

Approaches for Improving the Quality and Accessibility of Maternal and Child Health Data from Rural Communities: Action-Case Studies from Tanzania.

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PhD Thesis

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Acronyms

AIDS	Acquired ImmunoDeficiency Syndrome
ANC	Antenatal Care
CHAT	Cultural Historical Activity Theory
DHIS2	District Health Information Software Version 2
DTC	Diarrhea Treatment Corner
HIS	Health Information System
HISP	Health Information Systems Programme
HIV	Human ImmunoDeficiency Syndrome
HMIS	Health Management Information System
IMCI	Integrated Management of Childhood Illness
IS	Information System
IT	Information Technology
KCMC	Kilimanjaro Christian Medical Center
MDGs	Millennium Development Goals
MoHSW	Ministry of Health and Social Welfare
MRS	Medical Record System
NIMR	National Institute for Medical Research
PD	Participatory Design
PHC	Primary Health Care
PNC	Postnatal Care
PMTCT	Prevention of Mother-to-Child Transmission of HIV
RCH	Reproductive and Child Health
TBA	Traditional Birth Attendant
VHW	Village Health Worker
WHO	World Health Organisation

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Abstract

Health Information Systems have been marred by a lack of reliable data to support decision-making and planning, and for taking actions. This study provides knowledge on the application of different approaches to improve collection, recording and use of maternal and child health data in rural communities and hence improve the quality of data within the health information systems. It is a fact that maternal and child health data are collected only when mothers and children use the maternal and child health services in health facilities. In rural communities however, women and children may not prefer to seek for the services in health facilities. In such situations, studies illustrate the significance of involving community health workers to provide household visits and offer preventive services as well as to encourage them to use the services provided by the health facilities. Different from other data maternal and child health data in rural communities are also collected by the community health workers. In Tanzania they are categorized as traditional birth attendants and village health workers. Much has been demonstrated about the impact of involving community health workers on the healthcare provision but little is known about their impact on the quality of the data at the community and health facility levels.

In this study, two action-cases were conducted whereby the first action-case shows how the traditional birth attendants and village health workers can be involved and empowered in both collection of the data and encouraging and referring women to the health facilities. The case emphasizes on understanding information practices of traditional birth attendants and village health workers in collaboration with health facility workers and district health managers in collection and recording the data. This should be considered as the first step towards improving the quality of data. Results indicate that when traditional birth attendants and village health workers were provided with standardised data collection registers, which supported them to collect data as well as to record their performance, incentives and appropriate means to support them in data collection, their information behaviour towards data collection and recovering were improved. Consequently, there were improvements in data collection at the health facility which was a result of increased number of referred women and reported births that took place in the community.

The second action-case illustrates the process of designing a computer application to support provision of maternal and child health services in rural health facilities. The case describes challenges faced and opportunities provided to the designers by the application of several participatory design techniques. In particular, I demonstrate the application of hands-on training and system experimentations techniques to support users to learn about the technology; ethnographic techniques to support designers to learn about the users' work; and creating free-hand drawings and discussion to support users and designers to develop a mutual view on how to represent the work domain in the system design. Results indicate that the application of ethnographic and prototyping techniques did not support mutual learning in early stages of system development. This was because at this stage, the users had no IT knowledge to be able to participate in prototype development, and the designers had no experience in clinical work which hindered them from asking the right question and conducting appropriate observations. During and after the system implementation, the users and the designers were able to develop a future view of the system. This learning was supported by the creation of free-hand drawings and discussions after the users have received hands-on training and started to experiment with the system. The users also designed their own data entry form that integrated their multiple registers and supported them to enter data into the computer.

CHAPTER 1: Introduction

This chapter provides an overall view of the thesis. It is divided into seven sections. In the first section I introduce the thesis by describing the research problem area. Section two provides the research objectives and questions and section three presents the context of the study. The scope of the study is presented in section four and section five presents the research motivation. In section six I present the summary of empirical findings and the structure of the thesis is provided in section seven.

1.1 Research Problem Area

This study brings new knowledge on how the dynamics of everyday life of health workers can be learned and how to develop information systems that can support and enhance efficiency in performing their work. I specifically focus on the provision of maternal and child health services in rural health facilities in the developing countries. I use the term developing countries to refer to countries whose Primary Health Care (PHC) is constrained with poor infrastructure, and scarce financial and skilled human resources which are inadequately allocated and used. In this context, there are fewer health facilities and whose workers have low qualifications and are often inadequate compared to the population they serve. The health workers also lack basic IT skills. Also in this context, the clients have either poor quality of education or no education, and are individuals with low income. In terms of infrastructure I refer to inadequate availability of transport, electricity and internet connection that compromise provision of health care services and data management.

1.1.1 Maternal and Child Health

Maternal and Child Health services aim at improving the survival, health and well-being of all children, and women throughout pregnancy, delivery and after delivery. In most developing countries, most women in rural areas seek for the services outside of the health care system. In such areas women deliver their babies at home assisted by Traditional Birth Attendants (TBAs) who will hardly report the births and the delivery outcomes. For instance, in Tanzania, only 50% of births take place in health facilities (NBS and ICF 2011). This raises concerns within the Health Information System (HIS) about a high number of unregistered births and unrecorded delivery outcomes.

Though it has been a common perception that information is most useful at the management levels, in provision of healthcare services, the availability of accurate, complete and timely

information is crucial at all levels. According to the World Health Organisation (WHO) as reported by Lippeveld & Sauerborn (2000) the information is essential for management of clients, health unit and the overall health system planning and management. In provision of maternal and child health, the availability of reliable information is crucial for both health managers and health workers.

It is useful for health managers for purposes such as monitoring surveillance of birth defects and other prenatal health problems, analysing quality assurance on health services related to pregnancy, childbirth and the neonatal period and for epidemiological purposes. The information can provide the best answers on the rates of neonatal, infant, under-5, and maternal mortality, which are specifically measured against the number of live births, for a health facility, a community and a country at large. For health workers, the information is valuable for management of clients in the provision of maternal and child health care. Since maternal and child health services are provided over a prolonged period of time, reliable information is crucial for supporting health workers in following-up their clients, tracking those who do not meet their appointments as well as who drop-out of the service, and scheduling appointments for clients.

In Tanzania, maternal and child health data comprises above 60% of all routine data collected in the HIS. In this setting, health facilities are the major sources of the data collected. And data from health facilities incorporates data collected in communities. Hence the quality of data in health facilities highly depends on the data collected in communities. However, in most HIS including Tanzania, studies report that routine data collected in health facilities is highly unreliable and decision makers do not rely on it (Chambers 1994, WHO 2000, Braa et al. 2001, Lippeveld 2001, Kimaro et al. 2008) for planning, decision-making, conducting interventions and setting priorities. On the other hand, health workers often collect the data for reporting purposes rather than for utilising them (Kimaro 2006, Ngoma 2007, Igira 2012). They manage their clients based on the knowledge acquired when providing the services.

Studies conducted at the health facility levels (Kimaro 2006, Kimaro and Twaakyondo 2006, Igira 2008, Igira and Aanestad 2009) indicate that the major factors that contribute to the poor quality of data include too many reports to be processed and overworked staff. Another factor is the disparities between old and new registers which create double standards on the data collected. Late arrival of reports from communities is another factor that contributes to incomplete reporting of health facility data. Research indicate that, the quality of data at the health facility levels can be improved through taking measures such as building health

workers' capacity for understanding and using data (Braa et al. 2001, Lippeveld 2001) and motivating health workers by providing them adequate supportive supervision, meaningful feedback and incentives (Franco et al. 2002, Hongoro and Normand 2006, Mathauer and Imhoff 2006, Hamre and Kaasbøll 2008).

