additionally, a brief description of efforts to design and develop different HIS for Pakistan will be given as a background to understand the challenges that might be associated in this process.

2.1 The Pakistan context

Pakistan is located in the northwestern part of the south Asian subcontinent. The area of Pakistan is 796,096 square kilometers; and it features a diversified terrain and topology. The river system of Pakistan originates from the snow covered Himalayan and the Karakoram Range and embraces mainly five rivers that pass through Punjab province and leads to the Indus River which flows through the country for about 2,500 kilometers and ends up in the Arabian Sea in the south. The world's 14 highest mountain peaks each over 8,000 meters are situated in the northern areas of Pakistan and from them Koh-e-Karakoram K2 is considered the 2nd highest mountain in the world. Pakistan has four neighboring countries, on its east and southeast lies India, to the north is situated China, to the north and northwest is Afghanistan, to the west is Iran, and to the south is the Arabian Sea.

Figure 2.1 - Map of Pakistan with its neighboring countries

2.1.1 Population aspects

The population of Pakistan is estimated at 184,925,000 in 2012-2013 and current population growth rate is 2 percent (DHS 2013). Karachi, Lahore, Faisalabad and Rawalpindi are the most populated cities of Pakistan. Population has increased by about 3,776,000 annually between 2010- 2015. World Population Prospects reports that forty six per cent of the world's population lives in "intermediate fertility" countries that have already experienced substantial fertility decline and where women have on average between 2.1 and 5 children (DESA 2015). Intermediate-fertility countries are found in many regions, with the largest being India, Indonesia, Pakistan, Bangladesh, Mexico, and the Philippines. Pakistan is listed at 3rd position according to the size of its contribution to global population growth among nine countries expected to account for more than half of the world's projected population increase over the period of 2015 – 2050.

In the context of Pakistan, several organizations are trying to control the rapid population growth. Social franchising is one of the main strategies adopted by these organizations for

expanding access to reproductive health services. One such organization in Pakistan is GS-Pak, a NGO which consists of a network of family-planning franchises working in the private health sector (McBride and Ahmed 2001). GS-Pak provides better services when compared to other private organizations working within the same field (Bishai, Shah et al. 2008). The project under study is based on the design and development of the DHIS2 based solution to manage the data for health care products and supporting services of GS-Pak.

2.1.2 Administrative division

Administratively, Pakistan is composed of four provinces Punjab, Sindh, KPK and Baluchistan along with areas which are federally administrated namely Federally Administrated Tribal Areas (FATA), Islamabad Capital Territory and Gilgit-Balistan as well as an autonomous region with its own government that is Azad Jammu and Kashmir (AJK) (Jalal 2014). Federally administrated areas have their own legislative entities, which have less autonomy from the federal government than provincial governments. However, the traditional legislative system is operated independently of the federal government in tribal areas of Pakistan (WHO 2007). The administrative divisions consists of three lower tiers of government including thirty four divisions, one hundred and forty nine districts which are typically known as (Zillahs) and further divided into five hundred and eighty eight sub-districts which are known as Tehsils and several thousands of Union Councils (UC) under each Tehsil.

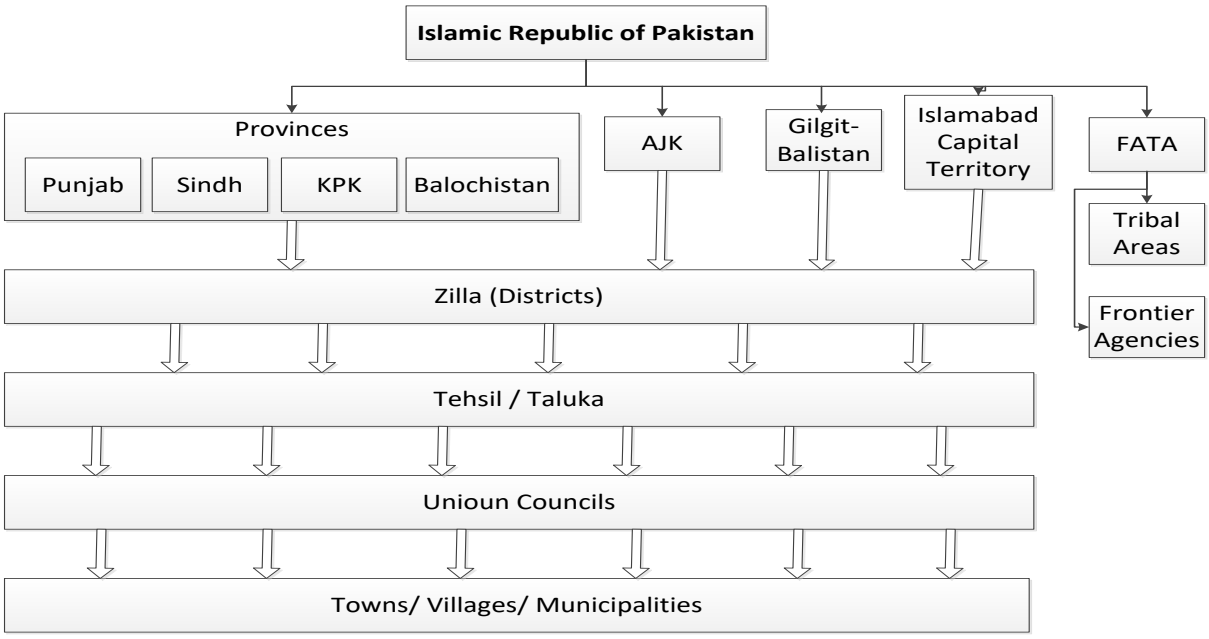

Figure 2.2 - Administrative division of "Islamic Republic of Pakistan"

The table below presents the number of districts and Tehsil (Taluka) of Pakistan.

Table 2.1 - Number of districts and Tehsil or Taluka of Pakistan

Provinces	**Districts**	**Tehsils/Talukas**
Punjab	36	144
Sindh	29	137
KPK	26	69
Baluchistan	32	133
AJK	10	32
Gilgit-Balistan	10	23
Islamabad Capital Territory	1	1
FATA	6 Tribal Areas 7 Frontier Agencies	

Total Districts/Agencies = 157

Total Tehsils/Talukas = 539

2.1.3 Structure of health care system

The structure of health care system in Pakistan is heavily influenced by the unstable political strategies of Pakistan. Since the decentralization policy "Local Government Ordinance 2001 (LGO)" was introduced, the Government of Pakistan (GoP) took an initiative to devolve powers. Provincial government was made predominantly responsible for health care under the constitution of Pakistan, except in the federally administrated areas (Ghaffar, Kazi et al. 2000). However, the federal government was in charge of policies and strategies for the entire population of the country, especially those who are under served. They set national goals and objectives including for maternal health care (WHO 2007) as well as coordination, technical assistance, capacity building and seeking foreign assistance (GoP 2005- 06). Additionally, the federal government plays a supportive and coordinating role to manage and implement a number of vertical public health programs such as the National HIV/AIDS program, National Malaria Control Program (JICA 2012), Extended Program of Immunization, Family Planning and Primary Health Care, National Tuberculosis Control Program etc. Moreover, the provincial department of health works separately under the supervision of Ministry of Health (MoH) that had regulatory, standard setting, technical support and resource mobilization functions which frames laws, regulations to impose government plans (TRF 2010). The health administration primarily reports to local authorities at the district level (WHO 2007). The purpose of the LGO was to transfer administrative and financial powers at the local level to enhance local accountability and improve service delivery (Jalal 2014).

District governments are responsible for planning, development and management including the implementation of health care deliveries for routine health services from District Headquarters Hospitals (DHQs) hospitals right down to the outreach programs through a network of Basic Health Units (BHUs), Rural Health Units (RHUs), maternal and child health centers (MCHCs). These are funded by the federal government (WHO 2007, TRF 2010).

Despite the several benefits of LGOs, there are a number of unresolved issues (Jalal 2014). The federal ministry's participation had grown beyond the role of over sight as described in the constitution due to the involvement in funding for large hospitals and medical college constructions at the provincial level and the management of national programs. The provincial government has failed to fully adjust to the changed role especially in building good relationships with districts particularly in smaller provinces where personnel management and

development resources were still under the control of the provincial government. According to the public, the government health services have not improved and they prefer private health services (Ansari, Cockcroft et al. 2011).

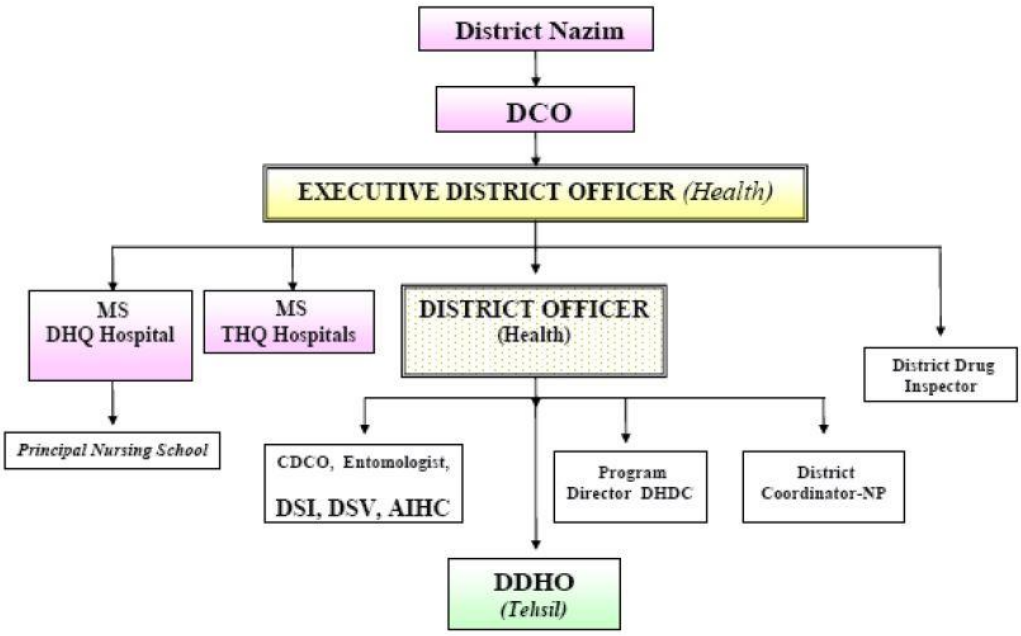

Figure 2.3 - Organizational setup at district level of Pakistan (obtained from "Health System Profile" (WHO 2007), p.32)

In 2010, the parliament of Pakistan passed the 18th Amendment[1] to the constitution which led to the decentralization of about 18 federal ministries or divisions to the four federating units. Later on, in 2011 the MoH was also decentralized. However, it was re-installed as the Ministry of National Health Services, Regulation and Coordination[2] (NHSRC).

The MoH was assigned the very important roles but due to lack of human resources, it was unable to fulfill its job properly in the pre-18th Amendment situation. Management of national health programs and day to day administrative control including logistic tasks overburdened the MoH (Nishtar 2013). The amendment envisages decentralization of authority from the federal government to the provinces (Jalal 2014) that transferred a number of key health responsibilities, including of the vertical programs, exclusively with absolute administration and financial autonomy (JICA 2012).

[1] http://www.pildat.org/Publications/publication/Publications.asp
[2] http://nhsrc.gov.pk

2.1.4 Levels of health care

Health care delivery in Pakistan is based on a three-tiered system and a variety of public health interventions (JICA 2012). The levels of health care are presented in the figure below.

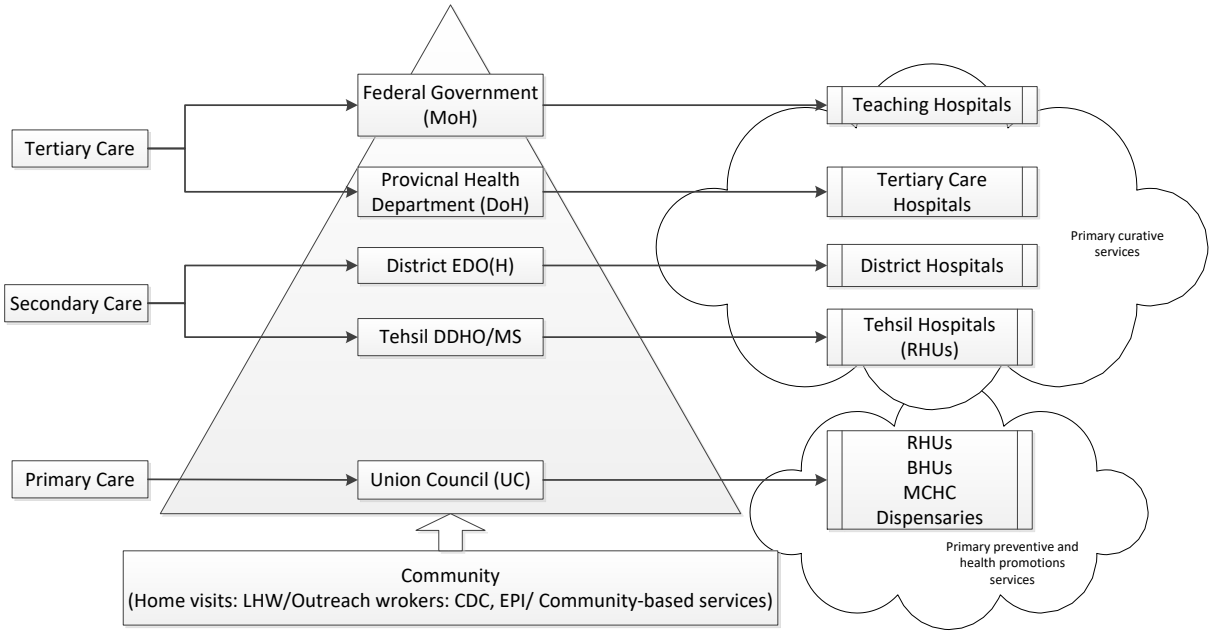

Figure 2.4 - Primary, secondary and territory health care form the three tiered of the health care system delivery

The primary health care is mainly implemented through the BHUs, RHUs, MCHCs and dispensaries (GoP 2005- 06). WHO (2007) reports that each UC has at least one primary health care center covering a range of ten to twenty five thousand people. Additionally, secondary care including first and second referral facilities providing critical, ambulatory and inpatient care through THQs serving a catchment population of about 0.5 -1 million people. Moreover, DHQH serves catchment population of about 1 to 2 million people and provides secondary care services along with Tehsil or Taluka (THQ) serving 100,000 to 300,000 people. There are tertiary care hospitals in all the provinces including those with the status of teaching hospitals under the control of the Federal Government Islamabad, Pakistan and are responsible to provide specialized curative services.

Recently in 2014 an article written on revisiting the three tiers of the health system of Pakistan and their implications for the achievement of MDGs by Pakistan reported some issues faced by MoH and Department of Health (Jalal 2014). These issues underline the lack

of dedicated, capable officials with poor transparency in the system and performance assessment as well as the lack of in-service training for the staff available.

2.1.5 Health care providers

The health sector in Pakistan has a variety of health service providers. These providers could mainly be divided into two major categories of public and private sectors. The Federal and provincial governments serve under the public sector whilst the private hospitals, clinics homeopaths, hakeems, NGOs and other traditional health care providers form the private sector.

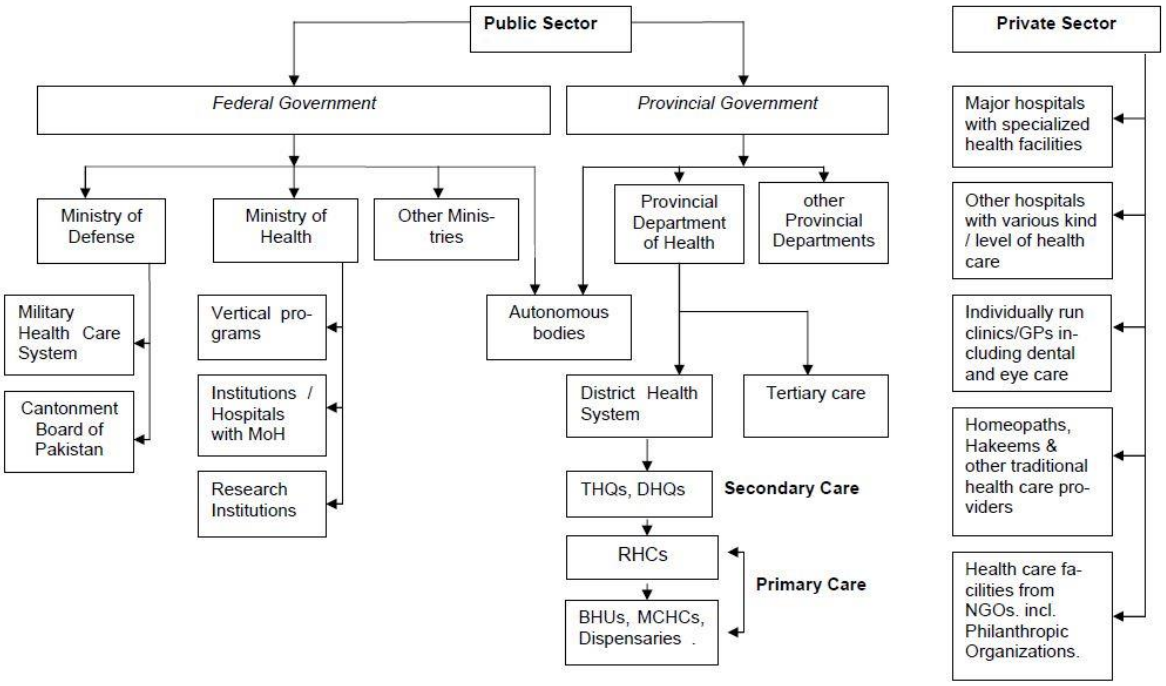

Figure 2.5 - Overview of the health care providers (obtained from "National Health Accounts- Pakistan" (GoP 2005- 06), p.12)

In addition, there are some other forms of treatments such as Unani Tibb or Islami Tibb, Galenic medicine augmented by Muslim scholars and Hakeems who learn the skills from their family members and are passing it down from generation to generations. Last but not the least, there is the Prophetic healing that is based on Hadith of the Prophet pertaining to hygiene, moral and physical health standards.

2.2 Cross-border relationships of Pakistan

The cross-border relationships of Pakistan vary from neighbor to neighbor and are also affected by historical events starting from its creation on the 14th August, 1947. The relationships with the neighboring countries which are on the north and west side of Pakistan are good. For instance, Pakistan opened its border for refugees from Afghanistan during USA's occupation of Afghanistan and hosted almost 1.5 million refuges which is the largest protracted refugee population globally (Crisp and Stigter 2001). On the other hand, relationship with India on the east side has been problematic.

Pakistan and India got independence after the division of the Indian sub-continent which was ruled by the British Empire from mid of 18th century until 1947. There have been several wars between these two countries (Ganguly 2013), which have led to economic problems and disputes around demographical divisions. Kashmir is one state which lies between these countries and still is an area of conflict. India claims a huge part of Kashmir as its own territory while the western side of Kashmir is administrated by government of Pakistan.

A history full of geographical and political conflicts has severely affected the traveling policies between India and Pakistan. Due to security reasons, strict rules and regulations are adopted by both countries when allowing their citizens to travel across. Hence, it is not easy to travel as visa processing takes a lot of time and there is a little transport infrastructure between both countries. These travel restriction have played an important role in this project as remote collaboration was required.

2.3 Different health information systems of Pakistan

In this section, I present different efforts made while designing and developing different HISs in the context of Pakistan. The challenges faced will be highlighted so that the new HIS could learn from previous experiences.

2.3.1 Health Information System (HIS) of Pakistan

The aim of a HIS is to improve the health service performance and the health of community by ensuring the appropriate and effective use of resources (Garrib, Herbst et al. 2008). The HIS of Pakistan has remained to data been unsuccessful to full fill this aim. Until early 1990s,

the HIS of Pakistan is of low quality at central planning levels for handling the routine information because of weak management (NHIRC 2007). NHIRC (2007) report revealed that routine reporting system was based at the facility level where health personnel who were collecting the data did not have appropriate technical skills. This contributed to the fragmentation of the reporting system and manual procedures were used to manage the aggregation of data on several levels. Thus, the poor functioning HIS was incapable of providing the required data for making decisions at different levels of management.

For all the reasons mentioned above, there was a need for a proper functioning HIS. Therefore, the MoH and GoP with collaboration of the United States Agency for International Development (USAID), United Nations Children's Fund (UNICEF) and some other stakeholders planned restructuring the existing HIS by replacing the routine reporting system at the government managed health facilities.

2.3.2 National Health Management Information System (HMIS) of Pakistan

In early 1990s a facility-based HMIS was developed in Pakistan. Federal and provincial governments as well as other stakeholders play an important role for the formulation of National HMIS of Pakistan. The ultimate objective of this initiative was to support health care managers in making informed decisions by ensuring that information needed at sub-districts, districts, provincial and federal levels is correct, reliable and available on time (WHO 2012-13).