Though health facilities and communities are both major sources of data in HIS, there are few studies conducted at the community level with a specific focus on maternal and child health (Kanjo 2011, Damtew and Aanestad 2012, Kanjo 2012, Damtew and Moges 2013). These studies also demonstrate a state of poor quality of data collected at the community level and the situation can be improved by involving community health workers in collecting and reporting the data. Recent studies (Damtew 2010, Mahmood and Ayub 2010, Kanjo 2011, Damtew and Aanestad 2012, Kanjo 2012, Otieno et al. 2012) indicate that community health workers are the crucial bridge between the health facilities and the communities whereby they can collect data from households and report to the health facilities. However data collected from communities is either under-reported (not all the households were visited) or not reported at all to the health facilities.

1.1.2 The Problem of Under-reporting and Non-reporting

In rural communities, the problem of under-reporting and non-reporting of maternal and child health data has been instigated by different factors. Previous research (Kanjo 2011, Damtew and Aanestad 2012) report that, due to long distances to reach households to collect data, large populations to be covered, not all the households can be reached within the reporting time. As a result the community health workers reported only the information they were able to collect. This led to under-reporting of maternal and child health data from the community.

Furthermore, Damtew and Moges (2013) indicate that the absence of standardised data collection tools can also lead to under-reporting of the data due to the absence of standards on what data to collect and what to report. In addition, Kanjo (2011) describe an introduction of a sexual reproductive health and rights policy in Malawi which contributed to poor quality of data. The policy banned the involvement of TBAs in collecting data on deliveries they conducted. As a result, the TBAs stopped reporting the data but continued to conduct deliveries in hiding. This led to non-reporting of maternal and child health data from the community level.

To eliminate the problem of under-reporting and non-reporting of maternal and child health data, research stress on the involvement of community health workers (Damtew 2010, Kanjo

2011, Damtew and Aanestad 2012, Kanjo 2012, Damtew and Moges 2013). HIS studies (Lippeveld 2001, Rowe et al. 2005) indicate that, to gain better results from involving community health workers, district health managers need to improve their performance based on their skills, practices and working conditions, and to introduce the application of Information Technology (IT) (Wilson and Smith 1991, Wilson 2000, Braa et al. 2001, Bodvala 2002, Manda and Herstad 2010).

i. Practice Change:

According to Rowe et al. (2005), the performance of health workers can be improved by health managers through promoting desirable practices in performing their daily activities. Desirable practices have been reported to be successfully promoted in developing countries through training whereby health workers get motivated due to improved skills (Ngoma 2007, Ngoma et al. 2008), receiving supportive supervision (Franco et al. 2002, Hongoro and Normand 2006, Mathauer and Imhoff 2006, Bosch-Capblanch and Garner 2008), feedback (Dieleman et al. 2003, Mathauer and Imhoff 2006, Frimpong et al. 2011) and incentives (Mathauer and Imhoff 2006, Henderson and Tulloch 2008) from their supervisors.

Though research has demonstrated the impact of practice change on the provision of health care services, little is known about its impact on the quality of data. Particularly in provision of maternal and child health by community health workers who are often regarded as voluntary and informal, it is essential to understand how they can be involved in collecting the data. It is also crucial to understand appropriate tools for data collection that will motivate them to collect and record the data, and how to design such tools. This study brings more insights into these subjects.

ii. Introduction of IT:

Research has shown that creative use of information technology can be a promising means for improving accuracy, completeness, timeliness, clarity, presentation, and use of relevant information (Wilson and Smith 1991, Wilson 2000, Braa et al. 2001, Bodvala 2002, Manda and Herstad 2010). Studies have revealed inventive use of many technologies including computers and mobile phones. According to the WHO report (WHO 2000), the use of computers has shown potentials in improving the quality of data collected by:

- giving automatic validation and immediate feedback,
- reducing duplication whereby data are entered only once,

- providing efficiency in analysing large amounts of data in a short time,
- providing a wide variety of data presentations that facilitate data interpretation and utilization,
- promoting data utilization by allowing monitoring attainment of targets and objectives and integration with other systems or sub-systems and
- improving data dissemination whereby information can be shared by different stakeholders across multiple levels.

A high diffusion of mobile phones in most developing countries has raised potentials on using mobile phone applications to support provision of health services and improve information transferring and sharing (Chatterjee et al. 2009, VitalWaveConsulting 2009) especially from hard to reach areas. Studies have determined the use of mobile phone applications for several purposes such as: capturing and transmission of health data (Kinkade and Verclas 2008, Manda and Herstad 2010); submission of child nutrition data through SMS (UNICEF 2009, Medhi et al. 2012); capturing patient-level data when providing home-based care (UN 2007, Bogan et al. 2009); improving cooperation among hospitals (Dinis et al. 2010); and collecting and reporting births and deaths for vital statistics (Raftree 2009). These studies have shown great potentials in improving provision of health care and the quality of data. However, the success is yet to be told because most of these applications have not gone beyond pilot implementation.

The ubiquitous nature of mobile phones poses advantages over computers especially for harnessing communications through sending data, SMS and calls. This can enhance collecting and reporting data and communication for the purpose of support, supervision and providing feedback. But mobile phones cannot work on their own, there is a need for other things to be operational such as a computer database where further data processing and storage can take place, availability of mobile networks, accessibility of electric power for charging batteries and obtainability of credits to be used (Manda and Msosa 2012).

Despite the reported potentials of using computers and mobile phones, the adaptation of IT in dominant of paper-based systems has been challenged. Not only is the question about what technologies can be appropriate, but also the process of designing, introducing and implementing technologies is further to be explored in research. To enhance development of Health Information Systems in developing countries, research (Sahay and Avgerou 2002, Puri et al. 2004, Igira 2008) propose a need for developing a critical understanding of the context

within which health workers perform their daily work in order to be able to design appropriate technologies and to apply suitable techniques in the design process. When it comes to technologies for supporting clinical work, extant research has explored the context of health workers at the health facility and district level while the community levels have been given very little attention. More understanding in this area is explored in this study.

1.2 Research Objectives and Questions

In conducting this study, three main objectives were set.

1. To explore existing health information systems relating to maternal health, including birth registration systems and describe the Tanzanian setting.
2. To adapt and implement a maternal and child health application that will enable health facility workers, traditional birth attendants and village health workers to register information of new births and to follow-up health status of children and pregnant women.
3. To evaluate the use of the maternal and child health application based on its effectiveness in maternal and child health data collection, analysis, reporting, accessibility and utilization.

However due to time limitations, the third objective was not accomplished. To achieve the first two objectives, this study answered the following research question:

RQ: How can elements of information practices concerning maternal and child health be translated into the design of a computer application?

This question is divided into two sub-questions:

RQ1: What are the underlying contradictions in collecting and recording maternal and child health data at the community level and how can they be resolved?

RQ2: Which participatory design techniques will support mutual learning where wide knowledge gaps exist between users and designers?

The first research question (RQ1) brings about an understanding on how maternal and child health data are collected and managed at the community level. It describes the activity of data collection and recording, contradictions in performing the activity and their resolutions. The second research question (RQ2) focuses on developing learning on designing a technology to support provision of maternal and child health care. The question aims at providing participatory design techniques that can guide designers to engage users in system development through mutual learning.

1.3 Research Context

In this section I present the empirical setting where the study was conducted, and the criteria taken for selecting the site and my roles in conducting the study.

1.3.1 Empirical Setting

This study was conducted in Tanzania under the Ministry of Health and Social Welfare (MoHSW). The research was done at the community and health facility levels of the health care structure from May 2009 to April 2012. The study was conducted in three districts, namely Kibaha, Bagamoyo and Mkoani town council of the Pwani region. Initially the Kibaha and Mkoani town council were merged as one district named Kibaha.

In this context, maternal and child health services included antenatal care, delivery, postnatal care, child health management, immunisation and family planning. Within the health facilities, these services were provided by health professionals such as nurses, midwives, MCH aides, medical doctors, and clinical officers. At the community level through household visits, the services were provided by non-medical professionals such as trained and untrained traditional birth attendants and village health workers. These were collectively referred to as community health workers and they were voluntary workers.

At the community level, individual-based data which could be traced back to a particular individual was collected. The data were then aggregated at the end of the month and/or quarter and reported to the health facility. The aggregated data contained combined sums of individual data and eliminated presenting data in individual-based format. At the health facilities individual-based data were also collected and reported in an aggregated format together with the data reported from the community.

1.3.2 Selection of the Research Site and My Roles

This study was part of the research project for improving availability and quality of maternal and child health data in the HISs. This study was also part of the Health Information System Programme (HISP) global research network. The primary goal of HISP is to design, implement, and sustain HIS to support local management of health care delivery and information flows (Braa et al. 2004). The study was conducted in one of the HISP's pilot area. In Tanzania, HISP had already established its roots since 2002. In this manner, I therefore gained access at the districts as a HISP member.

With the help of district health managers, I was able to identify health centers and a community to conduct this study. These health centers were identified based on the highest

numbers of births conducted at the community which were not reported. To conduct the research at the health centers and communities I acquired ethical clearance from the National Institute for Medical Research (NIMR) (see Appendix 6).

At the community level, I worked with TBAs, village health workers, health center nurse in-charge and district health managers in designing standardised data collection registers and re-organising work practices around data collection and recording. In conducting this study, I worked as a researcher, a facilitator (organize and conduct training, workshop and meetings), a consultant (share my experience and knowledge on designing data collection tools and computer applications), a designer (working with a programmer and nurses in designing the maternal and child health application), and an implementer (provide in-service support and supervision).

1.4 Scope of the Study

The scope of this research is to address ways that can improve reporting of maternal and child health data from rural communities in Tanzania. In provision of maternal and child health services, the focus of this study is on the information on births, deaths, child health and mothers' condition during pregnancy, delivery and after delivery. This study has not focused on the medical aspects around the provision of maternal and child health.

1.5 Research Motivation

I have been motivated to conduct this research because of the previous research study I conducted in a similar context in the implementation of management health information system in Zanzibar. The research objective was to suggest appropriate training and supporting strategies that can be used to sustain the implementation HMIS in Zanzibar (Ngoma 2007). In that study, I arranged, conducted and evaluated training and supported rural health workers in the facility and district levels to collect, report, analyse and use their data. Conducting this study was an opportunity to apply the knowledge I acquired on working with health workers in supporting them to improve their skills, understanding, performance and behaviour on data collection, reporting, analysis and utilisation.

Also as a woman, I have been motivated to work in the area of maternal and child health because I believe that with the experiences I have gained, I can contribute to improve the health status of pregnant women and children. Using my knowledge in health information systems design and implementation, I am motivated to join the efforts of reducing maternal, infant and child mortality in Tanzania by highlighting on the factors that can improve the

quality and availability of reliable information. This study propose factors that can facilitate communication between women and health facility workers, and between women and community health workers not only for the purpose of reporting accurate data on time but also for providing women prompted information concerning health education and clinic visits.

1.6 Summary of Empirical Findings

Throughout this thesis I will be referring to my empirical findings as papers whose references are presented below. The papers (Paper I - V) are appended in Appendix 1-6 consecutively.

Paper I: Ngoma, C., Chawani, M. S., Herstad, J. (2010). Adaptation of Mobile Application to Improve Flow of Birth Information from the Community to the District Level. *Proceedings of the 2nd International ICST Conference on E-Infrastructure and E-Services for Developing Countries: AFRICOMM 2010*. R. Popescu-Zeletin et al. Cape Town, South Africa, Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. 64: 79-92.

Paper II: Ngoma, C. and Igira, F. T. (2012). Contradictions in Collecting and Recording Maternal Health Data at the Community Level: A Case study from two Districts in Tanzania. *Journal of Health Informatics in Developing Countries*, 6(2): 509-520.

Paper III: Ngoma, C. and Igira, F. T. (Forthcoming). Re-organising Collection and Recording of Maternal and Child Health Data through an Intervention of Resolving Contradictions. *Submitted to an International Journal*.

Paper IV: Ngoma, C. (Forthcoming 2014). Mutual Learning in Designing a Maternal and Child Health Application: A case of One Health Center in Tanzania. *Accepted for Publication in the Scandinavian Journal of Information Systems*, 21(1).

Paper V: Ngoma, C., H. Kimaro, et al. (2012). Challenges in Implementing a Computerized Name-based Information Tracking System: Practical Experiences from Maternal Health Care. *IST-Africa 2012 Conference Proceedings*. P. Cunningham and M. Cunningham. Zanzibar, Tanzania, International Information Management Corporation.

1.7 Structure of the Thesis

The rest of the thesis follows this presentation: chapter two describes the theoretical framework. Chapter three describes where the study was conducted and under what conditions. Research methodology is presents in chapter four. Results obtained are presented in chapter five. Chapter six provides the conclusion by discussing the material and presenting the research contributions.

CHAPTER 2: Relevant Analysis and Design Theories

This chapter presents the theoretical perspectives that informed this study. It is divided into three sections. The first section presents the Activity Theory as an analytical lens used to inform aspects of information systems development. I also draw on the concept of health workers empowerment as a way of describing actions that can enforce individual to be engaged in an activity. In section two, I present IS design theory with a specific focus on Participatory Design (PD). Section three presents the summary of the chapter wherein I conceptualise the application of Activity Theory and design theories in developing information systems that aim at supporting clinical work.

2.1. Activity Theory

Activity Theory or Cultural-Historical Activity Theory (CHAT) is a philosophical framework for understanding human activity. It expounds on understanding individuals' daily activities in their social context with an emphasis that context cannot be understood without understanding the people and vice versa. Research in IS development has proposed using Activity Theory as a guiding framework for studying and developing information systems (Bødker and Grønbaek 1991, Kuutti 1996, Hasan 2001, Korpela et al. 2001, Kaptelinin and Nardi 2006, Igira and Aanestad 2009, Allen et al. 2011, Bardram and Doryab 2011). In these studies, understanding work practices is a central issue in informing the system development.

Activity Theory offers valuable concepts that can be used in IS development to unpack the complexity of collaborative activities, situatedness of work and information practices of individuals or groups under study in a particular social context. Such concepts can allow one to understand the context by identifying stakeholders involved, analysing individuals and collective activities at different levels of abstractions such as actions performed, goals associated with those actions and interactions of an activity with other activities in a network. In this manner, Activity Theory's concepts allow "going beyond cognition to analyse the totality of action, reflection and emotion" (Allen et al. 2011, p. 785). These concepts provide guidelines for understanding and incorporating lived practices of the users in developing information systems.

Activity Theory is also an interventionist approach that provides guiding principles for bringing about change or transformation, and interacting with the people under study (Engeström 2000, Allen et al. 2011, Sannino 2011). This study took an action-case research approach and some of the actions taken were inspired by Activity Theory's concept of

contradiction. In this section, I present a brief overview of the evolution of Activity Theory and details on the concepts used in this thesis.