The national HMIS of Pakistan recorded information on health events and also monitored the availability of critical items such as drugs, contraceptives, functionality of equipment, repair and maintenance of facilities and information on utilities at a monthly, quarterly and annual basis for first level care facilities. For the introduction of this newly developed system, trainings were launched at the health facilities spread over the country and through these trainings around 20,000 field staff got initial training on data collection techniques and later on after the completion of trainings at the district level the system was operationalized in all 120 districts of the country (NHIRC 2007).

The implementation of National HMIS Pakistan encounters several problems of financial support from the donors provided for its implementation nationally. In the very beginning, the

facility-based HMIS was planned to be implemented in all the provinces through the USAID funded Pak Child Survival Program, coordinated by MoH. However, this assistance was withdrawn in 1993 only on partial completion where 12 out of 21 districts of one province (Sindh) was able to implement this newly developed system (NHIRC 2007). The establishment and institutionalization in all the provinces restarted the year after through the Family Health Project of the World Bank upon the request of Health Department of Sindh. During this period the existing software system that was developed in Foxpro 6.2 and used the DOS platform was converted to a Windows based platform. In 1997, in addition to the replacement of existing software system the training modules on analysis, interpretation and use of facility-based HMIS generated indicators in planning and management of the health system and services were also developed. Later on, 2000 and onwards Asian Bank funded the Women Health Project, UNICEF and WHO invested in training of staff and availability of instruments in a province (Sindh) and another province (Punjab) took the benefit of this investment by implementing facility-based HMIS in its divisions. However due to unsustainable support, the other two provinces NWFP and Baluchistan had issues of implementation (NHIRC 2007). Information on service level indicators such as facility utilization rate, referrals, immunization, maternal care and family planning was available through the National HMIS Pakistan and data has been sent from about 8,000 facilities and represents information by age on 18 priority diseases, mostly communicable diseases. The National HMIS data has also been used to provide feedback reports by the National HMIS Cell.

Regardless of these concerted efforts, the National HMIS Pakistan has remained limited on numerous issues. The data is generated, analyzed ad disseminated through HIS; therefore sound data should be available on time to make better decisions for public health (AbouZahr and Boerma 2005). Health facilities were unsuccessful to provide data to the Provincial or National HMIS Cell due to the distance involved between these two levels, which resulted in delay in consolidation and the analysis of the data that had been sent. Although the funding to this project faced a number of problems but according to AbouZahr and Boerma (2005) only money is not enough to overcome the problems unless it is accompanied with allocation of proper responsibility. It was definitely insufficient because any department or unit particularly at the district level had not been assigned the explicit responsibility of the IS, where the data collection at facility level and its appropriate use could be handled. The national HMIS was

considered as additional workload to the facility staff and this burden caused poor data quality. The reports generated by the facility-based HMIS were given low importance and it remained limited to the facilities (i.e. RHCs, BHUs, MCHC) and the Out Patient Departments (OPDs) of some secondary hospitals. Since the National HMIS was unable to fulfill the requirement of good quality that was needed for making the management of health system functional at various levels (NHIRC 2007), there has been a critical scarcity of reliable and timely health information in Pakistan[3].

Facility-based HMIS was a decade old system and there was a growing concern amongst the Provincial Health Departments and also with the National Program Managers (NPMs) to make it more responsive to the information needs of its multiple stakeholders. Certain alterations and modifications in the existing structure of the system were very much required. For the redesigning of National HMIS Provincial and National Consensus building workshops on HMIS-Design Review were planned to address the issues of the existing national HIMS and for this five workshops namely one for each Province and one for NPMs was organized to ensure the active participation of its stakeholders for the redesigning of the system rather than the recommendations of experts at national level. A work document was developed based on the recommendations collected from these workshops and presented for a final consideration and adoption for the Inter-Provincial Workshop on HMIS Design held in February, 2002.

A study on the improvement of different Management Information Systems (MISs) in the health sector in Pakistan was carried out, as an assessment of the existing routine HMIS particularly on the facility-based HMIS, using the "Prism Framework". Results from this study revealed several problems (Aqil, Orabaton et al. 2005). These problems were mainly related to the human resources, poor data quality, and poor use of information for management decision-making, outdated design of existing HISs, inadequate strategic framework and organizational support for HIS, lack of ownership and accountability of HIS at provincial and district levels etc. So there was a need to develop a HIS for district and provincial health departments which can be evolved with the changing needs of the health system in Pakistan. In addition, the creation of a HIS strategic framework was required along with strengthening of the HIS design for districts, tertiary hospitals and the private health sector.

[3] http://www.emro.who.int/pak/programmes/health-managment-information-system.html

2.3.3 District Health Information System (DHIS) of Pakistan

The DHIS of Pakistan was developed in the period of 2004 to 2006 after widespread meetings with national, provincial and district stakeholders (NHIRC 2007). The National Health Information Resource Centre (NHIRC), which is the body responsible for implementing the DHIS, was established under the federal MoH in 2004 as the headquarters for the HIS. The approach to develop the DHIS included situation analysis, workshops, coordination of MoH and PHDs and extensive advice-giving meetings with national, provincial and district stakeholders. In 2006, the DHIS was successfully pilot tested in four districts of four provinces of Pakistan. The objective of the DHIS was to provide information for management and performance improvement of the district health system. More precisely it was to provide required key information from facilities, VPs, secondary hospitals and subsystems such as logistics, financial, human resources and capital asset management systems for improving the district health system's performance. Performance of Routine Information System Management PRISM Framework was used for supporting the DHIS design.

DHIS was to cater to the management needs of a devolved district health system. It would support enhancing the coverage of facilities, secondary hospitals, VP, and HIS sub-systems, viz. logistics, financial, human resources, capital assets HISs for self-regulation and performance monitoring at facility/district/province levels.

DHIS software

The DHIS software was developed by a consulting company Eycon[4] and was based on the open-source Linux system, thus not requiring licensing. It was user-friendly, designed to speed up data exchange among various levels through the initial use of web-based dial-up connections. This software application was installed at the respective district HIS units and received data from health facilities, and also VP in pre-defined formats on a monthly and yearly basis (NHIRC 2007).

Although a National Action Plan (NAP) was formulated to develop, introduce and utilize the DHIS but as of 2008, its utilization had not increased as predicted due to mix use of both systems, including the old HMIS and DHIS at the same time (JICA 2012). In 2009, the NHIRC and the MoH developed another 3 year project starting from 2009 to 2012, to develop

[4] http://www.eycon.co/eycon/

an upgraded DHIS aiming to enhance routine operations and budget planning practices in selected districts which would each have contracts for its support. Staff from PHDs and some DHOs was provided basic training on DHIS. The plan for monitoring of implementation was also followed, including of its scale-up strategy as approved by the joint coordinating committee. But during 2010, the introduction of the 18th Amendment led to the huge transformation in health sector, including the National HMIS being replaced with the DHIS and some national programs such as TB, Malaria and AIDS etc. being retained.

In 2012, WHO fielded a high level mission to review the opportunities and challenges as a result of decentralization and build recommendations to reduce fragmentation of health functions at the federal level. A new Ministry of NHSRC under the caretaker government was established after the WHO recommendations.

After the development and deployment of national HMIS, the DHIS was redesigned to cater to regular information flows reporting on a large number of priority health problems to strengthen evidence based decision making with the framework of an expanded health care structure. It was evident that the HMIS which was being refurbished into the donor supported DHIS, has not been a priority for the government and no effort has been made to draw the private sector into its ambit (Nishtar, Boerma et al. 2013).

2.3.4 Pakistan Health Information System PHIS

Recently, in 2016 the Ministry of NHSRC launched the PHIS[5] in the capital of Pakistan, Islamabad. This new system claimed to carry the latest nationwide statistics on diseases. In addition, this system was to provide reliable information on disease indicators and help strengthen coordination amongst policy makers and health mangers. The system included a dashboard with latest surveys including the Pakistan Social and Living Standard Measurement Survey, Multiple Indicator Cluster, and the Pakistan Demographic and Health Survey. This system was also expected to provide information on various health programs including the Expanded Immunization Program, AIDS, Tuberculosis, Lady Health Workers, Maternal, Newborn, and Child Health (MNCH) Care. This system was to help in the analysis of results and improve health indicators.

[5] nhsrc.gov.pk

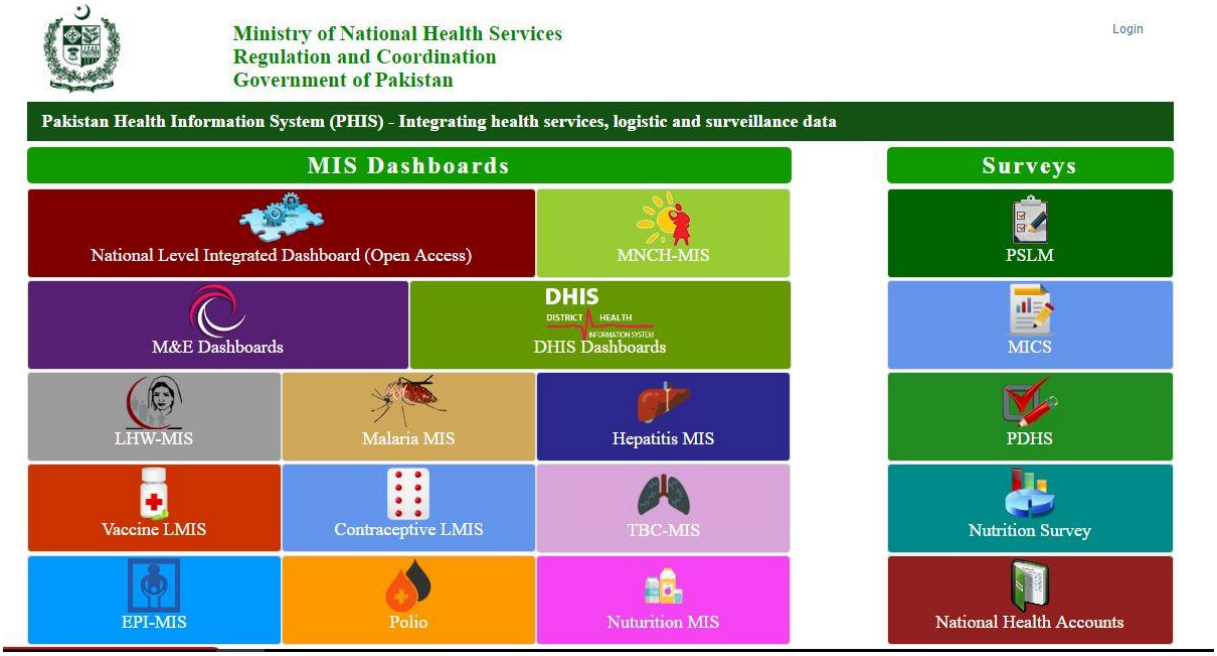

Figure 2.6 - Dashboards of Pakistan Health Information System PHIS (obtained from Ministry of National Health Services Regulation and Coordination[6])

2.4 Conclusion

The context of Pakistan is institutionally, socially and politically very complex. These complexities heavily influence the health sector in general and specifically organizations working within the health sector of Pakistan.

The current administrative division of Pakistan is unique and quite different from other developing countries. The structure of health care system is designed according to the administrative division of Pakistan and it also inherits certain complexities as a result. As a result, health care services are delivered at different levels to serve maximum population of Pakistan. Moreover, Pakistan is divided in different social groups such as rich, poor, traditional and religious. These social groups have different economies and beliefs while availing health care services which led to the existence of a variety of health care providers. It is also observed that the health management and delivery of health services in Pakistan is heavily influenced by political interference. Decisions taken at the government level results in huge transformation of the whole health structure in Pakistan (Shaikh, Naeem et al. 2012) and governments face challenges to fully adjust to the changed role (Jalal 2014).

[6] nhsrc.gov.pk

Efforts have been made to design, develop and implement the HISs within institutional, social and politically complex set of arrangements. Most of these efforts faced severe challenges in terms of insufficient financing, lack of human resources and political decisions (Nishtar, Boerma et al. 2013). User trainings, to some extent helped the health personnel to use the existing HISs but their utilization had not increased as expected due to overlapping use of several HISs at the same time (JICA 2012). The health personnel are overburdened with reporting the data and performing their routine work which results in data that have been reported is missing or of poor quality. Data quality and information usage are closely linked for decision making (Braa and Sahay 2012) but unreliable data (Nishtar, Boerma et al. 2013), lack of coordination amongst the various information system (Qazi and Ali 2009) or their partial implementation hinders the decision makers to monitor and manage performance.

In short words, the existing HISs in Pakistan are situated and continue to evolve in a complex web of social, political, institutional and cultural relations. Therefore, there is a need to consider all these aspects when it comes to designing, developing and implementing new HIS for health sector in Pakistan.

3 Research approach

The purpose of this chapter is to reflect on my research approach, including the study design and the development of the research report. I start by positioning the work in its philosophical foundation, the underlying assumptions and how this leads to different strategies of inquiry. The chapter will further describe research method adopted for this thesis and details of data collection and analysis, including the process by which I developed the research themes from the data collected.

3.1 Philosophical foundations

The selection of a research paradigm is critical to situate the work and identify specific methodological strategies (Maxwell 2008), and arrive at assumptions about the nature of reality (Maykut and Morehouse 1994).

IS influences and is influenced by context (Walsham 1993). Therefore it is crucial to get an in-depth understanding of the context and the interpretations of the people who are working within the context. Understanding of the context and people's interpretation to the context can help a researcher to analyze the influences of the IS on the context and vice versa. Studying individuals to understand the phenomenon from the people's point of view in their social and institutional context require natural settings of the context within which they work and collection of empirical data in the form of words (Kaplan and Maxwell 2005). These words can describe the understanding of the people to the situation according to their interpretations (Maykut and Morehouse 1994). Interpretive inquiries therefore with particular focus on human interpretations can be a possibility to understand the social issues related to computer based IS (Walsham 1995). Such an approach views the nature of reality subjectively as being shaped by human interpretations (Darke, Shanks et al. 1998), and "… *our knowledge to reality is gained through social constructions such as language, consciousness, shared meanings, documents, tools and other artifacts."*, (Klein and Myers 1999) p.69.

The study requires an understanding of the context and the people who were working within it. GS-Pak from Pakistan, the HISP India team and the India-Pakistan project based on DHIS2 solution were three core elements associated with the context. My research in this context required me to develop an understanding of the India-Pakistan project and its different phases

as well as the people's interpretations of the project. Through this understanding, I have tried to make a picture about the thinking of different people and their experiences in the context within their natural settings, the challenges they faced and how they dealt with them.

I have tried to include all the necessary elements required for reporting in an interpretive research. To accomplish this, I conducted interviews, and did user observations with the GS-Pak team in Pakistan. I also had discussions with the development team in India to get an overview of their understandings about the project. I also went through additional documents relevant to the project and context to further improve my understandings. Details of these elements are provided in data collection section. Frist, I present the research method which I selected for this thesis.

3.2 Research method

Research method is an essential component of a research design and often provides substantial information related to the questions such as "*What will you do in conducting this study? What approaches and techniques will you use to collect and analyze your data, and how do these constitute an integrated strategy?*" (Maxwell 2008) p. 216.

In this section, I am presenting the research method used in this thesis which is the case study.

3.2.1 A case study

"*A case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities...*" (Benbasat, Goldstein et al. 1987) p. 370. A case study serves a variety of research goals by using assorted data collection and analysis methods that enables the capture and understanding of the development, implementation and the use of the IS within organizations (Darke, Shanks et al. 1998). Moreover, the case study method allows a researcher to study the IS in its natural settings and to understand the complexity of the processes (Benbasat, Goldstein et al. 1987). The design of a case study required a broad literature analysis to understand the existing body of knowledge and to position the research question within the context of literature (Darke, Shanks et al. 1998). Designing the case study also helps to set up an initial theoretical framework based upon existing knowledge, which provides a reasonable theoretical basis for empirical work

(Walsham 1995). A case study could be conducted in terms of three prime tasks related to process, interactions, and the interpretations (Njie and Asimiran 2014).

The main goal of my thesis was to explore the topic of cross-border software development challenges for HIS and to answer the research questions mentioned in the introduction chapter. However, the aim of empirical work needed to be specific to understand the context, people involved in the context and influences of the IS on the context and vice versa. Therefore, I believed that a case study method would suit best to accomplish this because it allows the study of IS in its natural settings and uses diverse data collection and analysis methods. Since, the DHIS2 solution was designed and developed for GS-Pak; therefore I conducted a field visit in Pakistan during the month of June and July 2016. Next, I present what I did prior to the field visit and how I conducted the case study.

3.2.2 Prior to the field visit

According to Klein and Myers (1999), prior knowledge plays an important part in our understanding and Darke, Shanks et al. (1998) also emphasize the need for gathering adequate background information prior to the initiation of the field data collection process to gain a better understanding of the empirical context. Benbasat, Goldstein et al. (1987) provides recommendations of what kinds of data to be gathered from the field visit and suggests that the interview questions that should be decided prior to field visit. Formulation of good questions can be challenging, but they play an important role in exploring the understandings of people and their experiences of a situation (Goodman, Kuniavsky et al. 2012). Njie and Asimiran (2014) indicate that a process of thorough questioning can reveal the underlying meanings of the respondents that help to understand multiple dimensions of the phenomenon under study.

I followed recommendations for researchers given in the literature, which helped me to outline details of the data to be collected prior to the field visit. I obtained several documents that stated the background of the project, the team involved, as well as the requirements of the project (described further in Section 3.3.5). These documents provided opportunities to reflect on project context from different perspectives and pointed to the relevant questions to ask during the field visit. Thus, the interview questions were formulated prior to the conduct of field visit. When designing the questions, I emphasized that the questions can be answered

easily and at the same time should be interesting, important and valuable. The questions should also be open-ended and easy to understand.

3.2.3 Conduct of case study

To conduct the case study, I performed tasks related to process, interaction and interpretations. During the process task, I identified the casual activities such as daily routine activities of the people within the context that are mainly related to the collection of data and its use for decision making. This task provided me descriptive details about how the workplace actually functions and increased my understanding of the phenomenon.

Interactions helped me to identify important behaviors related to activities performed in particular situations specifically for the development of the DHIS2 based solution. I explored the interactions specifically relating to the communication between Indian and Pakistani teams, requirement gathering and development phases. My aim was to understand issues in these processes by investigating behaviors such as reactions, acceptance, resistance, consequences and the perceptions of the people in these situations and the context within which they act, which guided me in my data analysis.

The third task of the case study is referred to as interpretations and building meaning. I performed this task after the field visit because at that time I had enough data and understanding of the whole case. Interpretations of the case study data enabled an understanding to the phenomenon that further helped me explaining the whole story in a descriptive way. Next, I present the data collected during the field visit.

3.3 Data collection

A case study is used to inspect a phenomenon in its natural settings (Benbasat, Goldstein et al. 1987) and it enables the selection of multiple methods for data collection (Maykut and Morehouse 1994) from one or more entities. There are usually three main resources for data collection namely interviews, documents and observations (Kaplan and Maxwell 2005).

In this section, I explain the different data collection methods that I have used. According to my understanding interviews, user observations and the documents were the best data collection techniques for my thesis and therefore I have selected them and will explain each of

them in detail in separate sub-sections. Before presenting the data collection techniques, I will first introduce the goals defined for the collection of data and then the participants selected for interviews and observations.

3.3.1 Goals

The goal of data collection is to acquire a rich set of data surrounding the specific research issue and for apprehending the contextual complexities (Benbasat, Goldstein et al. 1987). The power of collection of data by multiple resources is explained by different authors. For example this approach increases the strength of results (Kaplan and Maxwell 2005) and reliability of findings (Maykut and Morehouse 1994). It may also allow cross-validation of findings (Kaplan and Maxwell 2005), and support the researcher's conclusions (Benbasat, Goldstein et al. 1987).

In my case, the first goal of data collection was specifically about gaining an understanding of the context in terms of its background, the project itself and different phases of the project to understand the issues and possibilities related to the context.

The second goal for data collection was to understand the perceptions of the people about the project itself and specifically the issues and opportunities related to DHIS2 based solution that were expected outcomes of this project.

In order to achieve these goals, I collected data by using different resources such as by performing different observations, conducting interviews, reading documents and additionally bringing my own thoughts and ideas for building interpretations. The purpose of using multiple resources of data was mainly to inspect the meaning of people's words and actions inductively obtained from this data. This approach also helped me to develop an understanding and interpretation that could explain what is going on in the context.