2.1.1. Evolution of CHAT

Through research, the theory has evolved in three generation. The first generation centered on the concepts of activity (Leont'ev 1978) and mediation (Vygotsky 1978). In this generation an activity was expressed in as a triad relationship between *subject*, *object* and *mediating artefact* as presented in Figure 2-1.

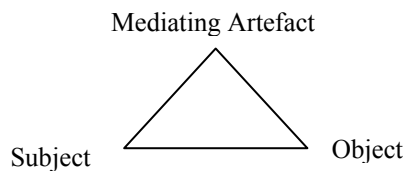


Figure 2-1: Common Reformulation of Vygotsky's (1978) Mediating Triangle

Engeström's work (Engeström 1987), discovered shortcomings of the first generation that it only focused on an individual as a unit of analysis and disregarding the social aspects in a collective activity. In his research he extended the Vygotsky's model by introducing the *community, rules and division of labour*, and redefined the object to represent a shared *object* among the *subject* and the *community*. Engeström proposed a structure of human activity system as presented in Figure 2-2. The second generation was thus introduced.

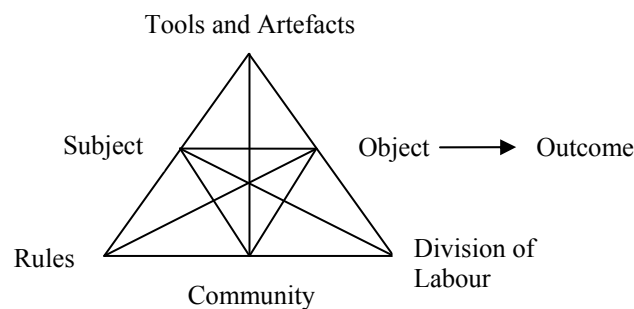


Figure 2-2: The Structure of Human Activity system (Engeström 1987)

As presented in Figure 2-2, Engeström describes that *subject* represents an individual or a group of individuals performing the activity. This is a person or a group of people chosen for analysis. The *object* demonstrates the purpose of the activity. The *object* can be tangible (plan, report and recorded data) or intangible (idea). *Tools and Artefacts* represent the means used by *subject* to perform the activity. They can be physical artefacts (register books, computers, mobile phones, and harmer) or signs (skills, language, and culture). *Rules* represent a set of conditions that determine how and why individuals may act in a certain way. *Division of labour* represents the allocation of responsibilities and variations in roles within the community. *Community* is where participants act within; it is the environment in which the

activity is carried out. Members of the *community* share the same *object* of the activity. *Outcome* represents the desired result for carrying out the activity (Engeström 1987). Further details on the structure of the human activity are presented in Section 2.1.2.

Building on the concept of mediation, further research indicated that, not only *tools and artefacts*, but also *rules* and *division of labour* mediate the interactions between individuals and their daily activities in a social context (Engeström 1987, Engeström 1993, Kuutti 1996, Korpela et al. 2001). *Tools* mediate the relationship between *subject* and *object*. *Rules* mediate the relationship between *subject* and *community*, and *division of labour* mediates the relationship between the *community* and *object* of an activity. According to Kuutti (1996) mediators have the power of enabling and restricting these interactions. The concept of mediation is further described in Section 2.1.2.

The third generation of CHAT came after further research that provided more insights on interacting activities in a network of activity systems (Engeström 1999, Engeström 2001). These studies illustrate that activities do not exist in a vacuum but in a network of other interacting activities. Hence each component of a central activity under study can be a product of other activity systems or can be consumed by other activity systems (Korpela et al. 2001). This is presented in Figure 2-3.

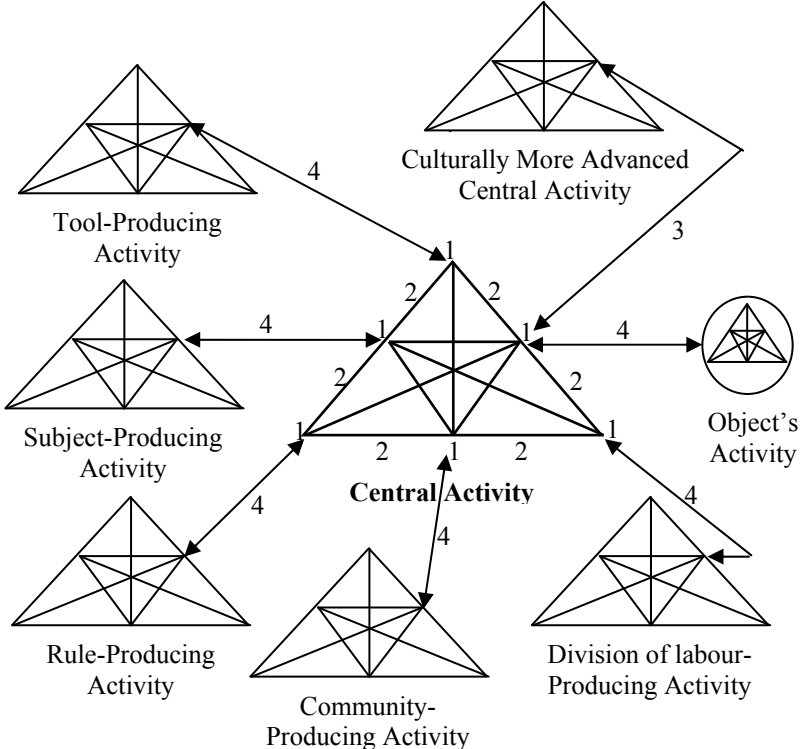


Figure 2-3: Network of Activities (Engeström 1987)

As depicted in Figure 2-3, an activity can be analysed in relation with other activities connected to it. According to Engeström (1987), this analysis can be guided by identifying manifestation of contradictions at four levels (as depicted in numbers 1 - 4 in Figure 2-3) whereby 1 - represents primary, 2 - secondary, 3 - tertiary and 4 - quaternary contradictions. These are further described in Section 2.1.2.

This study has adapted the third generation of CHAT because it provides concepts for analysing complex systems with multiple and conflicting relationships with other systems in a network of activities. In particular, I analysed the community health worker's information practices and the dynamics of introducing IT to support provision of maternal and child health services.

2.1.2. Activity Theory Concepts and Perspectives

Activity Theory offers many perspectives and concepts such as the structure of activity, mediation, zone of proximal development, internalisation and externalisation, and natural and higher psychological functions. In this thesis, the main concepts that were used are: the structure of activity, mediation and contradictions. These are further presented in this subsection.

i. The Structure of Activity:

Activity Theory describes that an activity can be understood through a systemic view of its components as depicted in Figure 2-2. The components of an activity system are in constant interaction whereby a change in one component will cause a change in others. There is an ongoing construction, negotiation, tension, and there are multiple voices and viewpoints between and among the components (Engeström et al. 2005). Korpela et al. (2001) describe that, understanding these components not as individual components but in relation with other components in an activity system is crucial in studying the context when developing information systems. This analysis can provide details of misalignments of the components and thus contradictions that manifest within and between the components can be identified.

For further analysis of an activity, Leont'ev (1978) describes the relationship between actions performed by individual subjects in a collective activity. He elaborate that an activity is comprised of a collection of actions with a shared *object* and every action has its own goal/motive (Leont'ev 1978). A goal can be motivating (attracts individuals to act) or directed goal (directed for instance by higher authority) (Kaptelinin and Nardi 2006). Understanding actions within an activity and their corresponding goals provides a deeper level of analysis

where a researcher can identify goals that may create tensions and hence a breakdown of an activity where all the actions are neglected. This analysis can be beneficial when studying activity systems whose components are produced by other activity systems henceforth the *subjects'* actions and goals are affected by such relationships.

As the focus of this study is to understand information practices that contribute to under-reporting of maternal and child health data from the community level and to find ways of changing the situation, the concept of structure of the activity has provided constructive insights in analysing my data. I used the concept to understand the context by studying the relationships between community health workers and their daily activities. I examine individual components of their activities and different actions performed with their corresponding goals. I also explore the interactions between these activities and other activities around it. As Allen (2011) puts it, this analysis guided me to have a dialog with the activity under study and hence to identify missing/broken links in data communication and manifestations of contradictions that hindered reporting of maternal and child health data.

ii. Mediation:

The concept of mediation is central to the Activity Theory because it describes that mediators facilitate realisation of the *object*. They hold a particular culture and history of the development of an activity, and “they shape the way human beings interact with reality” (Kaptelinin and Nardi 2006, p. 70).

This concept has been used to inform information systems development in several ways (Bødker 1989, Quek and Shah 2004). For example Quek & Shah (2004, p. 223) use the concept to “understand what tools are currently used, how they have evolved, and how their functions could be supported by the system”. This understanding can be used as a basis for designing computer applications that support and enhance what individuals do in their daily lives. The concept of mediation has also been used to understand how the users’ interaction with the world can be influenced by using computers as mediating artefacts (Bødker 1989). Such understanding has become valuable in designing computer applications that are not only conscious about the users’ activities, but also their emotions, competences and goals.

By taking both (Bødker 1989, Quek and Shah 2004) views, this study has use the concept of mediation to elaborate the introduction of new and improved *tools, rules* and roles in the *division of labour* as a way of transforming information practices in collecting and recording maternal and child health data which were otherwise deterred by contradictions. I also use the

concept to show an innovation made by users to design a paper-based register that supported them to enter data in a computer application.

iii. The Concept of Contradictions:

Contradictions are tensions that manifest themselves within and between components of an activity system, and in networks between activity systems. Understanding contradictions in an activity system is important in pointing out weaknesses/threats and eventually direct possibilities for change/improvement (Engeström 1993, Engeström 2000, Hashim and Jones 2007). Engeström (1987) propose four levels of contradictions; primary, secondary, tertiary and quaternary. See Levels 1- 4 as depicted in Figure 2-3;

1. Primary contradictions appear within each component of an activity system
2. Secondary contradictions appear between components of an activity system
3. Tertiary contradictions appear between object of the central activity system and object of a more cultural advanced activity system
4. Quaternary contradictions appear between components of the central activity system and components of other activities in a network of activity systems.

These contradictions however, cannot be directly identified, but they can be understood through their manifestation (Engeström and Sannino 2011). To study contradictions that manifest when an activity is performed, Engeström & Sannino (2011) propose a model of four types of discursive manifestations of contradiction. These are double binds, dilemmas, critical conflicts and conflicts:

- Double binds are “processes in which actors repeatedly face pressing and equally unacceptable alternatives in their activity system, with seemingly no way out” (p. 374)
- Dilemma is “an expression or exchange of incompatible evaluations, either between people or within the discourse of a single person” (p. 373)
- Critical conflicts are “Situations in which people face inner doubts that paralyze them in front of contradictory motives unsolvable by the subject alone” (p. 374) and
- Conflicts “take the form of resistance, disagreement, argument and criticism” (p. 373).

By adapting this model, I have been able to elaborate how the activity of data collections and recording unfolds within these manifestations of contradictions. This analysis guided this study in conducting an intervention to improve reporting of data from the community.

Furthermore, Activity Theory describes that the resolution of contradictions will re-mediate the activity (Virkkunen and Kuutti 2000) meaning that, the *object* of an activity will be perceived and “acted upon in a new way” (ibid, p. 300). In particular, the relationships between the components of an activity will change and a new context to exercise new practices will emerge. New contradictions can also emerge at this point.

Though Activity Theory provides guidelines for identifying and resolving contradictions to create a change, it does not emphasize the fact that individuals (*subjects*) may choose to participate in activities or not as raised by Kuutti (1996). Kuutti’s contribution to the Activity Theory is specifically important in this study because mediators (*tools, rules and division of labour*) of the central activity systems are produced by a management activity system. Hence it is necessary to further explore actions that will motivate the *subjects* to participate in their activities in addition to provision of new and improved mediators in such situations.

According to Roth (2007, p. 55) most people are likely to be driven by goals that promise some type of pay-off that provides “satisfaction, sense of accomplishment, expansion of action possibilities, expansion of control over life conditions”. This implies that, *subjects* are likely to perform actions that have motivating goals than otherwise. Kaptelinin & Nardi (2006) further describe that, when individuals are faced with incompatible goals (motivating and non-motivating) it is possible that all actions within the activity will be neglected. It is important to understand what action will bring about motivating goals to the *subjects*. This study draws on the concepts of motivation and learning as a way of describing actions that will empower health workers to utilise new and improved *tools*, to take upon new roles in the *division of labour* and to adhere to new and re-defined *rules*. These concepts are presented in the following sub-section.

2.1.3. Health Workers’ Empowerment

With a specific focus on improving collection and reporting of maternal and child health data from the community level, this study describes the importance of empowering TBAs and village health workers as *subjects* of an activity system, by motivating them to record the data and giving them necessary skills and registers for recording the data. Since health workers view data collection as an excessive demand from higher authority and not as a part of their job (Braa and Hedberg 2002), giving them new or improved data collection registers may not be enough. It is necessary to understand what actions will direct their behavior towards data collection and recording. According to Castelleo & Watson (1999, p. 76), “empowerment occurs when people come to critically understand, then act to change, their personal, social,

economic, political, and cultural situations”. In this study I describe motivation and learning as agents for such change because they occur at an individual level and they affect/are affected by emotions, competence and goals which are far beyond the availability of appropriate *tools*.

i. Motivation:

Motivation is “an individual's degree of willingness to exert and maintain an effort towards organisational goals” (Franco et al. 2002, p. 1255). The concept of motivation has been promoted by behavioral psychologists who regard that, actions of human beings are governed by rewards and punishments and their motives are governed by behaviors to seek pleasure (food, sex, companionship) and avoid pain (social rejection, physical harm, lack of food). Luoma (2006) describes this as an expectation for personal reward whereby workers will initiate and sustain to work if someone cares about their performance and whether there is a reward in return. In this regard, the concept of motivation brings an understanding that in performing an activity, the *subjects'* behaviour is expected to be created towards gaining a reward. The reward can motivate individuals to align their personal goals with the organisational goals.

Studies elaborate that motivation mechanisms such as provision of support, supervision, feedback and incentives to health workers can create an atmosphere for behaviour change on how work is done (Dieleman et al. 2003, Mathauer and Imhoff 2006, Hamre and Kaasbøll 2008, Henderson and Tulloch 2008). Supportive supervision not only motivates health workers to improve their performance, it is also a way of reducing/avoiding mistakes and updating their knowledge and skills (Franco et al. 2002, Hongoro and Normand 2006, Mathauer and Imhoff 2006, Bosch-Capblanch and Garner 2008). For instance in Kenya and Benin, Mathauer and Imhoff (2006) have shown that, health workers felt that their job was appreciated when they received supportive supervision from their supervisors, and this motivated them to perform better. However, providing supportive supervision may require a physical presence of both the supervisor and the health worker(s). This can be a setback in resource-constrained settings.