3.3.2 Participants

The first thing for conducting the interviews and observations is to find out when and where to observe, whom to talk to and what information sources to focus on. Such a situation led to sampling choices (Maxwell 2008), determined by the type of information and category of people (Njie and Asimiran 2014). Selection of suitable people for performing observations and conducting interviews is an essential component to make a research project successful (Goodman, Kuniavsky et al. 2012) but is often overlooked. The selection of people as a sample could base on the likelihood that each participant will give diverse observations (Maykut and Morehouse 1994) or could be used as a subset of representatives who are enough to ensure that they represent the entire range (Maxwell 2008).

I was interested to explore the issues and approaches used for the software development process for the conduct of DHIS2 based solution. Additionally, I needed the information related to the issues and opportunities associated with the DHIS2 application as compared to the existing system. With regard to interviews, I therefore selected the people who were directly involved throughout the development lifecycle of the DHIS2 based solution. Furthermore in order to perform user observations, I chose people who were currently using the existing system and were expected to use the DHIS2 based solution. Because a large number of people were expected to use the DHIS2, they were directly or indirectly involved in the project. It was not practical to conduct interviews or perform user observations on everyone involved. I selected a subset of representatives as mentioned below in the Table 3.1.

Table 3.1 - Details of participants along with the data collection method used for each participant

Organization	**Participants**	**Role**	**Method**
GS-Pak	Project manager	Leading the project from Pakistan	Interviews
	IT manager	Responsible for technical issues in the project	
	MIS manager	Responsible to provide and manage information	
	Data center manager	Manage the routine work performed by the data entry operators	
	Area manager	Responsible to manage the paper format data and were expected to use DHIS2 based solution	
	Data entry operators	Using the existing system and DHIS2 application in test environment	Observations
HISP-India	Project lead	Responsible for the overall project	Face to face conversations
	Team lead	Leading the development team from India	Email exchange and skype conversations

3.3.3 Interviews

Interviews are essential sources of data for interpretive case studies because through them a researcher can best accesses case participant's views and interpretations of actions and events (Walsham 1995). The interview format varied from being both structured or unstructured (Maykut and Morehouse 1994). There are several ways to convert the interview format into structure. A standard interview format can be divided into different phases (Goodman, Kuniavsky et al. 2012).

Interview questions are central to understand the participants' views and interpretations. Maykut and Morehouse (1994) provide some examples of writing good interview questions. The interview questions should be open-ended (Kaplan and Maxwell 2005) and focused, context specific and diverse (Maxwell 2008).

Recordings of interviews are also recommended (Maykut and Morehouse 1994) as it helps to develop a complete description of the interview (Walsham 1995) and the conversations that have taken place (Darke, Shanks et al. 1998).

Since interviews are considered the primary source of data collection, I decided to gather data in the form of interviews. During the field visit, I took interviews of GS-Pak participants mentioned in the Table above and used a structured interview format which is presented in a form of a table below.

Table 3.2 - Interview format

	Phases	Information collected from participants
1	Introduction	Name, education, experience and their role in India-Pakistan project
2	Warm-up	General understanding of existing system, expectation from DHIS2 application and its current use if applicable
3	General issues	Challenges and opportunities related to existing system and DHIS2 based application
4	Deep focus	Technical issue, and the challenges related to data, information and business processes, challenges and approaches used for the conduct of India-Pakistan project and how they dealt with these challenges
5	Retrospective	Verified my understanding to the answers with feedback from respondent
6	Wrap-up	Identified the relevant material to be collected from the field
6	Wrap-up	Identified the relevant material to be collected from the field

Details of the different phases used in the interview format are mentioned below.

The first phase included the introduction where I got the names and positions of the respondent including their qualifications and education. In the second phase, I asked the respondent about their roles in the respective organizations, their understanding of the existing system and their expectations from the new DHIS2 solution that was expected to replace the existing one. The third phase was focused on gaining an understanding of the general issues, including the issues and opportunities the participants were experiencing with these systems. In the fourth phase, a deeper understanding of the whole phenomenon was in focus. The focus of the interview in this part varied from participant to participant according to their position and professional role in the organization. For example, a participant from the IT department was asked to reflect upon the technical issues and participants from the MIS department were asked to discuss their perspectives on data, information and business functions in detail. The fifth phase was retrospective where I tried to confirm the answers

given to the questions by them, and to verify if my understanding was correct. During the retrospective phase, I rephrased the words of the interviewee to clarify whether any misinterpretation of the meanings of what participants said and how I recorded it. In the sixth and concluding section, I collected relevant material identified during the conduct of the interviews and ensured that the whole interview was recorded properly.

The environment during the interviews was informal where both the interviewer and the interviewees were sitting in a comfortable environment. The main language used during the interviews was Urdu which is the native language of the interviewer and interviewees; English was used as a supplementary language where necessary. There were no misunderstandings recorded, something which indicate that the questions were sufficiently precise.

3.3.4 User observations

I conducted observations in GS-Pak's data center where the people were using the DHIS2 based solution in a test environment. The data entry operators were using the existing system from the last two years therefore they had a very good understanding of the existing system.

During the observations, I observed the activities performed by the data entry operators and if something needed clarification then I asked questions. These questions were not formal, and rather were related to getting clarifications on what was going on in the context by primarily addressing questions of what, why and how. It produced descriptive information of what was taking place in the situation and prompting the system user's own explanations, assessments, and perspectives in the context of use. These strategies and techniques for observations helped me gathering the data from a different perspective that enabled rich description of the phenomenon under study.

3.3.5 Documents

Documents are important sources of data for interpretive studies (Bowen 2009). There are different types of documents which may be considered useful, including advertisements, agendas of meetings, manuals, background papers, books and brochures, journals, printed event programs, letters, maps, charts, newspapers, press releases, program proposals, application forms, organizational and institutional reports and various public records (Bowen 2009). According to (Kaplan and Maxwell 2005), documents also include pictures, photographs, artifacts. (Maykut and Morehouse 1994) further adds public documents such as organizational memos, policy manuals and video tapes. Other document types such as internal magazines and organizational bulletins can also provide supplementary information that often reflect the organizational culture and the current issues of interest for management and employees of the organization (Darke, Shanks et al. 1998).

From all the document types mentioned above, I used those that best suited my scope of research. These are summarized in the table below.

Table 3.3 - Overview of documents

Type of document	**Document description**	**Information gained**
– Background papers – Books and brochures – Pictures – Newspapers	• Books and papers written on Pakistan health sector, history of GS-Pak, evolution of DHIS2 and projects of HISP-India • Newspaper articles written on HIS of Pakistan generally and achievements of GS-Pak in health sector of Pakistan specifically	• Sufficient background information • Historical insight • Contextual details
– User manual – Program proposal	• DHIS2 application developed for GS-Pak user manual • India-Pakistan project capacity building workshop proposal	• Area of focus for specific observation activity • Interview questions

		required to facilitate clear understanding
– Public records – SRS	• GS-Pak, HISP India and DHIS2 websites • Software Requirement Specification document written for the India-Pakistan project	• Identification of the documents to be collected from the research site
– Annual reports – Organizational, institutional and internal documents	• GS-Pak annual reports 2016, 2014-2015 • Reports, documents, policy manuals written on GS-Pak Inter Personal Communication program	• Enable the comparison of different documents to identify changes
– Books – Journals – Literature	• Written on cross-border software development and open-source public HIS	• Corroboration of evidence from other sources • Verification of findings

3.4 Data analysis

Every study entails how to perform an analysis (Maxwell 2008). According to Goodman, Kuniavsky et al. (2012), data analysis is an art and craft. According to Benbasat, Goldstein et al. (1987), data analysis depends on the integrative powers of the researcher. Darke, Shanks et al. (1998) adds that the strength of analysis in interpretive studies rely on the interpretation of data that is used to explain the phenomenon.

In this section, I will explain how data were analyzed. I followed the steps recommended by Goodman, Kuniavsky et al. (2012) where the first step is the capturing of an initial insight,

second is preparing the data, third is finding patterns and themes. The fourth, and final, step is relating groups of pattern and themes into frameworks.

3.4.1 Capturing of initial insight

Data analysis is an iterative process that can be started by "*developing an initial understanding of the setting and perspectives of the people being studied*" (Kaplan and Maxwell 2005) p. 41. "*Data analysis is best conducted as an early and ongoing research activity"* (Maykut and Morehouse 1994) p. 113. In early stages, we can identify the patterns if we even have a single unit of information (Goodman, Kuniavsky et al. 2012).

I was interested to first gain an understanding of the information necessary to start my empirical work. Therefore, the unit of information, I picked first, were the documents to develop an initial understanding of the context and the people being studied. I used the documents as a means of analysis in combination with other methods that enabled triangulation (Bowen 2009) and could be used to increase the reliability of findings. Document analysis provided me an opportunity to set directions for the collection of more data, formulation of interview questions and defining the scope of situations and activities to be observed from the field visit. I applied the analysis of data simultaneously with data collection in the field as well, because data analysis is a cyclic process. A cyclic approach to data analysis enabled me to focus on interviews and observations, and helped me deciding how to test my initial interpretations.

3.4.2 Preparing the data

Data collection often results in a huge amount of data, and making sense of it is a challenge (Maykut and Morehouse 1994). Processing the raw data before its manipulation could be a wise solution (Goodman, Kuniavsky et al. 2012). There are also several ways to organize the data in order for conducting effective analysis (Darke, Shanks et al. 1998).

A huge amount of data was collected in the form of documents studied prior to the field visit and after the conduct of the field visit. The data gathered during the field visit was in the form of field notes, interview audios, documents collected from the field and pictures taken during the field visit.

In order to organize the data, I used electronic media on my PC in which I transferred all the audios and photos taken and captured during the field work. Secondly, all audio files were transcribed into text. Thirdly, I read the documents collected from the field to develop initial ideas about the events, statements and meanings and furthermore their relationships to other statements and events. Hard copy data gathered during the field work was organized by using different and separate files. In order to highlight the purpose of the document, I used sticky notes with different colors and gave a unique name. Such an approach for organizing data allowed me to retrieve relevant data easily during the analysis process.

The next step after the preparation of the data was to find the patterns within the collected data and identification of the themes.

3.4.3 Finding patterns and themes

There are several ways to find the patterns and themes. By re-reading and reviewing the data carefully and with more focus it is easy to select the data for performing coding and to construct categories (Bowen 2009). Coding is defined by Goodman, Kuniavsky et al. (2012) p. 425 as such *"A code is a descriptive word or short phrase that describes a piece of data. It's essentially a label".* The basic purpose of coding is to rearrange the data to construct the categories (Maxwell 2008). Moreover, there are different techniques that can be used either separately or with a combination for the identification of themes, development of categories and to explore the differences, similarities and relationships between them (Kaplan and Maxwell 2005).

In order to find the patterns and themes, I first read the available data, then reviewed the data and divided it into groups to perform coding. During the coding process I rearranged the data to construct the categories. In the early stages, I used predefined codes based on assumptions that were made towards building themes identified in the interviews and observations. Inductively, I identified various codes. After the sorting of data according to the coding, I constructed the categories to explore the relationships and patterns across the categories. Careful analysis of categories contributed to develop a general understanding of the phenomenon and the specific focus of inquiry. I generated different themes and theoretical concepts out of categorized data and used it to further refine and organize the data within each group. All the identified themes are discussed in the analysis chapter in detail.

3.4.4 Relate groups into frameworks

Complete understanding of a situation is dependent on framing the situation to relate several groups and elements with each other. Maxwell (2008) elaborated a brief account on an important set of distinctions in planning categorizing analysis that could be placed in different frameworks. There are several other ways too. Framing the situation can be done by using taxonomies, maps, timelines, flowcharts, spectrums and matrixes (Goodman, Kuniavsky et al. 2012).

The categories within each group were mainly used to frame the different concepts that I have analyzed in my case study. I identified different chapters and sections and sub-sections heading from these categories. Information taken from the categories was used for writing a descriptive and brief account on the case as it was observed and analyzed. I also used the expressions, comments and words used in some interviews. I presented my own concepts that incorporated a full description of the case study from my point of view as well as an explanation of the different themes that will be discussed in the analysis chapter. I have also used this information and my understanding to different topics in the form of displays for better presentation the data. I have used displays in the form of flowcharts and concept maps for example "administrative division of Pakistan" to display and present the ideas, collected data and to make my analysis more visible. Such presentation of data also allows seeing the situation as a whole and highlights the basic concepts and understanding to the situation.

The themes identified and the main findings are presented in the table below.

Table 3.4 - Overview of themes and main findings

Themes	**Main findings**	**Data collection method**
Context	• Contextual complexities is a challenge in cross-border software development • Information System is influencing and is influenced by the context • Shifting of existing system comes with challenges	• Interviews • Documents • Observations

	and opportunities to the context and for the people who worked within the context	
Requirements	• Unclear requirements led to the delays in the deliveries • Constant change in requirements created frustration and delays for the people involved in the project • Creating a mutual understanding to the requirements is a challenging task in cross-border software development	• Interviews • Documents
Culture	• Similar languages brought opportunities in cross-border software development • Communication and trainings are negatively influenced by traveling restrictions • Events and values associated with the culture are important to consider in cross-border software development	• Interviews • Documents • Observations
Communication	• Online means comes with a lot of opportunities in cross-border software development • Face-to-face communications are crucial element in cross-border software development	Interviews
Different expectations	• Different expectations can create problems but negotiations and mutual understanding can overcome the conflicts	Observations

4 Theoretical background

The purpose of this chapter is to introduce the literature used as the theoretical background for this thesis. First, the concept of cross-border software development (CBSD) is provided by explaining a generic overview of global software development (GSD) and its different business models. Second, open source software (OSS) is defined and explained as adopted in a GSD environment. The third area of focus in this chapter is to reflect on specific challenges of GSD generally and in the CBSD context specifically. The challenges which I chose to discuss here relate to distance, culture, communication and requirement engineering. At the end of this chapter, I briefly discuss how research and practice has tried to deal with these challenges.

4.1 Cross-border software development

CBSD term is not defined specifically in the literature but it has connections with IT projects outsourcing and software development (SD) in global context. In this section first, I present the taxonomy of a GSD. Second, I present a menu of different business models which can be adopted to develop a sourcing relationship between customer and supplier for IT projects. Then I present which model is close to CBSD by comparing characteristics of different business models.

4.1.1 Taxonomy of global software development

GSD is an interesting phenomenon and has been a topic of research since the last 3-4 decades. Research on GSD has been approached from many directions. These have included motives to create a GSD relationship (Herbsleb and Moitra 2001), challenges associated with GSD (Mockus and Herbsleb 2001) as well as experiences and learnings (Herbsleb, Paulish et al. 2005) from GSD. The challenges and desired future of GSD are also discussed (Damian and Moitra 2006, Herbsleb 2007), including issues related to coordination over distance due to cultural differences and dependencies on using communication media in a distributed environment. These issues have been addressed in the past, by highlighting political and cultural issues (Nicholson and Sahay 2001) and comparing the effects of distance (Herbsleb, Mockus et al. 2001) and communication influences (Herbsleb and Mockus 2003) on the speed

of execution of SD projects activities. Requirements engineering is a particular problem (Damian and Zowghi 2003) under these circumstances, and approaches to address them. Tactical approaches to alleviate distance have been developed (Carmel and Agarwal 2001), also to manage cross-cultural issues (Krishna, Sahay et al. 2004) and lessons around RE (Damian 2007).

Current research trends in this domain have focused on understanding customer and supplier relationships (Ebert 2011). In the past, worldwide there were well established customers in USA, UK, Australia and various European countries as well as from Japan and Korea for global software work (GSW) (Sahay, Nicholson et al. 2003). Customers and many organizations began to experiment with outsourcing to low cost countries with large labor pools (Herbsleb and Moitra 2001), hence creating global nodes of software suppliers in several countries, such as the three big nodes in India, Ireland and Israel as well as other low cost countries such as Philippines, Vietnam, Russia and China (Sahay, Nicholson et al. 2003).

Sahay, Nicholson et al. (2003) defined GSW as "*software work undertaken at geographically separated locations across national boundaries in a coordinated fashion involving real time or asynchronous interaction"*. They further described the strategies to do work across global borders through outsourcing, alliances, or subsidiary arrangements. In the past, most of the software work was in relation with proprietary software. In contrast, today a number of other services that can be potentially sourced from an external supplier includes business process outsourcing, information technology outsourcing, accounting outsourcing, application service provision, software sourcing and open source software (Ebert 2011).

The sourcing relationship between customer and supplier in a global environment is organized in a variety of forms. Based on published research, I conceptualize such software work through the schematic given below.

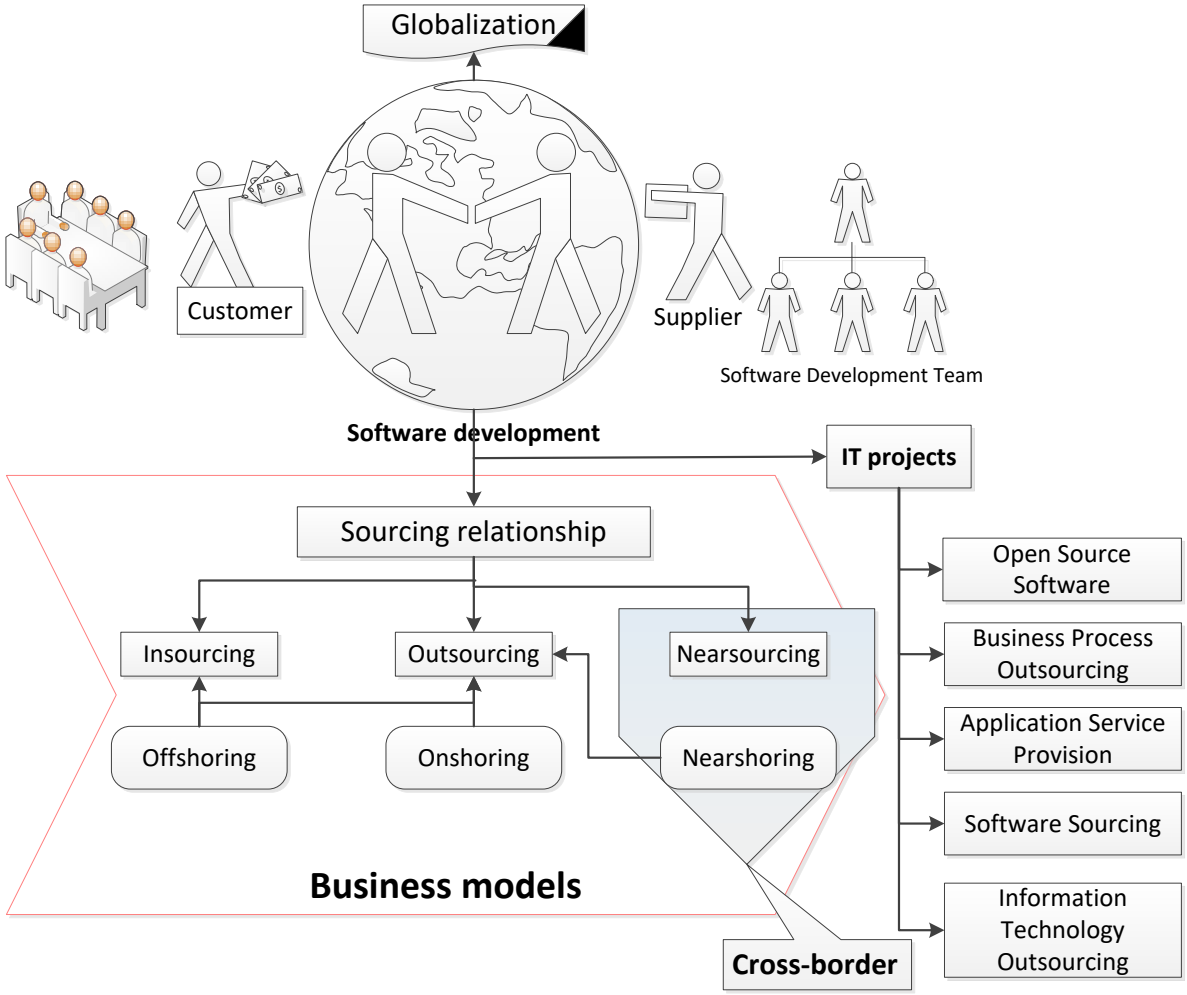

Figure 4.1 – Conceptual framework of GSD, different business models and IT projects

Figure 4.1 show that globalization is affecting current SD activities in terms of the relationships between customers and suppliers. A key motivation for establishing GSD work has been to leverage on cost advantages from lower labor cost countries as well as strengthen access to large labor pool. GSD can also enable round the clock development to achieve cyclic time acceleration and to cater to local markets (Damian and Moitra 2006). Some other benefits are for example, GSD offers to find an appropriate mix of expertise for the projects along with highly skilled resources (Herbsleb 2007). All in all, GSD provides an opportunity to customers to have an access to talent, markets, and flexibility to adjust according to their business needs (Ebert 2011).