Provision of meaningful feedback to health workers is a way of showing appreciation to their work. It is human nature to seek feedback for many reasons. One reason as described by (Ashford et al. 2003) is to attain a goal and improve performance. In this manner feedback is a reflection from which, one reflects on one's performance with regard to making a change in order to attain a perceived goal. Research has shown that when health workers received

feedback based on shortcomings and mistakes made on different aspects of service provision, they regarded it as a punishment (Mathauer and Imhoff 2006). Instead of improving their performance, they are demotivated. This study emphasizes the necessity for district health managers to provide meaningful feedback to TBAs and village health workers in order to motivate them to collect and report maternal and child health data. This feedback should be conducted regularly and indicate how much data was collected and reported and the constraints faced in doing so in order to improve. The provision of such feedback can be made more often through the use mobile phone technology.

Incentive is a reward associated with a positive meaning presented after the occurrence of an action with the intention to cause the behavior to occur again. Provision of incentives has been used as a motivational factor to improve work performance (Dieleman et al. 2003, Hongoro and Normand 2006, Mathauer and Imhoff 2006, Henderson and Tulloch 2008). In the study conducted in Cambodia, Henderson and Tulloch (2008) describe that when health workers received performance-based incentives, there were improvements on the quality of health services provision. Despite extant research that demonstrates the effects of incentives on the provision of healthcare services, no study has demonstrated the effects of incentives on data collection and recording.

According to Dieleman et al. (2003, p. 9) provision of incentives, being it financial or non-financial, can enforce individuals to achieve better performance if it is focused on “showing appreciation and respect”. Research has also cautioned the use of incentives because they are highly grounded in the context and they can produce different results in different contexts. Furthermore, designing incentive mechanisms for health care workers in developing countries can be challenging when it comes to deciding “what to measure and how to measure it” (Luoma 2006) (p. 3). Luoma proposes using ‘general productivity measures’ such as “hours worked, patients seen per day, cases treated and immunizations delivered” and ‘specific performance measures’ such as “adhering to clinical counseling guidelines, ensuring supply stocks, making supervision rounds and promoting condoms”. This study used ‘general productivity measures’ because they provide attributes that could be measured in this study. This measure centered on assessment of the data produced by TBAs and village health workers and hence reported to a health center.

ii. Learning:

Changing behavior by improving actions through better knowledge and understanding can be achieved through learning (Nadler 1970, Fiol and Lyles 1985, Swieringa and Wierdsma 1992,

Virkkunen and Kuutti 2000). This learning can be acquired through training, workshop, seminars etc. to make better decisions, improve the organizational ability to develop and apply specific tactics that will improve performance. Kuutti (1996, p. 33) describes that when individuals increase their skills in an activity system, new actions are “invented, experimented and adapted as responses to new situations or possibilities encountered”. When *subjects* learn, they acquire skills that will enable them to perform activities that they could not do without the skills or they could do better. In addition to skills, training can also be viewed as an incentive (Franco et al. 2002, Mathauer and Imhoff 2006) that may give individuals a satisfaction that someone cares about their performance.

I conceptualise training as defined by Nadler (1970) as “activities that are designed to improve job performance by introducing a new behavior or modifying existing behaviors.” Training has been widely used to impart knowledge to learners in different disciplines including HISs (Ngoma 2007, Ngoma et al. 2008). However, training is often ineffective if is not properly arranged and/or conducted. Ngoma (2007) describes that when health workers gain skills on data collection, report aggregation and data utilisation, they change their perceptions toward the data and start to ensure its completeness and accuracy in order to make appropriate decisions out of their data. Training is not only about giving *subjects* skills (*tool*) to perform their actions but also empowered them to direct their behavior towards performing their activities.

Research has shown varying reports on the improvement of women’s health during pregnancy, birth and after delivery when community health workers are trained (Smith et al. 2000, Ray and Salihu 2004, Sibley et al. 2004, Darmstadt et al. 2009). Despite the reports, there is a consensus that when community health workers are trained there are significant improvements in linkages between the community and the health facility level. This link is important in improving reporting of maternal and child health data. While previous studies have focused on assessing the impact of training community health workers by looking on the medical aspects, this study illustrates its impact on the quality of data.

2.2. IS Design Theory

Design theory in IS development conceptualises design both as a process and a product (Walls et al. 1992, Gregor 2006). Hence it provides methodologies, tools and guiding principles in developing information systems. Different from other fields, the main focus of IS research is to study “more than just the technological system, or just the social system, or

even the two side by side; in addition, it investigates the phenomena that emerge when the two interact” (Gregor 2006, p. 613). Participatory Design (PD) offers principles, and guiding techniques for examining such a phenomenon. This study has adapted the PD principles and follows its proposed techniques in IS development. In the following sub-sections I describe the principles and techniques of PD. I also demonstrate the application of these techniques in the developing countries context.

2.2.1. Participatory Design Principles

Participatory design with its roots in the Scandinavian countries centers “on the design of information and communication technologies and technology-enabled systems” (Robertson and Simonsen 2012, p. 2). It emphasizes on involving all the stakeholders, with different degrees of involvement, to ensure that their needs are met and the developed outcome is usable. PD focuses on participation of users in system design, promotion of workplace democracy, mutual learning and empowerment as its main principles.

These principles however have been highly challenged when applied in PD projects in the developing countries context. Studies have documented challenges such as the necessity of developing users’ capacity in order to enable them to participate (Braa et al. 2004; Nhampossa et al. 2004; Byrne and Sahay 2007; Kimaro and Titlestad 2008; Winschiers et al. 2010). These studies draw attention to the participation of users with no IT skills in system development.

Another challenge is a need for including a range of stakeholders to participate with the purpose of catering to issues such as shortage of human resources, power relations, strong hierarchies and politics (Puri et al. 2004; Elovaara et al. 2006; Byrne and Sahay 2007). In particular, this challenge may lead to wastage of resources as well as the determination on how the project is established, conducted and evaluated. What participation means as defined in different contexts and cultures is also a further challenge (Winschiers et al. 2010).

2.2.2. Participatory Design Techniques

Studies have indicated that the involvement of users in developing computer applications is vital when system acceptance is critical and/or when information required for designing the system can only be obtained from users (Bødker and Grønbæk 1991, Bødker and Iversen 2002). With PD, designers can understand the social context within which details of interactions in the accomplishment of tasks are defined by giving users a chance to contribute to the design through sharing their knowledge on how they actually do their work. To allow for such learning to take place, PD prescribes the application of techniques that allow designers to

use tools that are familiar to users, create scenarios that envision future work situations and design with the users in their real-life environment (Bødker and Grønbæk 1991, Greenbaum and Kyng 1991, Kyng 1991, Trigg et al. 1991, Blomberg et al. 1993). These approaches support mutual learning whereby designers and users can jointly share their experiences as they “learn together to create, develop, express and evaluate their ideas and vision” (Robertson and Simonsen 2012, p. 8).

Research proposes several techniques that can be used by designers to support mutual learning. These include prompted reflections, storytelling, future workshop, design games, thinking-aloud and mapping (Greenbaum and Kyng 1991; Bratteteig 1997; Kensing 1998; Karasti 2001; Bødker et al. 2004; Mörtberg et al. 2010). This study has focused on prototyping technique to support users in gaining IT skills, ethnographic techniques to support designers in learning about users’ work, and prompted reflections technique to support creation of a mutual vision of a new system.

Prototyping technique has been used in system development as a technique for supporting users to acquire IT skills related to the system under design and for evaluating the system under design (Bødker and Grønbæk 1991, Mörtberg et al. 2010, Brandt et al. 2012). The technique however has been criticised for its usefulness in settings where users have no basic IT skills (Nhampossa et al. 2004, Kimaro and Titlestad 2008). In these settings, research report that, users need IT skills before they can be engaged in developing prototypes with the designers.

Ethnographic techniques have been used to support designers to learn about users’ work. PD literature proposes the application of ethnographic techniques such as interviews, document reviews, observations and focus groups (Blomberg et al. 1993, Blomberg et al. 2003, Mörtberg et al. 2010, Blomberg and Karasti 2012). However these techniques have shown to be insufficient to provide knowledge about users’ actual work especially when the designer is not familiar with the users’ work domain (Bjerknes and Bratteteig 1987, Bødker et al. 2004). To strengthen the techniques, Kensing et al. (2004) and Stewart & Williams (2005) propose using ethnographic techniques together with other techniques that allow users to be engaged in expressing their views about requirement specifications and design decisions.

Prompted Reflections is one of the PD techniques that can be used when designers are unfamiliar with users’ work and when an understanding of users’ work has not been achieved through interviews, document analysis and observations conducted (Bødker et al. 2004, Kensing 1998). The technique consists of four activities; preparation, workshops, analysis and

discussion of results (Kensing 1998). In preparations discussion topics and participants capable of making free-hand drawings are selected to demonstrate areas that the designers had difficulties in understanding. The drawings are then discussed in workshops to prompt the participants' reflections on their practices. The data collected during workshops in analysis by the designers. This analysis allows them to gain an understanding about the users' work and guide them in conducting an intervention. Discussion of results is the final activity whereby the designers discuss their analysis report with the workshop participants to allow the participants to challenge their interpretations and to gain new insights from the designers.

The most important part of this technique is the use of prompts that will allow the users to reflect on their lived practices then define their work domain from their point of view, and the designers to gain more understanding about the users' work as they engage in discussions of free-hand drawings. Though Bødker et al. 2004 propose the application of the prompted reflections technique during system analysis and design, it is valuable to explore the application of the technique in other stages of system development. This can be beneficial when the question is not only about what prompts to use but also when to use them depending on the level of competence of the users and the designers in defining system requirements.

Furthermore, PD provides many techniques to support engagements with users by combining, extending and adapting them in different ways. Since these techniques have been developed and applied within western culture and contexts, their application has been questioned when used in other contexts and cultures (Puri et al. 2004, Winschiers 2006, Kimaro and Titlestad 2008, Winschiers et al. 2010). Understanding the application of PD techniques specifically in the developing countries context requires further research to evaluate the techniques.

2.2.3. Participatory Design Techniques in Developing Countries

Research in developing countries has reported significant potentials of using PD in IS development with high emphasis on mutual learning (Korpela et al. 1998, Braa and Hedberg 2002, Puri et al. 2004, Elovaara et al. 2006, Kimaro and Titlestad 2008, Winschiers et al. 2010, Jensen et al. 2012, Rodil et al. 2012). The approaches used will certainly prescribe how different techniques should be applied. Within the HISs, Braa & Sahay (2012) describe how in the absence of IT skills and presence of complex social relations, cultural aspects and political systems, mutual learning can pave way for designers and users to learn from each other and eventually develop a future view of the system.

Kimaro et al (2008) describe the application of hands-on training and system experimentation techniques to support users to gain IT skills in Tanzania. These techniques were used during system customisation whereby users received training on basic computer skills, including how to use mouse, keyboard and printers, and at the same time they were engaged in customisation of the already designed system. Designers learned from users through observations conducted during the customisation process. Using these techniques however Kimaro et al. (2008) describe that, they faced a challenge of not being able to get the right people to participate in the training. Thus there was a need for re-training when the system went live.

In a study conducted in Zanzibar, Elovaara et al. (2006) describe challenges faced in using ethnographic techniques, such as interviews, observations and discussions, when defining requirements for system customisation. Due to different opinions raised by health workers, designers were challenged on agreeing about whose views mattered whereby in that case, the designers' opinions were regarded above the users'. The designers were also in constant negotiation with users on their availability for interviews and discussions due to a tight working schedules and shortage of health workers at the hospital.

In Namibia, researchers (Winschiers 2006, Winschiers et al. 2010) provide their experiences in designing technologies with rural communities. In that context, the application of techniques such as future workshops, brainstorming and story-telling with a western cultural approach did not work with the Namibian users. This was due to cultural concerns such as “where a story ‘comes from’ or who is permitted to voice it” (Winschiers et al. 2010, p. 3) and a view of the future system based on “existing items” rather than a “vision” (Winschiers 2006, p. 74). These studies demonstrate that, for a technique to be useful in this context there is a need for changing how it is applied from its traditional use.

In general, it is significant to evaluate the application of participatory design techniques in the developing countries context in order to gain more understanding on their usefulness in settings and cultures different from the western. This understanding will enlighten its principles and techniques.

2.3. Summary

In clinical work, tasks have to be performed at hand with the available personnel, equipment and/or medication. In such conditions, research indicates that the accomplishment of tasks involves complex relationships between people, procedures and tools used (Symon et al. 1996, Berg 1999). As a result, Symon et al. (1996) describe that health workers may rely on

detours and work-arounds to accomplish their tasks Using insights from Activity Theory, one can comprehend the connections between individuals and their daily activities (Engeström 1987, Engeström 1993, Kuutti 1996, Korpela et al. 2001) by identifying components of individuals' activities and analysing contradictions that arise between and within the components and also between activity systems.

Furthermore, in developing computer applications PD provides techniques and guiding principles that can enhance gaining IT knowledge and knowledge about individuals' work experiences through mutual learning. Previous research (Bjerknes and Bratteteig 1987) indicate that, when designing computerised systems to support clinical work, mutual learning is highly important in gaining users' first-hand experience. According to Suchman (1995, p. 61) first-hand experience includes what people do and the "specifics of how people work". For an outsider, gaining such an experience may not be easy (Bjerknes and Bratteteig 1987, Nardi and Engeström 1999, Star and Strauss 1999, Karasti 2001).

However, applying PD techniques in the developing countries' context, there is a need for understanding not only about the techniques that will support mutual learning but also about when (stage of system development) the designers can learn about the tools and procedures used by health workers, and the users can learn about the technology. Such applications can provide learning to the PD community on the sufficiency of its techniques when applied in contexts where there are wide knowledge gaps between users and designers also in a non-western culture.

A long tradition of health worker relying on detours and work-arounds to accomplish their tasks has also been a central focus in this study. It is also not uncommon for users to create tweak and work-arounds to accomplish their tasks in computerised systems (Dahlbom and Mathiassen 1993, Orlikowski 2000, Boudreau and Robey 2005). Boudreau and Robey (2005, p. 14) describe that "response in which users work around a technology's limitations and their own limited knowledge, thereby producing unintended patterns of technology use" can be termed as re-invention. These are user innovations that determine their point of view on the design of the system. Such innovations can be valuable in designing systems that are conscious about the users' lived practices.

According to (Dahlbom and Mathiassen 1993), when users start to use a computer application, contradictions will emerge. They emphasize that these contradictions should be treated as "opportunities for intervention" (p. 120). Similarly, Carroll (2004) describe that designers should pay attention to user's innovations when they are using the system because

this can shape how systems are designed and new requirements are defined. This study also illustrates the importance of embracing user innovations and contradictions that arise during and after system implementation in order to define system requirements from the users' perspectives.