4.1.2 Business models

The following table present an overview of the different terms used in Figure 4.1.

Table 4.1 - Overview of terms used to present different business models along with their explanations

Term	Explanation	Citation
Insourcing	Companies set up their own captive processes centers overseas, taking advantage of their cheaper surroundings while maintaining control of their back-office work and business processes.	(Prikladnicki, Audy et al. 2007)
Outsourcing	Processes are handed over to third party vendors which reside in direct neighborhood, offshore or remain in-house.	(Sahay, Nicholson et al. 2003, Prikladnicki, Audy et al. 2007, Ebert 2011)
Nearsourcing	Organizations in neighborhood countries which provides cheaper alternate or advantage of proximity in culture and geographical closeness for software development.	(Sahay, Nicholson et al. 2003)
Offshoring	Organizations have local branches in lower-cost countries or they ask specialized companies abroad to perform a service from them.	(Sahay, Nicholson et al. 2003, Prikladnicki, Audy et al. 2007, Ebert 2011)
Onshoring	Separate entities are located in the same country (different city or place) where the client and the company headquarters are located.	(Prikladnicki, Audy et al. 2007)
Nearshoring	Sourcing service work to a foreign, lower-wage country that is relatively close in distance or time zone (or both). The customer expects to benefit from one or more of the following constructs of proximity: geographic, temporal, cultural, linguistic,	(Carmel and Abbott 2007)

	economic, political, and historical linkages	
Following explanations of business models are adopted from (Prikladnicki, Audy et al. 2007)		
Offshore insourcing		
Organizations create their own SD center located in a different country than the company's headquarters, to supply the internal demand.		
Offshore outsourcing		
Customers' contracts an external supplier located in another country for SD.		
Onshore insourcing		
A company which provides SD service throughout internal projects in the same country.		
Onshore outsourcing		
An external company located in client's country is responsible for providing SD services or products for the client company.		

There are several practices and challenges associated with the different business models of GSD (Prikladnicki, Audy et al. 2007). Since all types of business models involved distributed development environments, hence distance matters. Customers and suppliers need to communicate with each other over distance for conducting different SD activities. There is an element of geographical, temporal and cultural distance between the customer and supplier which is clearly challenging to address (Holmstrom, Conchúir et al. 2006). Prikladnicki, Audy et al. (2007) presented practices and challenges in the different strategies of offshoring and on-shoring. They observed from their case study that each business model contains one or many challenges including cultural differences, lack of formalization in communication and common processes for RE. The study conducted by Holmstrom, Conchúir et al. (2006) interestingly revealed that people who are working within GSD believe that nearshoring (also referred to nearsourcing) could be an interesting phenomenon to cope with these problems. I now discuss this-

4.1.3 Nearshoring or nearsourcing

Nearsourcing and nearshoring are two terms that has been used interchangeably. Carmel and Abbott (2007) define:

"Nearshoring: sourcing service work to a foreign, lower-wage country that is relatively close in distance or time zone (or both). The customer expects to benefit from one or more of the following constructs of proximity: geographic, temporal, cultural, linguistic, economic, political, and historical linkages"

Outsourcing of projects in geographically close countries (referred to nearsourcing) was considered as a cheaper alternate to get an advantage of geographical and cultural proximity (Sahay, Nicholson et al. 2003).

Carmel and Agarwal (2001) claimed that nearshoring may overcome the challenge of temporal distance (Carmel and Agarwal 2001), however, such claims were not always proved effective in the past. Nearshoring or nearsourcing business models did not acquire much attention with some exceptions (Abbott and Jones 2003). Abbott and Jones (2003) noted that an established body of research on nearshore software outsourcing is visibly lacking therefore they relied on primary interviews to explore this phenomenon, especially in relation to resources, location and context. In the past, several researchers suggested nearshore outsourcing as a possible solution to overcome limitations of other models, but without significant justification (Carmel and Abbott 2006). Carmel and Abbott (2006) argued that as the GSD and IT services market is growing, geographical differences will continue to play a role in nearshore settings too. Despite some arguments that nearshoring will overcome the distance problems, Carmel and Abbott (2007) argued that distance still matters. They noted an absence of a concrete definition of nearshoring. In addition, they found that proximity of geographical, temporal, cultural, linguistic, historical and political or economic constructs to constitute nearshore. They further developed a global distribution of nearshore destinations and their division into three clusters.

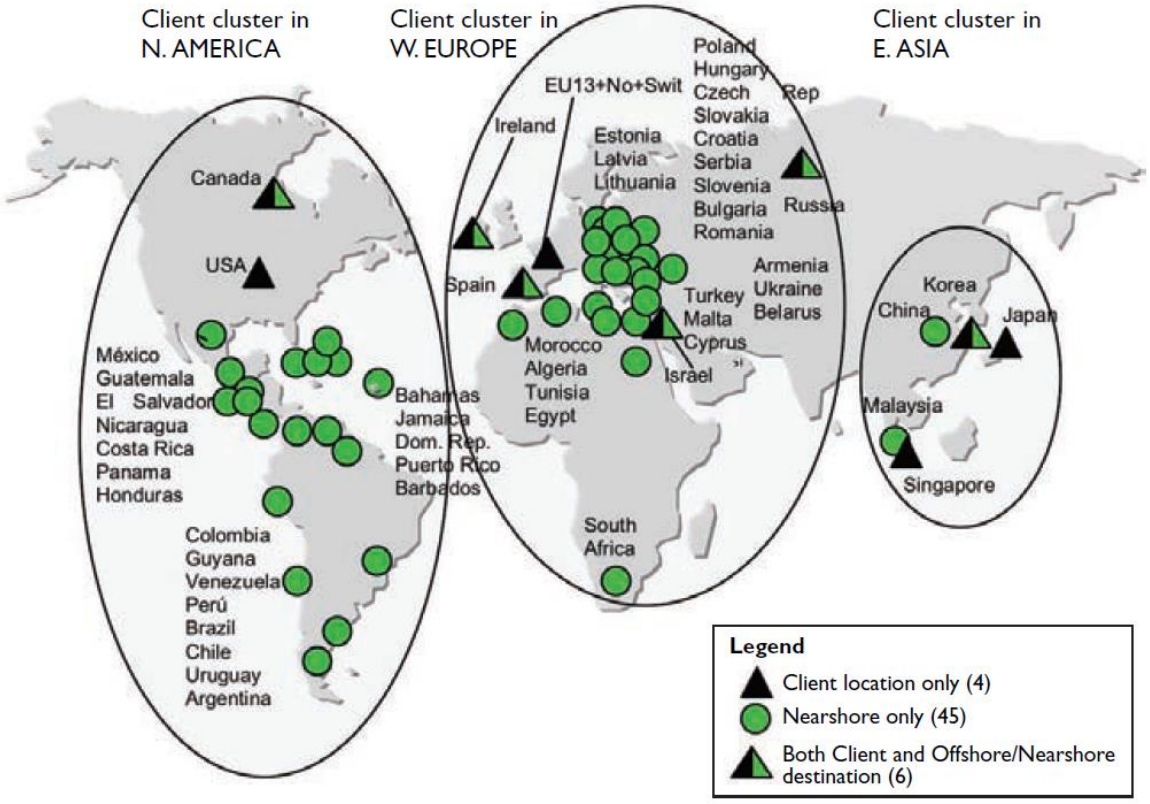

Figure 4.2 - Global distribution of nearshore destination and their division into three clusters, adopted from (Carmel and Abbott 2007)

Cross-border refers to countries which are sharing the same border or are neighboring countries, while nearshoring shares similarities with cross-border. Therefore, I will say that 'cross-border software development involves relationships between customer and suppliers for software development activities between countries which are sharing the same border'. As a result, these countries are often close in time zones, culture, linguistics, economic, political and historical conditions. In the light of CBSD defined here, cross-border collaborations for SD may refer to for example: from American continent between Canada and US, from European continent between Norway and Sweden and from the Asian continent between India and Pakistan.

Making a SD project successful that is crossing the border is dependent on many factors. The right choice of the projects to be outsourced is one of them (Krishna, Sahay et al. 2004). There are several types of IT projects or services that could be considered for sourcing across borders but due to the specific scope of this thesis and limited space, I only discuss open source software (OSS) as an option for GSD.

4.2 Open source software development

Open Source (OS) reflects a term is not controlled or owned by anyone (Feller and Fitzgerald 2002). However, Feller and Fitzgerald (2002) defined the term "Open source software is software distributed under terms that comply with the Open Source Definition". For an outline of key conditions of the Open Source Definition (OSD) see Table 4.2.

Table 4.2 – Outline of key conditions of Open Source Definition (adopted from Feller and Fitzgerald 2000)

Condition	Commentary
The source code must be available to user.	The software distribution must include the source code (i.e., the original programming language), or else the code must be made available by free, public Internet download.
The software must be redistributable.	The user of an OSS release is given full rights to reproduce and redistribute the software, on any medium, to any party, either gratis or for a fee.
The software must be modifiable, and the creation of derivative works must be permitted.	All users are given the right to modify the software or produce derivative works. There is considerable variation among licenses regarding whether or not modifications must also be released publicly under an OSD compliant license.
The license must not discriminate against any user, group of users, or field of endeavor.	In an attempt to counter overtly ideological content in software licenses, the OSD precludes any limitations on the possible uses of an OSS distribution.
The license must apply to all parties to whom the software is distributed.	While some licenses might allow modifications to be released under a non-compliant license, an OSS distribution cannot be "relicensed" by the user.
The license cannot restrict aggregations of software.	OSD compliant licenses cannot be limited to a particular distribution, nor can they seek to contaminate separately licensed software with which it is aggregated.

The OSS development process involves large communities of globally distributed developers and users (Feller and Fitzgerald 2002), involving both commercial and non-commercial organizations.

The free nature of OSS has opened the doors to various world-wide organizations to invest in OS (Ebert 2011), enabling access to skills and for creating new markets. As a result, the distributed nature of OSS activities has helped create a customer and supplier relationship globally spanning large communities, with both positive and negative effects (Ruffin and Ebert 2004). Therefore, choosing the right OSS might reduce the risks of negative effects, such as by meeting required technical criteria presented by Ruffin and Ebert (2004), outlined below:

- Builds on and follows a mature and commonly used industry
- Having a strong OSS community
- Be broadly supported by several independent software vendors for distribution, evolution and support
- Have a clear, indisputable legal status regarding intellectual property rights and the right to use

There are several large OSS developers and users communities around the world. The Health Information System Program (HISP) network is one of them which consists of highly skilled developers as well as a large community of user groups from several developing countries. HISP is a global network established, managed and coordinated by the Department of Informatics (IFI), University of Oslo (UIO) since the mid-nineties. The HISP network involves different people, institutions, technologies and activities spreading across more than fifty countries at regional and national levels (Braa and Sahay 2012).

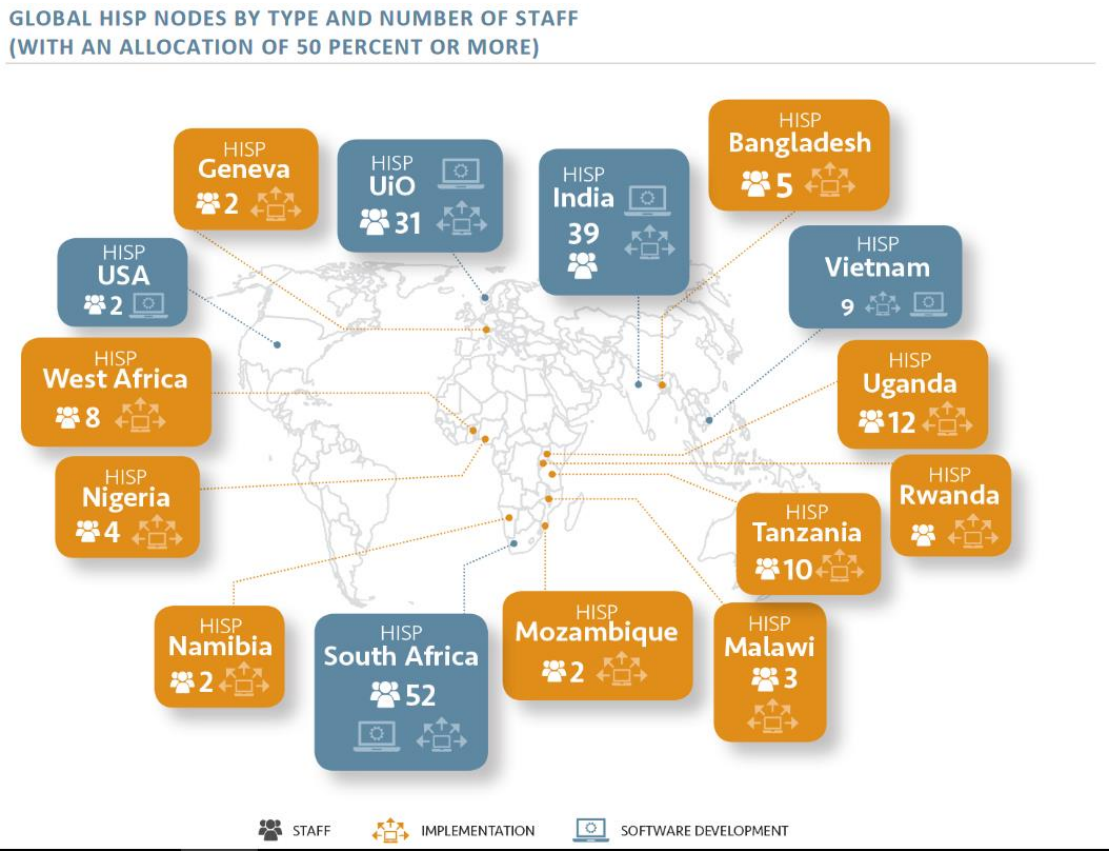

Figure 4.3 - Global HISP nodes adopted from "An interim review of the Health Information System Programme- University of Oslo- with recommendations for future action"[7]

4.2.1 Open source public health information systems

There are several free open source software (FOSS) that are used for public health information systems (HIS) management. I will only focus on FOSS (DHIS2) related to the HISP network. HISP is currently collaborating with software development groups around DHIS2. There are two other main FOSS groups that are OpenMRS and iHRIS (Braa and Sahay 2012). A short description of OpenMRS, iHRIS and DHIS2 is given below.

The Open Medical Record System (OpenMRS) is a platform and a reference application which can be used to customize medical record system for supporting delivery of health care mainly in developing countries[8].

The open source Integrated Human Resources Information System (iHRIS) is used for managing health workforce information system in resource constraint countries[9].

[7] http://www.mn.uio.no/ifi/english/research/networks/hisp/
[8] http://www.openmrs.org/

The District Health Information Software 2 (DHIS-2) is an application used for collecting validating, analyzing and presenting aggregated and individual level health data[10].

Managing public health information systems in developing countries by using FOSS has several advantages but there are some certain limitations as well. FOSS potentially reduces the costs of acquiring new software but there may be several challenges associated with them as well (Shidende, Chawani et al. 2014). Shidende, Chawani et al. (2014) studied the challenges of participation with a focus on interaction between software implementers, end users and global OSS developers. They found that implementation mediators faced challenges related to communication, conveying context specific requirements and coping with other contextual challenges such as related to human resources and infrastructure. They also indicated the limited capacity of end users and software implementers about domain knowledge. They argued that capacity building of health workers by providing them required resources such as setting up local installations for practice on dummy data, online training courses and learning material might be helpful. They also suggested global developers to provide detailed documentation on the software which can facilitate worldwide capacity development for implementation mediators. Another suggestion was speeding up the processes of getting the local requirements incorporated into the global software. While implementation mediators can access the detailed documentation by using internet based tools, training courses and face-to-face meetings are very important to support the process of implementation (Seebregts, Mamlin et al. 2009). According to Seebregts, Mamlin et al. (2009) such meetings serve as an opportunity for implementers to interact with core developers and attend technical training sessions.

The basic purpose of the HMIS is to strengthen the health system by enabling health data consumers to make effective use of information (Thangasamy, Gebremichael et al. 2016). A pilot study on DHIS2 in Ethiopia conducted by Thangasamy, Gebremichael et al. (2016) indicated that by using DHIS2, several areas within the health sector have improved, especially with respect to data utilization and information usage. However, they have pointed to capacity building, relevant infrastructure and evaluation of staff as some important factors that must be addressed before rolling out DHIS at the national level.

[9] https://www.ihris.org/
[10] https://www.dhis2.org/

GSD itself is a complex phenomenon which includes a number of business models. Almost every business model involves communication over distance where people from different cultures collaborate. OSS development is truly adopted in GSD environment and it is even more complicated if the development context are in and of developing countries. The complexity of HIS development lies within the context specific requirements specification, need for detailed domain knowledge as well as the poor infrastructures of developing countries. We can conclude that GSD in general and CBSD in specific when applied to the development of OSS based public HIS is indeed an interesting phenomenon but not yet fully explored.

In the absence of an established body of research on CBSD challenges for public HIS, the challenges I present in next section are adopted from GSD literature in general and from the nearshoring literature specifically.

4.3 Challenges

There are several challenges highlighted by different researchers in the field of GSD. In the context of my thesis, I discuss four main challenges related to: distance, culture, communication and requirements.

4.3.1 Distance

GSD has brought a number of opportunities for different countries in the form of outsourcing their work, both as suppliers and customers However, distance and time-zone related issues are ongoing challenges for both suppliers and users to contend with (Rao 2004). Distance increases complexity in organizational processes such as of coordination and control (Carmel and Agarwal 2001). Coordination is dependent on several activities including communication, tools, processes and practices (Herbsleb 2007). Coordination and communication problems may be a threat for planning, requirement gathering, analysis and negotiation which are crucial activities during the various phases of projects (Damian and Zowghi 2003).

Differences in time-zone introduces several challenges requiring more frequent work handoffs (Mockus and Herbsleb 2001) and difficulties in scheduling meetings (Herbsleb, Paulish et al. 2005). Rao (2004) gave an example of time difference between the Seattle corporate headquarters and the New Delhi office, and how the lack of overlapping working

hours raised difficulties in scheduling meetings to assess project status. Herbsleb, Paulish et al. (2005) reported similar challenges in the context of Siemens Corporation's nine globally-distributed SD projects. The challenges were magnified in the context of projects which required fast-paced interactions.

Placing the development centers outside of customer's host country but geographically close and in same or similar time-zone is referred to nearshoring (Abbott and Jones 2003). Distance still matters in nearshoring due to its involvement in virtual forms of working (Carmel and Abbott 2007), involving cross-site projects. Cross-site coordination could be problematic, if there is not a common understanding of who to contact about what, of initiating contact and of effective communication (Herbsleb, Mockus et al. 2001).

Lack of such shared understanding can lead to conflicts, break downs and associated delays. Such delays can significantly slow down the development process. The issues otherwise requiring minutes and hours to address might be extended to days and weeks. These delays are due to challenges such as finding the responsible people and establishing necessary collaborative sessions with them Herbsleb and Mockus et al. (2001). Countries that are geographically located close to each other may also have certain kind of challenges. Such challenges are lack of transport infrastructure and difficulties in getting visa and permits (Holmstrom, Conchúir et al. 2006).

Temporal distance may also exist when different countries are working within almost similar time zones. Holmstrom, Conchúir et al. (2006) gave an example of countries working within Europe which may have one hour difference in time zone but their different routines during a working day increases the temporal distance. Minor overlapping hours also cannot be ignored because for teams adopting asynchronous modes of communication, these hours can be quite crucial. Few overlapping hours means replies often do not come until the next day (Herbsleb 2007) or can be longer if there are weekends and holidays in between.

4.3.2 Culture

Cultural differences escalate with increasing geographic distances between countries. GSD tends to involve different people from varying cultural backgrounds (Herbsleb and Moitra 2001). They might have different native languages and might be used to different processes

(Mockus and Herbsleb 2001). Therefore, understanding culture and how it affects GSD is very important.

There is no exact definition of culture; rather scholars of different fields have approached the concept of culture from different perspectives. The definition adopted for culture in GSD context by Sahay, Nicholson et al. (2003) is, "*A group or community that shares some common experiences that shape the way in which its members understand the world*". According to them, human actors belong to a social system which carries some rules and resources that shapes the expressing of actions and building interpretations of the actors. Walsham (2002) conceptualizes culture as "*shared symbols, norms, and values in social collectivity such as a country*" (Walsham 2002). Dorothy and Kayworth (2006) further elaborated that assured set of values persevere in all countries nonetheless will vary to different extents across geographies.

Culture involves complex dimensions which includes language, politics, individual motivations, work ethics, organizational and national culture (Holmstrom, Conchúir et al. 2006). Significant variations on any of these dimensions can be a challenge in GSD work (Herbsleb and Moitra 2001) which may introduce misunderstandings and communication problems. Direct communication may be considered odd in some societies and odd sounding messages are less likely to be answered (Herbsleb and Moitra 2001). The impact of different language and inappropriate knowledge sharing could lead to difficulties in requirements elicitation and validation (Damian and Zowghi 2003), thus resulting in building poor trusting working relationships and misunderstood requirements. Additionally, interaction between customers and clients for requirements gathering could be extremely time-consuming if both parties are speaking different native languages (Sahay, Nicholson et al. 2003).

Difference in national cultures is another factor that can lead to misunderstandings. Herbsleb, Paulish et al. (2005) found that modes of expressing agreement and disagreement between Asian cultures when compared to American or European cultures created confusions and misunderstandings. For example Asian colleague's politeness is often considered as a commitment by European and American colleagues. One can assume that countries with linguistic and cultural closeness might not have such problems to the same extent.

Cultural and linguistic closeness may be beneficial in some cases when dealing with GSD but there are some tradeoffs as well. Similar cultural values and linguistic resemblances are two

main characteristics of nearshoring (Carmel and Abbott 2007). Countries which are sharing the same language may have difficulties in interpreting the meanings differently (Holmstrom, Conchúir et al. 2006). Holmstrom, Conchúir et al (2006) found that participants of their study (from US and Ireland) complained about difficulties despite sharing the same native language. The problem was that there were different interpretations of same terms in USA and Ireland which led to misunderstandings. One such example is varying interpretations of same idiomatic expressions in different countries (Rao 2004). Different interpretations are not the only problem. Shared understanding of the technical nature of language used for SD activities can also be problematic (Sahay, Nicholson et al. 2003).

Cultural dimensions such as individual and organizational culture are also important. New technologies and the outcomes of GSD might affect individual and organizational culture. Walsham (2002) presented the concept of culture as shared values, norms and symbols that are associated to a social group. These types of social groups exist at the organization as well as individual levels and they form organizational cultures. IT related activities such as introduction of new IS may change the values and behaviors these organizational cultures are carrying (Leidner and Kayworth 2006). Leidner and Kayworth (2006) analyzed that groups are more expected to adopt a technology if their own values match or fit the values implanted with the new technology. According to them, similarities in cultural values among organizational stakeholders will lead to more effective use of IT. They also pointed out that challenges with rising conflicts and their resolution. They present the idea that IT changes the culture over a period of time. Initially, user groups face conflicts when using new IT products but this use in turn reorients values of the users. As these values become positive, user groups are expected to adopt the new IT, thus reducing the conflicts raised in the initial stages. An example of this is provided by Walsham (2002) based on a case study between Indian and Jamaican teams working on IS development. He argued that conflicts and contradictions arising during the early stages but over time the SD process changed the respective values of each group resulting in the development of a negotiated culture.

Distance and cultural differences exist in nearly each business model of GSD and these differences may introduce communication problems which I discuss next.

4.3.3 Communication

There are two dimensions of communication's complexity in GSD. One is cross-site and other is cross-cultural.

Communication across sites is potentially the biggest source of problems in GSDs (Mockus and Herbsleb 2001). Communication across sites use ICTs to define the content of work (Sahay, Nicholson et al. 2003). According to Sahay, Nicholson et al. compatibility, protocols, standards and issues of power and control are some key challenges associated with the use of such ICTs. These challenges are magnified in the absence of reliable infrastructure and in domain where user specifications are constantly changing. Poor telecommunication infrastructure of a country may also influence global souring relationships (Rao 2004).

Communications for SD project involves both formal and informal communications (Herbsleb and Moitra 2001). In GSD projects, chances of informal communication are fewer. The communication mediums are mostly used for scheduled meetings such as project planning, requirement negotiations and discussing technical aspects of the project. In addition to these scheduled meetings, sometimes communication is also required for discussing overall progress or any change in requirements. Herbsleb and Moitra (2001) argued that inadequate communication may lead to issues cropping up on almost a daily basis on one site but are entirely unrecognized and unresolved on the other site. Limited communication increases lack of awareness (Herbsleb 2007). Herbsleb (2007) discussed that people who are working together in a distributed environment tend to have less knowledge of what people at other site are doing day to day. Lack of awareness is clearly challenging to initiate contact, and often leads to misunderstandings of communication contents. Distance across-sites is also clearly challenging for face-to-face communications that results in reduced level of trust (Damian and Zowghi 2003).

Communication in distributed work tends to involve many people as compared to same-site work (Herbsleb and Mockus 2003) and that could often be problematic. Herbsleb and Mockus (2003) investigated relationships in relation to delays, communication, coordination and geographical distribution of work. They found distributed work required longer time to complete hence resulting in systematic delays.

Communication over distance is even more complicated if cultural difference exists, leading to frustrations and misunderstandings (Herbsleb, Paulish et al. 2005). Cross-cultural

communication is difficult due to different views of the relevance, applicability and value of particular modes of working and use of ICTs, often producing conflict (Walsham 2002). Sahay, Nicholson et al. (2003) described cross-cultural communication challenges between Japanese and Indian firms. According to their understanding, both countries share religious and cultural values such as respect for elders and the importance given to family. However on investigation they realized that for understanding each other's' practices requires to fill the gap of communication. Indians faced difficulties to understand Japanese requirements whereas Japanese faced problems to express them. According to them the process of communication was a central task for requirement analysis.

4.3.4 Requirements

Eliciting and communicating requirements is one of the critical challenges faced by global software engineering (Herbsleb 2007). RE process involves developing, specifying, analyzing, verifying, allocating, tracing and managing requirements. Further, it also involves the establishment and maintenance of agreements between customer and project teams about the process of management of requirement changes (Ebert 2011). Ebert (2011) presented the RE process in a GSD context from a project domain perspective rather than a product domain.

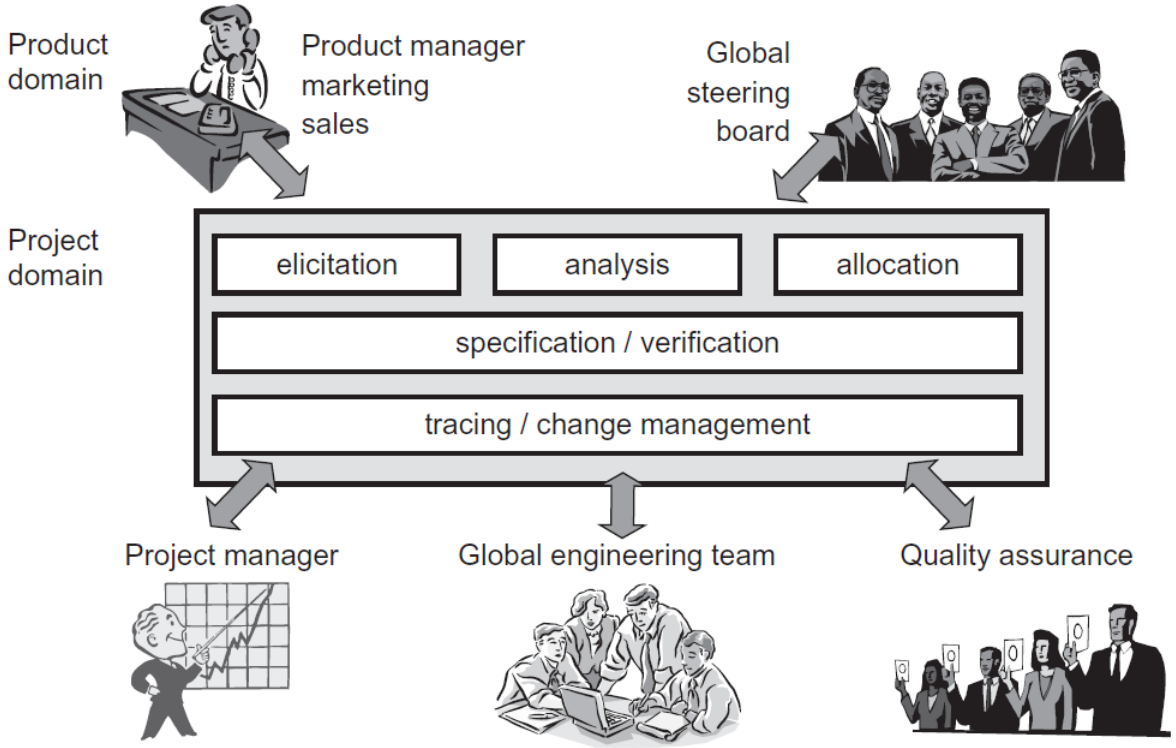

Figure 4.4 – Project domain RE process adopted from (Ebert 2011) p. 40

Requirements engineering is a very complicated task even when it is taking place in local contexts and much more difficult in a GSD context (Damian and Zowghi 2003). In GSDs, different stakeholders are involved for specifying and understanding requirements. These stakeholders often belong to different cultures, speaking different languages and collaborating from different time zones.

Ebert (2011) pointed to the requirements uncertainties that are associated with user's inability to state their requirements properly and in changing circumstances. Both these factors affect the entire project resulting in delays. Herbsleb (2007) highlighted many challenges that stand in the way of achieving the desired future of a socio-technical coordination vision, including relating to RE. According to him, requirements not only include end user requirements but also include anything that specifies what a team should deliver. Damian and Zowghi (2003) described a model of RE challenges that is a result of geographical distribution of stakeholders. According to their model, four known problems of GSD namely cultural diversity, inadequate communication, knowledge sharing and time differences create specific difficulties in RE activities. They argued that diversity in customer culture and business creates difficulties in understanding and checking back meanings of particular requirements.

Particular requirements may only be meaningful in the context of a certain culture, beliefs and values. Another issue highlighted by them is the lack of informal communication and diminished awareness of the local working context. This issue is a result of requirements related communication through formal channels. They also observed in their case study that ineffective formal decision-making meetings combined with use of email couldn't deliver desired outcomes and issues remained unresolved longer than necessary.

Distribution of stakeholders affects communication for global RE (Damian 2007). Damian (2007) emphasized particular challenges of interaction that are related to the knowledge acquisition and sharing, aligning RE processes and tools along with effective communication and coordination. She mentioned that multiple layers of stakeholders hinder designers from seeking out relevant knowledge. Another issue pointed out by her is lack of informal communication necessary for requirements negotiation, which negatively influences relationship building.

4.4 Approaches to deal with challenges

As we have seen, distance in GSD is very important irrespective of the business model in outsourcing projects. If distance increases within countries, cultural differences are also magnified. These differences create difficulties in communication for IT projects and RE processes. There are several approaches to deal with these challenges.

4.4.1 Alleviating distance

Distance is one of the most important factor introduced in GSD and there are several tactical approaches to alleviate the problems related to distance (Carmel and Agarwal 2001). Carmel and Agrawal (2001) argued that reducing intensive collaboration, cultural distance and temporal distance may be some tactical approaches that can address the issues introduced by distance. According to them, countries which are trying to reduce the cultural barriers by bridgeheads, by internalizing foreign entities, by creating cultural liaison and by learning the English language have achieved significant success in reducing cultural distance in the GSD context.

4.4.2 Managing cross-cultural relationships

There are several approaches to manage cross-cultural relationships. Krishna, Sahay et al. (2004) have presented the idea of harmonizing customer and supplier by understanding differences in norms and values. They also encourage the development of a negotiated culture. According to them training on both customer and supplier side can reduce some of these cultural barriers.

Formal courses and on-the-job facilitation may be some useful means of cross-cultural training and education (Walsham 2002). According to Walsham, there is a need to understand attitudes, norms and values of others within cross-cultural teams and open discussions can increase such understanding. Damian (2007) also supports the idea of bridging the cultural gap across sites and organizations. She argued that cultural liaison is important for relationship building as well as in requirements elicitation and validation.

4.4.3 Enabling effective communication through tools and travelling

According to Mockus and Herbselb (2001), creation of a virtual site that involves tools, practices and processes can help deal with several challenges of distributed work across distance. For example it can be helpful in overcoming the problem of different time zones as well as to efficiently deal with coordination and communication problems across sites. They also provided steps for creating a virtual site in which a set of common development tools are set up in the first place, followed by provision of infrastructure which can enable collaborative sessions. According to them it is also necessary to show presence by using common calendars and instant messaging and by setting up common practices on how to respond on emails and phone calls. They have supported the idea of travelling for project kickoff meetings, establishing communication etiquette and training at remote sites which can contribute to establishing effective relationships.

The idea of using instant messaging application and shared calendars is also supported by Herbsleb, Mockus et al. (2001). Herbsleb, Paulish et al. (2005) have also suggested creating virtual sites and shared processes such as for project management, background knowledge sharing, and planned communication regimes in their proposed solution to overcome communication problems. Additionally, they subscribe to the idea of spending the budget on travel in the early stages of the project to build shared understanding and a social glue which

can be a sound foundation for future work (Holmstrom, Conchúir et al. 2006). The participants of the study conducted by Holmstrom, Conchúir et al. (2006) suggested face-to-face meetings in critical phases of the projects. Such meetings may provide an opportunity for participants to know each other and can create a social network which in turn can generate trust, respect and commitment and in the long term facilitate development work across various geographical sites. Participants also added that informal communication play a critical role in coordination activities for co-located development. They also mentioned that technologies which facilitated facial expressions may be a solution to the problems that are created by different interpretations of meanings influenced by different socio-cultural conditions of countries.

Appropriate roles in remote stakeholders groups must be defined so that team members know who to contact for what kind of issue. Herbsleb, Paulish et al. (2005) supported the idea of direct communication for avoiding frequent bottlenecks in project work. They argued that project expectations must be very clear. There is a need to develop ways of testing the service provider's understanding especially when schedules and plans give optimistic impressions of project progress.

4.4.4 Handling requirement engineering problem

There are some solutions discussed in the literature to mitigate RE related problems. Damian and Zowghi (2003) suggested enabling better and more frequent interactions with field personnel. Interactions can be in the form of field visits by the representatives which can potentially reduce problems related to language and terminology misunderstandings and help build trust based relationships. Field visits will also help in increasing the awareness of the user's local working context and enable better communication. They also motivated the idea of using richer communication mediums to address the challenge of unclear requirements and managing conflicts. Damian (2007) suggests using RE artifacts, a requirements specification vocabulary for notations and terminologies and their frequent validation which can give the visibility of progress to stakeholders.

Based on an experience on global system engineering projects Ebert (2012) present the best practices to mitigate the risks in the RE process:

- Specifying requirements
- Specifying the understanding of requirements
- Sorting out requirements
- Assuring adequate collaboration and communication workflow management
- Managing change
- Designing for change

4.5 Conclusions

GSD consists of many business models and each of them has different challenges. However, most of the challenges observed in business models are related to distance, culture which in turn affects communications and RE processes. CBSD shares similarities with nearshoring business model in which challenges are relatively minimal due to proximity of geographic, temporal, cultural, linguistic, historical, political or economic conditions within neighboring countries. Even though proximate conditions are helpful, CBSD is affected by some other factors such as lack of transport infrastructure, visa and permit issues. Such factors create difficulties in arranging face to face meetings that are necessary for project kick offs, RE process and for developing shared understanding. ICT means are often adopted in such situations for developing a shared understanding and for defining requirements of the project. ICT may to some extent overcome the challenges associated with temporal, coordination and communication problems and facilitate the creation of virtual sites but it also comes with its own challenges. ICT is often used for planned meetings and therefore reduces the chances of having informal communication. Changes in requirements, layers of multiple stakeholders and inability of users to state their requirements properly are some other challenges which are difficult to communicate by using only ICT and therefore results in delay and poor trust relationship.

Another important factor is the type of project adopted in GSD environment. OSS is truly adopted in GSD environment and that is why there is a need to understand effects of the challenges highlighted in GSD. This chapter presented an example of HISP network which consists of highly skilled developers and a large community of user groups mainly from

developing countries. Since, the area specifically chosen for this thesis is missing an established body of literature; the challenges observed in OSS context are indicating issues such as communication problems and conveying context-specific requirements. Context specific requirements, when conveyed properly in GSD environment can provide the benefit of development of FOSS which can be used to strengthen the public HIS of developing countries. Additionally, the challenges associated with the health system of a particular country must not be ignored. Such challenges may associate with human resource in the form of limited capacity of domain knowledge of end users and software implementers as well as lack of proper infrastructure. Focusing on capacity building, providing proper infrastructure and evaluation of staff would be very helpful and that might overcome the challenges associated with the health sector of developing countries.

5 Cross-border software development between GS-Pak and HISP-India

In this chapter, I present the case study for the thesis. This case study involved the design and development of an information systems project between India and Pakistan based on the DHIS2 solution. I will first present the GS-Pak organization which is the customer in this project along with its business domain and existing process associated with the IPC program, which is the key focus of this thesis. I will then present HISP India which is the supplier in this project who is to do the system development. This section discusses objectives pursued by HISP India, other projects they were been engaged with and the team specifically involved in this project. At the end of this section, I discuss the India-Pakistan project, its goals, phases and approaches that were followed.

5.1 The customer (GS-Pak)

First I present GS-Pak which is a NGO in Pakistan and the customer in this project. Selected business domain of GS-Pak will be discussed next and at the end, I present existing processes in this domain.

5.1.1 Introduction

The organization under study is GS-Pak which was established in 1991, as a social enterprise, and as a member of the Population Services International network. It was established to improve the sexual and reproductive health of people in Pakistan by enabling cumulative choices and access to quality modern family planning methods and contraceptives. This organization is offering quality family planning services through a wide network of private providers including clinics or health care facilities usually known as “Sabzsitara” as well as retail outlets. Taken together, both are responsible for the provision of roughly 53% of all contraceptives, distributed by the private sector in Pakistan.

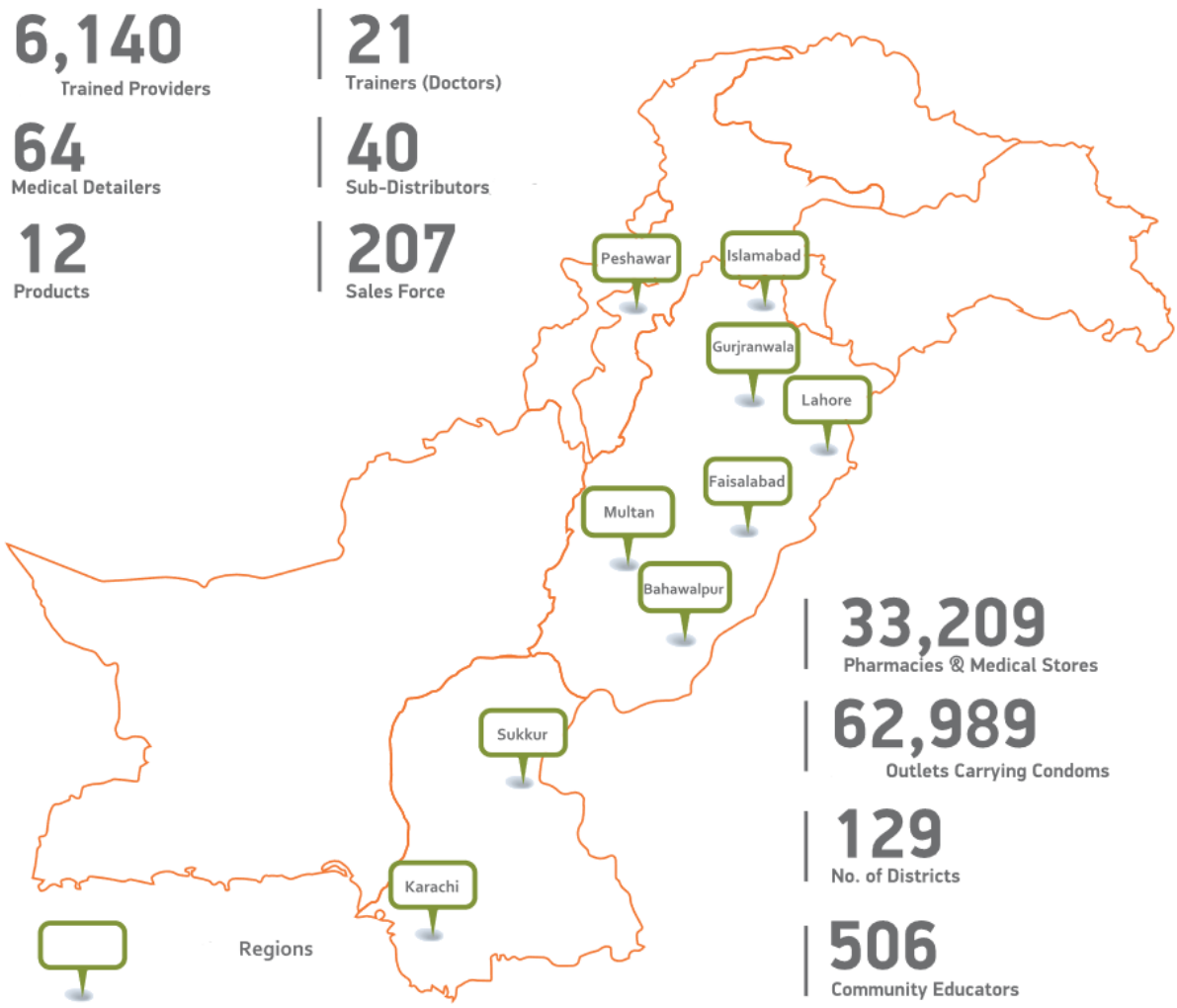

Figure 5.1 - Facts and figures about GS-Pak (obtained from GS-Pak annual report 2015 p. 24)[11]

The administration of GS-Pak is controlled and divided into 9 regions. GS-Pak is providing family planning information, referrals and commodities through a strong crew of trained community educators covering 129 districts and some specific Tehsils, which are considered as “underserved”.

5.1.2 Business domain

GS-Pak is covering a wide range of business domains but the Inter Personal Communications (IPC) is selected for this thesis. The reason for selecting this area is that the DHIS2 platform is planned to support the IPC business area in the first phase of the project.

[11] https://www.greenstar.org.pk/annualreports

IPC was defined by an Area Manager of GS-Pak in following words.

"*IPC basically represents a face to face exchange of information between the field force and target audience*".

The field force is creating awareness about the benefits of birth spacing and trying to motivate the target audience towards the adoption of contraceptive methods at the community level within a defined catchment area. IPC intervention is considered as the backbone for changing behaviors in communities which is a main goal of GS-Pak.

GS-Pak is doing demand generation in three ways within this business domain:

- Creating new users
- Motivating the existing users
- Taking market share from competing behaviors

5.1.3 Existing process

In this section, the existing processes of GS-Pak related to IPC program are presented. IPC represents a face to face interaction between field force and the clients with the objective of changing their behavior in relation with the use of modern contraceptive methods. Following are the details of the field force and clients in the existing process.

Field force

Field force comprises Health Service Providers (HSP), Community Educators (CEs), IPC supervisors and Area Managers (AM).

HSP team consists of doctors, nurses and lady health visitors. GS-Pak has one of the most experienced HSP team in the country which has spearheaded the provision of quality reproductive health and family planning services since 1991. They are assuring the provision of quality family planning services for clients through the social franchise network and they also visit multiple clinics for providing their services to clients who either are referred by CEs or to walk-in clients coming without prior appointment or referral.

There are two types of CEs, Female Community Educators FCEs and Male Community Educators MCEs. The basic functions performed by the FCEs & MCEs are to conduct IPC activities at the community level by organizing various awareness events. In this way they reach out to the people and enroll them for services offered by GS-Pak. IPC activities involves client registration, conducting door-to-door visits, household visits, issuing referral tokens and conducting neighborhood meetings.

Figure 5.2 – IPC team activities (adopted from GS-Pak annual report 2015)[12]

Relevant data is collected according to the IPC activities and handed over to the IPC supervisors. An IPC supervisor has a number of CEs assigned to him or her and is responsible for managing their work and IPC activities. They could be obliged to be responsible for one or multiple tehsils (sub-district level). Data entered by the CEs is monitored by the IPC supervisor to perform a supervisory role and back-checks. They are also responsible to ensure that data is entered correctly. The gaps in data is identified and corrected by them before submission to higher authorities at regional (district) levels. The supervisors can re-visit the clients along with the CEs or as a back-check to gather information about the visit made and information given to the clients. Based on this information they are responsible to fill in the Supportive Supervision Form (SSF) and grade the visit parameters as excellent, good, average etc.

[12] www.greenstar.org.pk/annualreports

AMs analyze the data gathered by the IPC supervisors through SSF as well as they check the form filled by the CEs to monitor the work done for the conduct of IPC activities.

Sample forms used for IPC activities are presented below.

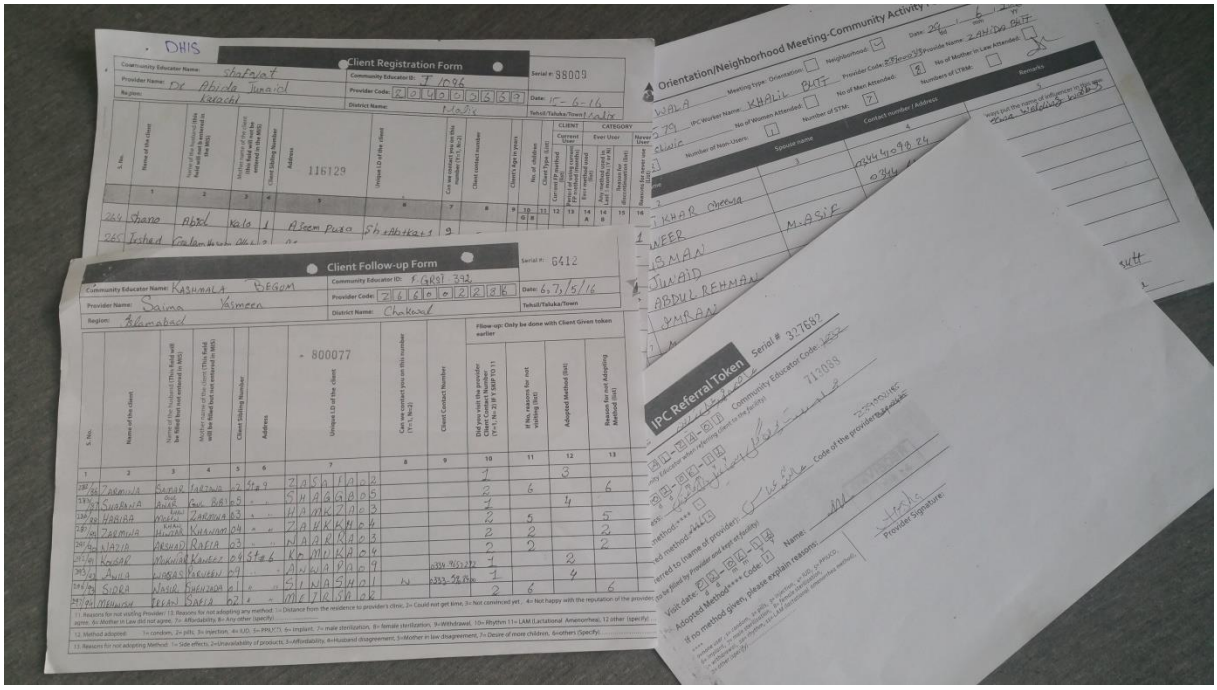

Figure 5.3 - Form used during the IPC activities

After checking the forms, they are sent to the head office at the end of every week for computerized entry in the software developed in-house to support the IPC program. TCS courier services[13] available in Pakistan are used to send the forms.

Clients

Clients are the most important part of IPC program. A Client is a person availing the services. Married Women in Reproductive Age (MAWRA) are the target audiences of the IPC program. The objective is to change their behavior in relation with the use of modern contraceptive methods. They are gaining information from the field force awareness programs and the services from provider's outlet or clinics to which they can visit or be referred by the field force. They are counseled towards the adoption of family planning methods, basic well-being in terms of sexual and reproductive health through the participation in community or neighborhood meetings. Here they can collect the referral token to gain the services to the

[13] http://www.tcscouriers.com/pk/home.aspx

service provider to whom they have been referred. They can also collect the brochures which contains the detailed information of family planning methods. For the convenience of the clients and to provide the information, door-to-door visits are also conducted in their community.

Figure 5.4 - A client is collecting the brochure from FCE during door-to-door visit (adopted from GS-Pak annual report 2015 p. 16)[14]

After getting the information, if they are interested they are registered by the field force upon provision of personal information, and can acquire the referral token to avail services at a service provider. Clients are also followed up by the field force to check if they have visited the service provider or not and if not, why? Additionally, updated information of clients about the adoption of family planning methods is recorded as well as they are motivated continuously.

5.2 The supplier (HISP-India)

HISP is a global research and development network, which was established in 1994 to support HIS strengthening in developing countries (Braa and Sahay 2012). IFI, UIO initiated and established this network and is also responsible for the management and coordination of it

[14] www.greenstar.org.pk/annualreports

(Braa, Monteiro et al. 2004). HISP-India is a NGO and is a node of HISP network which is helping to create a regional node in South East Asia. HISP-India was initiated around 2000 with the inspiration of earlier interventions in South Africa related to the development of integrated district-based information systems with decentralized structures, standardization of minimum data sets and OSS development (Braa and Sahay 2012).

In 2000, the Administrative School of India and Indian Institute of Management Bangalore were both partners of HISP-India and their responsibilities were research, training, implementing, contract with state DoH (Braa, Monteiro et al. 2004). From 2000 onwards, several efforts have been put by the HISP-India to build and sustain the HIS in different states of India. Through these efforts, various standards were established reflecting a mix of technical and practice based and related to data elements, datasets, indicators reporting forms and relationships.

5.2.1 Objectives of HISP-India

The main objectives defined by HISP-India are to play an important role concerning the design, development and implementation of Integrated Health Information Architectures (IHIA) including the core components such as of routine aggregate reporting systems, mobile based reporting systems, geographic information systems etc. The principles of developing mutual learning and participatory designs were used by the Indian team to design, develop and implement the IHIA. To enable strengthening the information culture in public health systems, HISP-India actively participates in various capacity building initiatives including Oslo enabled DHIS2 Academies.

5.2.2 Projects

Currently HISP-India is involved in various projects both at the national and global levels. At the national level, most projects are related to the customization, deployment, implementation and technical support for DHIS2 based solutions in different states or regions of India such as Himachal Pradesh, Punjab, Bihar and Kerala. HISP-India is involved in many projects[15] worldwide including countries such as Kenya, Bangladesh, Sri Lanka, Rwanda and Tajikistan.

[15] https://www.hispindia.org/index.php/our-projects/global

5.2.3 The team

The HISP-India team consists of a dedicated and multidisciplinary crew of specialists that have both expertise and experience from different domains such as computer sciences, social sciences, public health and psychology that enables competencies in the domain of public health informatics. Here I will discuss only those members who are involved in the India-Pakistan project of GS-Pak that is selected for study in this thesis.

The founder of HISP-India is my supervisor and responsible for the whole project. He participated in the requirement gathering phase and was responsible throughout for communication for this project from start to end.

Business requirement analyst is also a leader of health systems in India on behalf of HISP-India and plays an important role in the conduct of this project. During the business requirement analysis, requirements were gathered, understood, documented and communicated with the project development team of HISP-India and with the Pakistani team for verification.

The software development team comprises currently of eleven members. Members of the team had different responsibilities in the project such as of design, development, system testing, bug fixing and customization of DHIS2.

Additionally the capacity building material such as of plans, user documentation, presentations, handouts and test scenarios were also prepared by the software development team with the help of the business requirement analyst. The main functions of HISP-India include DHIS2 customization, use of tracker applications, use of information for action, data management, server management and supporting capacity building processes.

5.3 The project (India-Pakistan)

The project was initiated in the month of July 2015 after several conversations between the teams from India and Pakistan. In this section, I first present the defined goals and then the approaches agreed upon for accomplishment of the project including details of the project phases.

5.3.1 Goals

The goal of this project was to develop an information system for GS-Pak to help manage their data for the healthcare products and support services provided by various stakeholders in their service delivery framework. In the preceding section, it was discussed in detail the data collected by the field force and network of service providers at different locations across Pakistan. The DHIS2 platform was selected for the implementation of this project.

Main functions identified for the DHIS2 based solution were as follows:

- To provide client based information capture from the point of care delivery, which can be either, through the interaction with an IPC or a walk in client at any of the service providers or clinics.
- To track the clients referred to by the CEs to a HSP to ensure they receive appropriate services.
- To manage the performance of the field force by monitoring their activities against the set performance standards and visit plans issued by the department of M&E of GS-Pak.
- To evaluate the HSP network for quality of services provided and to ensure service delivery at the respective clinics.

5.3.2 Approaches

There exists various travel restrictions between India-Pakistan as mentioned in section 2.2, and therefore online means of communication were adopted for the primary conduct of the project. The project was initiated in July 2015 and a prototyping approach to development was adopted.

There are several business domains within the GS-Pak but only specific areas were decided to be developed based on the DHIS2 solution, which included the following three modules:

1. IPC
2. Field Force Monitoring

3. Sales

After completion of each stage, it was planned that HISP-India would present the module to GS-Pak who would provide feedback on the required improvements. In an interview the project manager from GS-Pak told me about how they utilized the online means of communication for passing on feedback in this project.

"*The HISP India was presenting us the module after completion and we were providing them feedback about the improvements through online means*"

The IPC module was picked first, which is also the main focus of this thesis. This module was developed earlier by using Visual Fox-Pro as in-house software. Data from the forms collected from all the regions working under GS-Pak, was entered by data entry operators at the data center.

In the coming section, I present different phases in the development of the IPC module.

5.3.3 Phases

In the following section, details of the different phases for the software development process specifically related to the IPC module are discussed.

Requirements gathering

Since there are various travel restrictions between the two countries – India and Pakistan – the requirements gathering phase was carried out through online means. The requirement analysis was done for 2 modules initially. Multiple Skype meetings and phone call conversations were used for the capture of the requirements during the period July to August 2015, and the SRS was finalized by September 2015 after several conversations and rounds of revisions.

In an interview the HISP-Indian team lead described the challenges of using online means of communication during the requirement gathering phase.

"*All the discussions were done online; therefore it took longer than expected to develop a mutual understanding of the overall workflows for the IPC and field force monitoring module*".

Since online communication was the only means, much more time than expected was taken to develop a mutual understanding of the overall workflows of the two modules. Additionally the requirements were changed frequently, leading to constant changes in the development work plan.

Development

After the finalization of the requirements of the first two modules, development started in September 2015. The basic prototype of the IPC module was released in November 2015. The subsequent iterations were released with enhanced functionalities based on the feedback received. Change in requirements and complex functionalities according to business needs of GS-Pak resulted in delays and extra work for the developers.

In an email conversation, the HISP-India's developers described how the ambiguous and constantly changing requirements led to delays during the development phase.

"*Subsequent iterations were released with enhanced functionalities based on the feedback received on the initial prototypes. Since the requirements gathering process took longer than expected, hence it accounted for the delays*".

On other hand, GS-Pak complained about the deadlines which were not met for the IPC module. According to them,

"*The development process was slow and we faced delay of 6 months for first module of this project*".

Since the requirements process ran longer than expected, hence it accounted for the delays in development phases too. When the first two modules were completed, a capacity building workshop was planned to present these modules to the end users.

Capacity building

Due to travel restrictions between India-Pakistan, the capacity building workshop was conducted in the neutral location of Dubai in mid of March 2016. Two key participants from HISP-India including the project lead and the main developer along with ten key participants from GS-Pak joined the workshop. Since criteria for the selection of people from GS-Pak was mainly based on business and IT. Three people each from the MIS and IT Departments were selected from GS-Pak as well as three more participants from the research department who were to stay only 3 days out of the total 10 days planned for the workshop. All these participants were led by the Chief Finance Officer of GS-Pak. Hands on training were given to the end users on the DHIS2 based solution as well as on the basics of DHIS2 customization and configuration.

MIS manager from GS-Pak participated in training phase and he explained the benefits of face to face meeting for this phase in following words.

"*Training workshop developed a mutual trust and build strong understanding about how we think about the project and overall values as a team member. Both teams got the opportunity to know each other. It became very easy to communicate and ask about the problems and discuss possible solutions*".

Further, GS-Pak learned about the installation, development and management of the system. Additionally, post to the trainings the scope of work for the remaining modules was finalized along with a discussion on the gathered requirements. HISP Indian manager's experience with face to face meeting was described in following words.

"*We gave trainings to the end users based upon requirements from GS-Pak along with DHIS2 customizations and configurations possibilities. We also defined the scope of the work for the remaining modules and discussed gathered requirements*".

There are heavy costs involved to conduct such trainings, and therefore it was planned to do the remaining trainings online. I have observed that after the face to face capacity building workshop, the next modules were released in less time and there was very good impressions about the project from both teams.

The trainings at the national level were given to the employees of the data center in Pakistan by the team who got training in Dubai. The employees at the data center were using the existing system for data entry. Training at the national level was given in three hours. Initially it was quite challenging for the staff to understand the concepts used in the DHIS2 which had a multiplicity of functionalities. However, as they did the hands on practice, they realized that this new solution was quite similar to the existing system that they had previously used.

The data entry operator in an interview said,

"*The DHIS2 solution is not much different from the existing one*".

The staff was given the time of two weeks to practically use the DHIS2 solution to make dummy entries such as:

- Register workforce such as IPC worker, IPC Supervisor and Area or Regional Manager.
- Register client's information and follow-up plan provided by the IPC Worker.
- Enter details for orientation/neighborhood meetings in the application.
- Enter details of the Supportive Supervision provided by the IPC Supervisor.
- Edit, remove or disable information of the workforce and clients under various custom designed workforce registries for IPCs, IPC Supervisors, Area or Regional Managers and Service Providers.
- Assign SPs to the IPCs and link the provider for 6 months and after this period change the SP.

The employees were entering sample forms on test servers and providing feedback about the usage and their understanding to the system. Based on the provided feedback, refresher training was given for around one hour to make the concepts more clear. These trainings and opportunity for hands on practice increased the confidence of the end users prior to the actual deployment. The IPC module was completely tested by the end users in the test environment.

Deployment

My field visit was conducted during the month of June and July in which I observed that the employees at GS-Pak were too much busy with annual closing therefore could not start to use the DHIS2 solution in July as originally planned. The system was deployed in the test environment initially and since the teams from Pakistan were waiting for all the modules to be deployed on live servers, deployment was delayed.

The information about the deployment of DHIS2 was shared to the Pakistani team to understand and follow the standard practices for server deployment of the DHIS2 based solution. They catered to all those requirements and in the month of July they were using two different servers. For DHIS2, one potential server was up and the other one was a testing server. The staff was regularly updating these servers. The data entered into servers were checked and analyzed by the teams and management people sitting in the head office on the test server whereas the data center staffs were making entries on the live server. In case of errors, if reported, they were checked on the test server but not on the live data. Additionally the backups of application and data were taken on daily basis.

In an interview I asked the GS-Pak project manager about how GS-Pak is tackling the risk of unstable electricity and internet connectivity. He replied,

"*We are using multiple services backups to reduce the risks caused by the unstable electrical supply and unreliable internet connectivity*".

The data was managed through two different cloud services, one was on multi net cloud and the other was on cyber net cloud. If any kind of problem was encountered in one cloud the network would automatically shift to the other cloud. Additionally the supervisors and managers were given the Wi-Fi enabled USB (3G EVO Wingle)[16] to connect the internet through laptops. In case the entire network was down or they were facing electricity problems they could send the data and reports through their laptops.

The field force monitoring module was released in May 2016 for client testing after successful integration with the (Mobilink SMS API)[17] which receives the data sent by GS-Pak work force using SMSs. The sales module was also released by July 2016. Since the annual

[16] https://www.ptcl.com.pk/Shop/Product?id=122
[17] https://www.smsgateway.to/en/mobilink

closing of GS-Pak was in the month of July, the testing of new modules was delayed. A capacity building workshop was planned in July for the roll-out the DHIS2 based solution all over in the Pakistan but due to internal work load this was postponed to the August.

6 Analysis

In this chapter, I will present the main themes identified from my empirical study. The challenges associated with each theme will be elaborated in a separate section with the help of examples. The first theme identified relates to context where I present how contextual complexities affected the project and vice versa. The second theme is about requirements where I will elaborate the challenges encountered during the requirement gathering phase and how it delayed the overall progress of the project. The third theme is about culture where I will elaborate the differences and similarities of the cultures in India and Pakistan and how they played a crucial role in this project. The fourth theme is communication where I will discuss the communication challenges during the project. The last theme discusses different expectations from different stakeholders in the project and the challenges these created. At the end, I conclude my main findings.

6.1 Context

In this section, I present the challenges and opportunities related to the context of this project. In this project, context plays a very important role in shaping the project and vice versa. This section elaborates both perspectives of the role of context.

6.1.1 Organizational hierarchy

It is very important to understand the organizational structure (hierarchy) of the customer organization for the development of an IS. Such an understanding makes it easier to address how to deal with the information flows and points of aggregation and reporting. My understanding of the organizational hierarchy specifically related to the IPC program is shown in the figure below. Based on my understanding, I further discuss challenges caused by this organizational hierarchy.

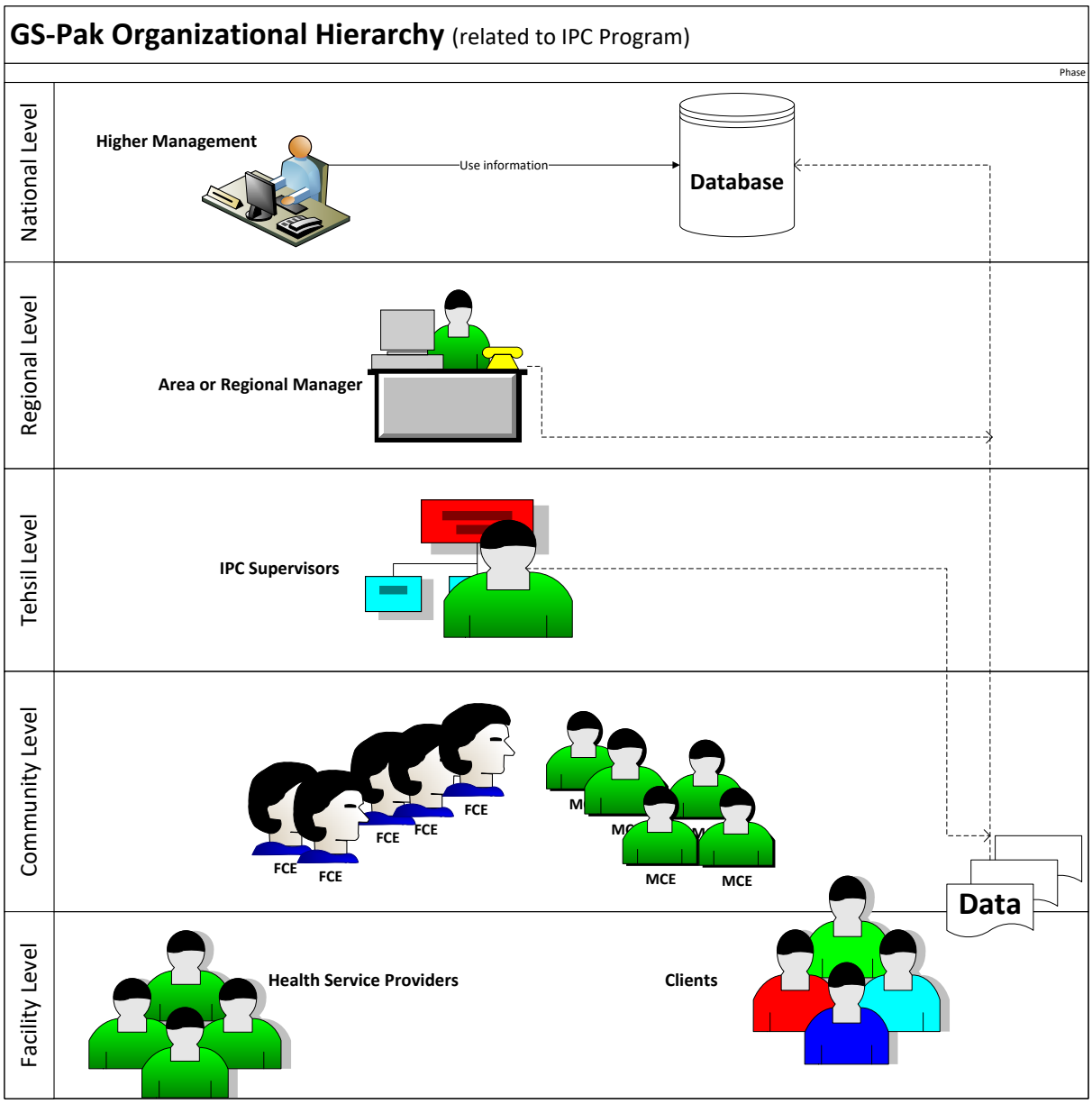

Figure 6.1 - GS-Pak organization hierarchy related to IPC program

GS-Pak has five hierarchal levels for administration of the IPC program that are national, regional, tehsil, community and facility.

Higher management at the national level (which is also the top level of organization) is responsible for decision making which uses the reports from the database. As we can see in the figure above, the regional level is next in the organizational hierarchy. Area/regional managers (AM) at this level are responsible for their respective areas which cover certain districts. There are nine regions in total including Islamabad, Peshawar, Gujranwala, Lahore, Faisalabad, Multan, Bahawalpur, Sukkur and Karachi. Tehsil level comes under regional/district level and they are equal to a sub-district. IPC supervisors at this level

supervise Female Community Educators (FCEs) and Male Community Educators (MCEs) working for the IPC program at the community level. FCs and MCs provides information to clients during an IPC program and also collect data from them. These clients acquire health services from Health Service Providers (HSPs) at the facility level based on the information provided by the FCs and MCs. The HSPs are available either at the health clinics or GS-Pak franchises.

The first challenge with GS-Pak was its organizational hierarchy. It was very different from that found in other developing countries. In other countries, DHIS2 has been used to strengthen HIS at the district level whereas the business support required by GS-Pak was at the sub-district (Tehsil) level. In GS-Pak, a region represents a district but these regions do not cover all the provinces and territories due to different reasons such as the lack of donor support and security issues. Since the hierarchical structure required in this project was different than in existing applications of DHIS2, it affected the core structure of DHIS2 design which hence resulted in unexpected delays.

The second challenge was the large amount of data involved and how that was to be adjusted in the organizational hierarchy. One example of this was that approximately 6000 providers at the Tehsil level had to be adjusted in organizational hierarchy.

Next, I presented how the roles and responsibilities within this hierarchical structure affected by this project.

6.1.2 Roles and responsibilities

The existing GS-Pak's data flow and different stakeholders around the information are shown in figure below. I then explain how different roles and responsibilities of these stakeholders were affected by this project.

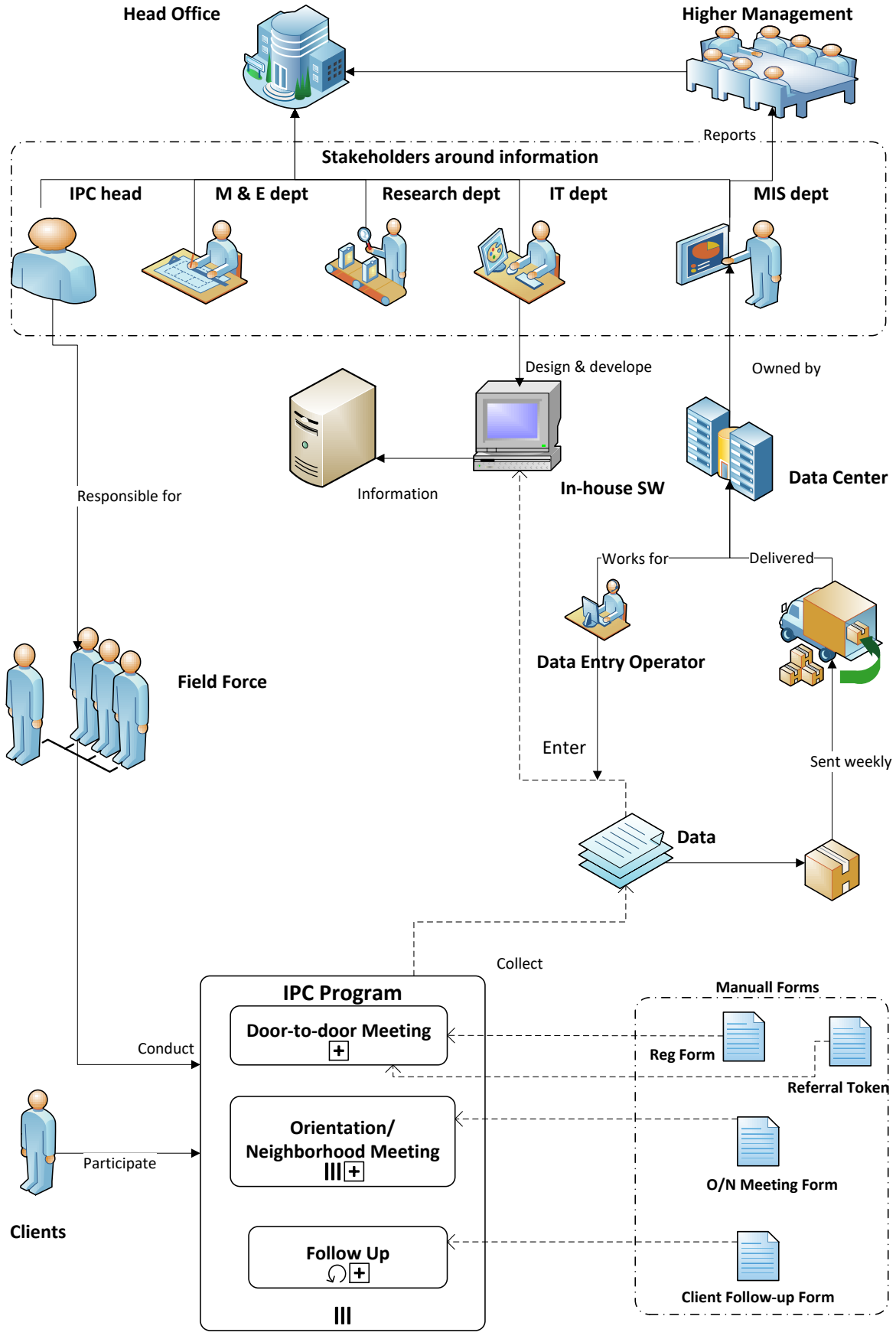

Figure 6.2 - GS-Pak data flow and stakeholders around the information

The figure represents different stakeholders around the information who have different roles. The MIS department plays a strategic role for achievement of the organizational goals as they are not only the data custodians but also responsible for providing reports to the higher authorities for decision making. In the existing system, extracting report data was quite difficult. Whenever higher management required reports from the MIS department it put extra burden on them as it was in addition to their daily routine work. DHIS2 provides a module for automatic generation of custom reports which will considerably reduce the amount of work for the users in the MIS department in the future.

The research department was responsible to provide robust inputs to the program teams on proposal development, research requirements, and realistic timelines related to studies that can explore and assess impact. The research department also took the lead in the dissemination of findings from all research projects, both at the national as well as in international forums.

The M&E department is responsible for the measurement and evaluation of the program results at all levels (input, output, outcome and impact). The results are gathered to provide the basis for accountability and informed decision-making at both the program and policy levels. The performance of the organization is demonstrated by this department according to the indicators and targets to be achieved by the donors of the GS-Pak organization.

The DHIS2 application was considered as an opportunity for research and M&E departments to become more efficient in their tasks such as through the presentation of the information in the form of graphs, charts and tables which would enable a better overview of information for these departments. Flexibility in setting indicators and targets in DHIS2 is another feature that was considered viable for increased efficiency in GS-Pak functional areas.

The IPC department is controlling the IPC interventions and performance spread throughout the country. A field force works for IPC program in the field. The basic functions performed by the field force includes conducting IPC activities by organizing various awareness events under the IPC program as shown in Figure 6.2. Each person from this team except the AM is responsible to work for 6 months within the area of a specific HSP. After six months an IPC worker has to move to the next Tehsil.

This kind of role required a dynamic hierarchy level management. In the existing DHIS2, the hierarchal levels were designed in a way where worker were fixed within the hierarchy. By providing a dynamic level management the core structure of DHIS2 needed to be changed to fit in the context. The Indian team could not change the core thus; development of this new feature in DHIS2 resulted in delays.

I have discussed how DHIS2 provided opportunities to the context. Changes in core DHIS2 affected by the context but may also provide an opportunity to other countries to have access to this different kind of organizational hierarchy.

6.1.3 Shifting of the existing system

Context is heavily influenced when there is a major shift required in existing ways of working to a different one. Such a shift comes with lot of challenges as well as opportunities in the context.

In GS-Pak's existing system, data was handled in paper format. Paper forms in the system are presented in Figure 6.2. For the IPC program, "Client Registration Forms" and "IPC Referral tokens" are used in door-to-door meetings. "Orientation/Neighborhood Meeting-Community Activity Forms" are used under orientation meetings. "Client follow-up Form" is used for client's follow-up in the IPC program. These forms are filled and then collected by the field force before they are sent to the head office on a weekly basis. Data center is attached to the head office and owned by MIS department, and was responsible to enter the manual data into the existing in-house application designed in FoxPro. DHIS2 will replace this existing in house built data entry application.

Since Data Entry Operators (DEOs) were using the existing system for a long time, ideally the new system should resemble the existing one so that the DEOs get to adapt to the new system quickly and efficiently. During my field interviews I discovered that the DEOs were not feeling much difference between the old and new applications and switching to new system was not seen to be very difficult for them.

Figure 6.1 shows that even though AMs have access to existing application it was not of much use since the managers mostly worked in the field. The nature of their job gave AMs little chances to avail the benefits of using the existing system which was dependent on an

infrastructure that was only available in the offices of their respective areas. The best utilization of the application for the managers at this level was to be able to access the system not only from the offices but also from the field, allowing users to be able to utilize the information whenever and wherever required. Mobile based applications that were expected to be integrated with the DHIS2 application will provide managers an opportunity to utilize the new system making them much more efficient.

In my empirical work, I found that the replacement of the existing system by the new system was considered as an opportunity to increase performance, accessibility and reduction in heavy costs during the transportation of paper based data collection. But new opportunities come with a lot of challenges too. Moving to a new system required new infrastructure, user training and maintenance resulting in additional costs which was found challenging by GS-Pak.

6.2 Requirements

The second theme identified in my empirical work was requirements related supplementary delays. I have identified three main contributing obstacles during the requirement gathering phase: constant changes in requirements; unclear requirements; and weak shared understanding of requirements. These obstacles are elaborated with the help of examples below.

6.2.1 Constant changing of requirements

The requirements were changed several times and there were two main reasons for that. First, the basic purpose of this project was to fulfill the needs of several stakeholders but a lack of their technical knowledge led to them constantly changing their requirements. Some important stakeholders involved around the information are shown in Fig. 2

GS-Pak's IT department was playing a role as a mediator between the Indian and Pakistani teams. Other departments shown in Figure 6.2 had little or no understanding about how to convey their needs correctly into requirements specifications, especially in the early phases of this process. Every time a prototype was demonstrated to the relevant stakeholders, new features and needs were identified by them and their picture for the desired system got clearer.

These newly identified features and functionalities were then demanded from the Indian team which might have looked easy for them being customers, but often required bigger design changes and additional work.

The second reason for the change in requirements was the introduction of new business needs in the system. For example when the requirements were gathered initially, IPC workers were responsible for a period of three weeks within a specific HSP's area at the Tehsil level and after three weeks (twenty one days) the IPC worker moved to another Tehsil. The management realized that three weeks were not enough to perform the IPC program properly due to several issues such as unentertained remaining follow-ups when the IPC worker moved to the next Tehsil resulting in poor overall performance. The management of GS-Pak wanted to change the functions for IPC workers to see the impact of performance and took a decision to fix the IPC workers for a period of six months within the Tehsil that is assigned to them. During this period of assignment, their key responsibility was to register or contact 15 MAWRAs on a daily basis, conduct door-to-door orientation meetings to spread family planning awareness and issuing referral tokens to gain services from HSPs in the first 4 months. In the last two months, their responsibility was to conduct follow-ups of those MAWRAs who were given the vouchers but did not visit the service provider yet, and to motivate them to adopt suggested family planning methods. The new IPC intervention models constituted of six months duration with intensive community mobilization and demand generation activities with sustained and regular follow up visits to around 0.1mil MAWRAs in catchment areas of three hundred GS-Pak HSPs with three hundred CEs. This change in business area required re-work of the functionality that already had been developed working for three weeks by the Indian team. This change in requirement caused further delays to the delivery of the IPC module.

Changes that were not discovered earlier or changes in business processes during the development affected the overall progress and there were undesired delays.

6.2.2 Unclear requirements

The requirements received by Indian team at the start were not clear enough as there was no common dictionary explaining all the domain concepts. The domain concepts were often ambiguous and overlapping. This resulted in unplanned communication rounds to clarify concepts and resulted in delays to the overall progress of the project.

One example is about differences in understanding of concepts around different organization levels. Domain concepts were clearer at the lower levels of the organization where people were working in the field and collecting the data. The data was collected by the field force manually on paper forms designed for different purposes.

The understanding of the terms and concepts at higher levels were too abstract. The higher management was mainly responsible for decision making and they couldn't clarify terminologies in detail. This ambiguity in concepts made it difficult for the Indian team to have a good understanding of what was desired. One such example was finding out the difference between orientation meeting and neighborhood meeting. For the Indian team, this sounded like two different types of meetings while in reality it was just a title of the same data collection form. The title of the form was "Orientation/ Neighborhood Meeting-Community Activity Form". Another example was about calculating the final rating of the IPC worker for their evaluation. The formula was not conveyed to the Indian team so it was not possible for them to find out how IPC working rating was calculated. This led to a gap in the understanding of requirements. The difference between back-check and participatory-check was another example where it was not explained in detail what these actually meant.

The comprehensibility of these key domain concepts and processes was extremely important for starting the design of an effective system and this was clearly lacking in the GS-Pak case. Several rounds of conversations were required to accomplish this which led to the whole process taking much longer than expected.

6.2.3 Weak shared understanding

For the development of a successful IS it is very important to have a shared understanding of business domain and processes amongst different stakeholders. This was clearly one of the major challenges in this case.

In section 6.1.1, I have discussed how GS-Pak's organizational hierarchy is different from those in many other developing countries and in section 6.1.2 I explained why GS-Pak required dynamic management in DHIS2. Such a requirement was not previously encountered by the Indian team and it took time for them to create a shared understanding with GS-Pak on what was actually required. Another example discussed earlier was about abstract use of terminologies conveyed to the Indian team which had a negative impact on the creation of this shared understanding.

Due to travel restrictions between Pakistan and India, only online communication was possible, which made it more difficult to create a shared understanding of problems, conveying the message clearly and explaining the complexities. Due to all these factors creating a shared understanding took longer than expected.

6.3 Culture

In this section, I discuss how cultural differences and similarities influenced the project being developed in a cross-cultural environment.

6.3.1 Language

India and Pakistan not only share a long border but also share many other things including an almost similar language (Hindi and Urdu) in conversation though written scripts are different. English is the official language in Pakistan and Indians generally have good knowledge of English and was the reason why the official language of the GS-Pak project was also English. The documentation for this project such as the SRS and user manuals were in English and so was the communication through emails, chats etc. English language was chosen because the people involved in this project were highly qualified and had very good command over English.

For verbal discussions and clarifications, Hindi/Urdu was also sometimes used. The use of common language is considered a powerful tool for creating mutual understanding but it was not always the case in this project. Creation of mutual understanding had many challenges such as due to the complex organizational structure, limited communication channels and travel restrictions. As a result, a similar language couldn't help all the time to overcome these barriers. Complexity of organizational structure has been discussed earlier whereas online

means of communications will be discussed later. In the next section, one of the major problems in the creation of mutual understanding, relating to travel restrictions is discussed.

6.3.2 Traveling restrictions

Pakistan and India were a part of Indian subcontinent under the rule of British Empire as mentioned in section 2.2. Pakistan got independence on 14th August while Indian on the 15th of August in 1947. Millions and millions of people migrated across the border mainly on religious grounds, Pakistan was a Muslim majority country while India had Hindu majority.

Pakistan and India have had several conflicts since their creation and have had three major wars. Diplomatic relations have seldom been very good. Both countries accuse each other of interfering in each other's internal affairs and have both imposed severe travelling restrictions. Visa process is quite complex with a lot of verifications and security checks involved leading to long delays and rejections of travel permissions. All these traveling restrictions had significant impacts on this project.

In complex contexts such as related to this project it is often very helpful if suppliers can visit customers for requirements gathering. Travel restriction limits such possibilities. Online communication then was the only available way of requirement gathering, which resulted in various ambiguous requirements having different meanings interpreted according to respective cultures, and also many cycles of communication to resolve these differences.

User trainings were especially difficult to conduct online. It was decided that these trainings should be arranged at a neutral venue that would be convenient for both teams. The trainings were then conducted in Dubai. This arrangement provided an opportunity for both the teams to have an open dialogue about not only the technical aspects of the project but also on the social aspects. A trust relationship was built, cultural values were better understood and a shared understanding was developed. Teams were able to socially integrate on a face to face basis.

6.3.3 Vacations

While climate is more or less same in both counties but due to differences in religion and culture, the public holidays fall on different times. India has a rich cultural and religious diversity so they have multiple public holidays respecting most of the religions and ethnicities.

Some major cities in Pakistan have been targets of terrorism and additionally there is a political instability which causes unexpected holidays and hence delays in the overall progress in the projects when planned meetings could not be held or were delayed.

When there is a public holiday in one country and it is working day in the other, communication is affected. There were thus difficulties in scheduling urgent meetings during the vacations which resulted in unexpected delays.

6.4 Communication

In this section, I discuss different means of communication used in this project and the associated issues.

6.4.1 Online means

Online communication has brought a revolution in recent years and it is especially very helpful in scenarios where customer and development teams are geographically separated. Online means of communication enabled distributed teams from different locations to communicate in this project. The project lead was in Norway, development team was in India while the customer was in Pakistan.

In this project, different types of online means were used such as skype conferences, email exchange and live chats. Project issues were tracked on an online tool called Redmine[18]. A group was created in skype and all related persons were added to that group so that everyone is updated about what was happening. User manuals were shared online and everyone was notified on the group which made it possible for participants to have a prior knowledge of system before the training sessions. Although online means of communication comes with a lot of possibilities there were certain difficulties as well and these are discussed below.

[18] http://www.redmine.org/projects/redmine

The development team was working on multiple projects so the demand by their various customers on their online availability and frequent communications were often distracting them from their development tasks. Knowledge sharing was not fast enough, mutual understanding was slow, scheduling meetings was another challenge and clarifications were required which were not quickly forthcoming, all of which resulted in delays.

6.4.2 Face-to-face meeting

Face-to-face meetings are very helpful in creating a better mutual understanding among project stakeholders and being able to address issues on the spot. Such meetings provide a common platform for distributed teams where all participants not only discuss the technical aspects but also develop social understandings of each other.

As we have seen in the previous sections that even though online communication helped to a great extent, there were many issues as well. GS-Pak management decided to arrange a two week long meeting of the key people involved in project. This was to conduct training and also to help build a stronger relationship. Dubai was chosen for meeting as it was convenient for all the stakeholders to participate there. We have discussed complexities related to traveling between India and Pakistan in an earlier section.

The meeting served the purpose of a capacity building workshop. The goal of the meeting was to familiarize both teams and to train users to use the system in the best possible way. The users also learned about installation and customization of the system. Another goal of this meeting was to gather and review requirements for further development that was planned in the next phases. This meeting also helped in finding out weaknesses in the earlier approaches adopted and possible improvements for the future. As a whole, this meeting served the purpose. However, such meetings have high costs and cannot be arranged regularly. As a result, this was to be a one-off meeting.

6.4.3 Telephonic conversations

Telephones are another popular way of communication and it was frequently used during the development of the project. It was considered to be the fastest way of exchanging information between the teams. I was told by the Pakistani team that whenever they have any urgent need to contact they used telephones. It is necessary to mention that although not on regular basis but sometimes telephone services are suspended in Pakistan due to security reasons. There are also associated costs to telephone calls.

6.5 Different expectations

In this section, I present my findings about the different teams and their respective expectations.

6.5.1 HISP-India

Development team in India was working with some other projects as well in addition to GS-Pak. They wanted clear specifications and good time for delivering the functionality. GS-Pak's demand for regular availability of the development team to provide feedback to them did not give developers enough time for uninterrupted development. Daily feedback to the Project team in Pakistan was neither convenient nor necessary in the opinion of the developers.

6.5.2 GS-Pak

The project team in Pakistan wanted a dedicated development team with a full and uninterrupted focus on their project. The project manager from Pakistan wanted regular feedback from the development team and details of progress.

6.5.3 DHIS2

One of the main purposes for GS-Pak for adopting the DHIS2 based solution was to enable effective decision making for strengthening the management of their various health programs.

My field visit revealed that different stakeholders had varying expectations form the system. For example DEOs had the impression that the new system was not entirely different from the

old system. For them it was all about data entry and both systems were more or less the same. Whereas for users at the managerial level the system provided many new features such as much better graphical representations of data and a user friendly interface. Such features are considered very helpful to support decision making.

On the regional level, the existing system was used for auditing purposes only as the AM were mostly out in the field and had no access to the system. A customized mobile app specially developed for the IPC workers was realized as an opportunity to those workers for conducting activities in the field. Such an opportunity was considered to give a sense of ownership and share of responsibility to the IPC workers.

Opportunities also come with new challenges such as migration of the paper based system into the automated one was not an easy task. As discussed earlier it involves the availability of proper infrastructure, resources and the conduct of comprehensive trainings. User acceptance was also another challenge associated with the replacement of existing systems.

My analysis is based on the experience and perceptions of the users as I understood them during the course of my fieldwork. These users are either using the system in the test environment or expecting to use the application on mobile from the field in a few months in the future. Since the system was not deployed in production and the mobile app was also not in use at that time, my analysis is limited to the perceptions of the people that I interviewed. Broadly, they had very positive expectations from the DHIS2 based solution.

6.6 Conclusions

An IS influences a context and is influenced by that context. This influence results in a lot of challenges and opportunities that are mostly associated with the people, processes and the tools, and their respective expectations.

In my empirical work, the IS under study was the DHIS2 under development and the context was provided by the GS-Pak organization and their project with the HISP-India development team. I found out that the context required complex changes in the core functionality of DHIS2. These changes required extra time, access and efforts of the DHIS2 developers. However, building these functionalities might also provide opportunities to other developing countries. Additionally DHIS2 also provided opportunities to the context in the form of

innovative, efficient, quick and more reliable ways of using the information at different levels. The introduction of DHIS2 was expected to improve the presentation of information, availability and accessibility of data which would improve the overall processes and information processing would get easier. However, availability of proper infrastructure, additional cost of training and acceptance from the users were some of the challenges observed in the context.

The key focus of my thesis was studying the DHIS2 based application development process in the context of CBSD. From my empirical work, I found that cultural similarities and online means of communications provided also a lot of opportunities. I found out that similar language and online means of communications provides the opportunity to communicate in a better, quick and efficient way to transfer knowledge from customers to suppliers and vice versa. However, cultural differences and communications limited only to online means also created a lot of challenges in such a context. Contextual complexities are very difficult to convey and understand when the communication possibilities are limited. Scheduling the meetings was difficult due to cultural differences such as different public holidays. Travel restrictions made it difficult and expensive to conduct face-to-face meetings. Unclear or constantly changing requirements made the situation even worse and led to unexpected delays. However, I found that building mutual understanding can contribute positively in achieving common goals. Face-to-face meetings at a neutral place in case of travel restrictions could also be a useful way to develop such shared understandings. Such meetings help in understanding cultural values and build a trust relationship between geographically dispread teams thus make the project successful.

7 Discussion

This chapter is divided into four sections. The first and second section will discuss and answer the two research questions chosen for this thesis. The research questions are as follows:

1. What are challenges in cross-border software development for open source public health information systems?

2. What are different approaches to address these challenges?

The third and fourth sections will discuss my contributions to existing research and practice respectively.

7.2 Challenges to cross-border software development of open source public HIS

My field study has revealed that complexity of contextual factors is closely connected to several challenges in CBSD of HIS. I have found three major challenges. The first challenge concerns context specific requirements that delay the development process. The second challenge concerns differences in cultural values and expectations, both at the national and organizational levels that result in project related conflicts. The third challenge concerns communication issues in distributed working environments. Now, I discuss the reasons for these challenges in greater detail.

In chapter 2, the context of Pakistan was discussed in detail. I found out that, administrative division of Pakistan (see section 2.1.2), is quite complex and different when compared to other developing countries where DHIS2 has been deployed earlier. Due to these differences, requirements were different but they were not initially identified and hence they were not conveyed by GS-Pak and understood by HISP-India. Additionally, GS-Pak was dealing with limited human resources and trying to address it by moving their existing workforce to different areas. Such a strategy has not been adopted in earlier DHIS2 deployments and which followed a relatively fixed hierarchal structure. The requirement of having a dynamic hierarchical structure and catering different administrative divisions was poorly understood by both sides and delayed the development process. Further, making such changes to the core

functionality required the active involvement of HISP-Norway, which was not easily forthcoming. Extra and unexpected rounds of communication were required with HISP-Norway, with no easy outcomes. Based on these observations, I conclude that since OSS are purely adopted in distributed and global development environments and involves multiple layers of stakeholders, communication over distance between these stakeholders back and forth requires more time and provides greater difficulties in building shared understandings. Extensive communication between multiple stakeholders was required to convey and understand requirements over distance, ICT was the only way of communication and it slowed down the process of development and resulted in delays.

Limited human resources and technical skills related to the IT and health domains, led to either constant changes in requirements or requirements being poorly understood and shared. India and Pakistan are sharing a number of cultural similarities such as linguistic closeness and shared borders and history. However, the results from my case study showed that both countries have some differences in their cultural values. These differences led to different interpretations of the meanings of same thing that raised conflicts and introduced problems. These interpretations may be due to religious, political or other cultural values such as a cow is considered a holy creature and is worshiped in India whereas in Pakistan a cow is considered an ordinary domestic animal and consumed as food. After the political division in 1947 there have been several wars contributing to an ongoing tension across borders. Traveling restrictions between India and Pakistan as mentioned in section 6.3.2 made it impossible for both groups to visit each other which severely affected this project as well. Online means of communication was the only possibility for collaboration between both teams which introduced several other problems such as conveying context specific requirements as well as understanding of the requirements by the development team. Understanding of both teams was dependent on their prior experience, contextual knowledge and interpretation of meanings influenced by the culture that led to weak shared understanding of requirements. The changing requirements were not easy to handle because unexpected communication sessions were required and they were not previously planned. This resulted in delaying the process of development. Different working routines at the organizational level and public vacations at the national level provided obstacles in scheduling urgent meetings (see section 6.3.3). Additionally, both teams had different expectations from each other, which often raised conflicts. These results indicate that there are

several contextual factors such as religion, history, organizational and national cultures that can negatively affect CBSD, even when the physical distance is not significant. .

Cross-site coordination and communication was another challenging issue. There was a need to coordinate between both teams back and forth if things were not clear enough. Identifying who to contact about what, initiating contact and effective communication was to some extent lacking and led to delays. Additionally, since online means of communication were adopted to coordinate cross-site work, there was a little chance for informal conversations to take place which hindered the building of awareness of the local context.

The results of this case study also indicated that there are some other factors that are not directly connected with CBSD generally but related to the particularities of the HIS. Managing different expectations that are associated with newly developed HISs is one such challenge, which were both underestimated and overestimated. In my case, different stakeholders had different expectations from the DHIS2, both positive and negative, which were often difficult to manage. One of the negative expectations was from the DEOs who were not feeling any difference between the new and that existing, and thus couldn't understand the potential value of using DHIS2. On the other hand, the higher management had a lot of positive expectations and they believed that DHIS2 will help overcome the existing problems faced by the health personal to manage their daily routines (see section 6.1.2). I believe that expecting a system to automatically solve all of your problems can never be a solution, as there will always be human and institutions associated challenges as well. Implementing an automated system to replace an existing paper based system requires proper infrastructure, appropriate capacity building and it also comes with issues related to building user acceptance.

7.3 Dealing with challenges

Developing countries are contextually complex therefore may challenges arise from the particular social, historical, cultural and institutional conditions. Here I present on how GS-Pak and HISP-India had tried to deal with these challenges.

First of all, I found out that face-to-face meetings are the best way in dealing with the challenge of complex requirements. Meeting of stakeholders in person makes it easier to

convey and understand context specific requirements. Both teams arranged a capacity building workshop at a neutral place (Dubai) where both teams met face-to-face. This meeting enhanced the process of communication and increased the awareness of the local context. The stakeholders involved in these meetings had high technical skills and were experts in their respective domains. Therefore, the requirements of remaining modules were conveyed and understood properly with minimum misinterpretations. Both teams got a chance to have informal conversations as well. Both countries share linguistic similarities and similar interests such as Cricket and Bollywood movies that in turn contributed very positively in building social glue and a sense of trust. Moreover, results indicated that although, the workshop lasted just two weeks but it clearly speeded up the process of development of remaining modules which were discussed in this workshop.

The second thing I found that both teams managed to resolve conflicts which were created by the different cultural values and expectations by creating a negotiated culture. Since both countries are geographically close, they have many cultural values in common as well, such as respecting and being polite with each other. I found that both teams were negotiating on several things including requirements, scheduling, delays and expectations, which proved to be very helpful in building a long term working relationship for the project. I observed that instead of blaming others for certain issues faced during different stages of the projects, the teams pointed to the situations and how they could jointly try and tackle these problems. One example is the requirement changes from GS-Pak where HISP-India team ideally wanted to have requirements cleared before start of the development process. By realizing the need of change in business domain and putting extra effort on rebuilding the existing functionalities, the HISP-India team tried to create a negotiated culture.GS-Pak on the other hand showed flexibility with deadlines knowing the fact that change in requirement was causing delays in overall deliveries. Overall, both teams had a very good impression of each other and were quite satisfied with their work although the project was delayed by several months.

Thirdly, I found that the challenge of communication in a distributed working environment can be dealt with by using online means and by conducting face-to-face meetings where possible. As mentioned in 6.4.1, the teams involved in this project utilized several means of communication. Since India and Pakistan have half hour difference in time zones so the scheduled online meetings worked well for both teams. I found that adopting online means of communication is indeed the best way to overcome the challenge of distance in GSD in

general and CBSD in special. As mentioned earlier, meeting face-to-face makes it easy to convey and understand requirements as well as helping to develop a trust based working relationship.

Managing different expectations related to the use of newly developed HIS is another challenge. I found that capacity building workshops conducted at the international and national levels helped a lot in managing both positive and negative expectations associated with the DHIS2. Moreover, users of the system gained confidence in the system and the level of user acceptance increased through the training sessions in these workshops. The end-users of the DHIS2 application learned how to implement, deploy and use the system in future during these workshops. As a result, the real purpose of developing the OSS based public HIS was achieved.

7.4 Contributions to research

In chapter 4, I have presented several issues that are associated with GSD. Herbsleb, Mockus et al. (2001) point to the challenge of distance and according to Herbsleb and Mockus (2003) communication affect the speed of execution of SD projects activities. Feller and Fitzgerald (2002) presented that FOSS are adopted in distributed and GSD environments. The case study results confirms that since DHIS2 development process is of a global and distributed nature, the distance between development teams and the rounds of communication required between teams clearly affects the speed of development process.

The challenges presented in GSD are geographical, temporal and cultural differences (Holmstrom, Conchúir et al. 2006). If these differences are huge and there are multiple stakeholders (Damian 2007), the requirements process is specifically challenging . However, in nearshoring settings these differences are believed to be minimal (Abbott and Jones 2003), since people involved in the projects shares similarities in one or more dimensions including geographical, temporal, linguistic and cultural., it is believed that the process of communication and requirements engineering would be relatively easy. The results of my case study are very similar to the study conducted by Abbott (2004) which confirms such claims but also refer to some contradictions. In the light of my case study, I would say that in nearshoring there are some advantages such as linguistic closeness, similar interests and some cultural values. Such similarities can positively contribute in creating a negotiated culture

which in turn enables trusting and long term working relationship. Additionally, geographical closeness means temporal closeness which can enhance the process of communication by using online means within similar time zones. Such closeness can be beneficial for scheduling meetings. On the other hand, the results of my case study also indicate that not all the claims are valid as Carmel and Abbot (2007) pointed out and that distance still matters. For instance, if countries have severe historical problems then it can lead to travel restrictions and thus negatively affect the processes of collaboration. Speaking similar languages is also not very helpful if the requirements are too complex and context specific and therefore conveying and understanding them remains a challenge in not only GSD setting but also in CBSD settings.

Herbsleb and Moitra (2001) presented that using online means of communication can be a powerful tool in GSD. In the light of the results obtained from this case study, I also agree with this point. However, I would say that relying only on online means of communication can delay the process of development if there is no common understanding of how to arrange unscheduled meetings. Such a mode of communication can also distract the concentration of teams if extensive communication is taking place. Hence there is a need to have a common understanding and adoption of practices in which both parties can utilize such a mode of communication in the best possible way. This was provided by the face to face meeting.

Prior research in this domain has not considered countries which have mutual travel restrictions. This case study raises this issue and also shows efforts to tackle such problems. In the case of travel restrictions, countries can pick a neutral place in which teams (customer and supplier) can meet face-to-face to discuss the project and can convey and understand the requirements properly. Face-to-face meetings in the initial or critical phases of a project can be more helpful than having it after the design and development has been done. The results of this case study also added that linguistic closeness might be quite helpful in the conduct of such face-to-face meetings.

I have concluded that the benefits of nearshoring in minimizing temporal and cultural distance as well as linguistic closeness can bring several opportunities as seen in this case. Having same cultural values can speed up the trust working relationship and can contribute positively in creating a negotiated culture. Online means of communication can overcome some of the challenges of distance. I argue that face-to-face meetings in early stages of the project might be more effective in nearshoring settings.

7.5 Contribution to practice

Here, I present how the practitioners can take benefits from the results and observations made based on this case study.

In my case, it is clearly evident that GS-Pak utilized their existing human resources by moving them all around Pakistan. GS-Pak tested this strategy several times and in several ways and developed very effective ways to utilize their existing workforce. In this way, they used their existing and experienced workforce at several Tehsils and in providing maximum coverage. DHIS2 now comes with a dynamic hierarchal structure and one of the bright aspects of creating this through this project is that this feature becomes available also to other resource constrained countries. Other developing countries may also take inspiration for using their existing workforce overall in the country and use experienced and expert workforce in multiple areas. Based on these results, I would support the argument made by Braa and Sahay (2012) that resource constrained countries need to better manage their limited existing resources.

Currently, a number of countries have hostile situations which results in travel restrictions, and selecting a neutral place for a meeting can provide a useful solution.

Most of the time, if a new HIS will be replacing an existing system, there will be many expectations associated with the new system. There is a need to provide proper infrastructure and capacity building prior to using the system so that the best outcome can be obtained. Moreover, the best way to tackle the contextual complexities is to design, develop, implement and scale the public HIS by taking into account the complex cultural, institutional and social structures as well as the resource constraints.

8 Conclusion

HIS are often quite complex, context specific and user dependent and they are even more challenging to develop than structured applications in the context of developing countries. Developing countries have limited resources of money, infrastructure and people and their public HIS often are poorly managed. Therefore, using OSS to manage public HIS is no doubt an attractive choice for these countries because of the savings in terms of licensing costs. OSS is developed in a GSD environment and such environments are providing a number of benefits but also include a number of challenges. CBSD is one element of GSD, which indicates a number of proximity conditions between the teams that are working together as a supplier and customer for the conduct of a project. These proximity based conditions includes linguistic, temporal, geographical and cultural closeness. Therefore, research claims that collaboration between teams in such proximity conditions is expected to be less challenging. India and Pakistan reflect countries with such proximity conditions. However, the study of CBSD phenomenon within this context has not been a subject of prior research.

Through this thesis, I have studied CBSD between India and Pakistan involving OSS for public HIS. A case study approach was used as the primary research method, in which I collected data from different sources including interviews, user observations and documents. The focus of data collection was inspired by the interpretive paradigm which helped me to understand the phenomenon under study through the interpretations of the different stakeholders I could speak to during the course of the project. Through this process, I could analyze the two research questions posed in this to understand the challenges and approaches that are seen in such relationships.

The findings of this case study revealed that most of the challenges in CBSD of OSS public HIS are related to the factors associated with the context. HIS of developing countries are context specific and user dependent. Therefore, such context specific requirements must be conveyed properly and effectively by the users and must be understood appropriately by the development team. However, such a mutual understanding was clearly lacking between India and Pakistan, especially in the early stages of the project. Thus, this resulted in various delays to the development process. Although, face-to-face meeting of stakeholders is an effective way to deal with the conveying and understanding of requirements, it was not possible to do this in a regular way in this project because of travel restrictions. Meetings in person to

discuss requirements can be positive when customers and suppliers share linguistic similarities which reduce the chances of requirements being misinterpreted. Differences in cultural values are also a context specific challenge which might be there due to different religions, history or political backgrounds. Such differences lead to different expectations from each other and become a source for conflicts. However, such challenges can be mitigated by establishing a negotiated culture, where there is a shared understanding of norms of conduct of the different stakeholders. OSS are adopted in distributed working environments hence, involves multiple layers of stakeholders. Such a working environment poses a challenge to develop such a negotiated culture, but can be enabled through online means of communication. It enhances the process of communication between stakeholders and is effective given the temporal closeness. However, relying only on online means of communication can be problematic and inadequate, and needs to be supplemented with some degree of face-to-face meetings which helps to provide social glue and help build trust. It is also seen that such face-to-face meetings are more effective in early stages of the project.

There are some limitations in this thesis. Due to travel restrictions, I was not able to visit India, and as a result, my contact with HISP-India was only limited to the online means of communication. Additionally, due to limited funding, I was not able to participate in the capacity building workshops conducted at the neutral location of Dubai. This workshop was a very important part of the project and could have provided an opportunity to observe the project participants and provide a better overall view of the whole project and the participant expectations. The results of my case study clearly indicate that this capacity building workshop was crucial to the overall project, and by not being able to attend I missed out on something important. There were some other limitations as well, for example, when I visited Pakistan, DHIS2 was not deployed yet and I could not see it operational. I thus could talk with users only about their expectations with the new application but not their direct experiences. Studying DHIS2 in action will be a fruitful area of future research.

Overall, I believe I learnt from this research experience of an important and neglected area of CBSD research. My research has also helped to identify future interesting avenues of research.

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