CHAPTER 3: Context and Setting of the Research

This chapter presents the context and the setting where this study was conducted. It is divided into three sections. In the first section I describe the Tanzanian’s healthcare structure and data flows therein. The status of maternal and child health services is presented in the second section. The third section presents a detailed description of the data collection tools used and procedures applied in provision of maternal and child health at the community and health facility levels.

3.1. Healthcare Structure and Data Flows

Tanzania is a country in Eastern Africa surrounded by the great lakes. It has an area of 945,000 square kilometres and a population of approximately 44 million. There are 30 administrative regions in Tanzania (25 Mainland and 5 Zanzibar) which contain 169 administrative districts (Mainland has 159 and Zanzibar has 10) (NBS and OCGS 2012). This study was conducted in three districts of the Pwani region in Tanzania Mainland. The three districts are Kibaha, Mkoani town council (a.k.a. Kibaha town council) and Bagamoyo. Figure 3-1 indicates the map of Pwani region to the left and the districts to the right.

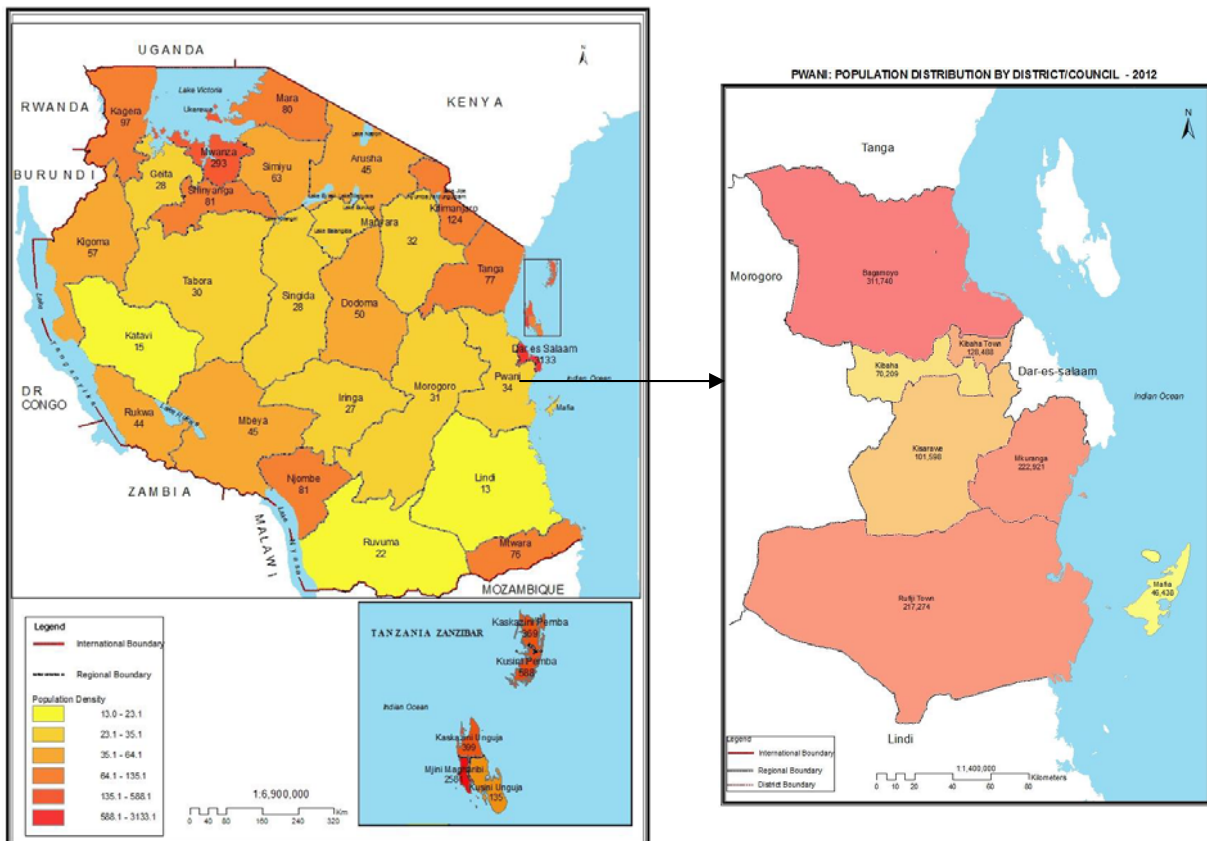


Figure 3-1: Population density of Tanzania: Source (NBS and OCGS 2012)

In the three districts, this study was conducted within the Ministry of Health and Social Welfare (MoHSW) whose administration is based on the same regional and districts divisions. The health care structure in Tanzania mainland is divided into five levels, as depicted in Figure 3-2, where primary, secondary and tertiary services are provided.

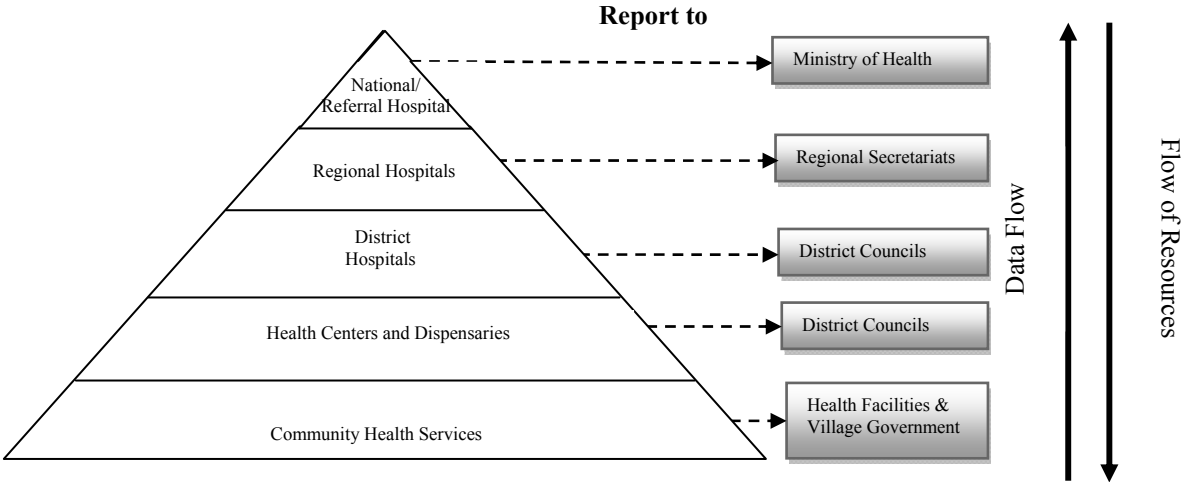


Figure 3-2: Health care Structure and Data Flows in Tanzania Mainland

Primary level services are provided in communities, health centers and dispensaries. In district hospitals, secondary level services are provided and tertiary services are provided in regional and national hospitals. Dispensaries serve the population of 6,000 to 10,000 people and health centers are expected to serve the population of at least 50,000 – 80,000 people. District hospitals are expected to serve at least 520,000 people and regional hospitals are referral centers for 4-8 district hospitals. In hospitals, health centers and dispensaries, healthcare services are provided by medical professionals. These are nurses, midwives, MCH aides, medical doctors, and clinical officers. As presented in Figure 3-2, health centers, dispensaries and district hospitals report their data to the district councils. Regional hospitals and district councils report to the regional secretariats. Referral hospitals and regional secretariats report to the ministry.

At the community level, non-medical professionals provide preventive health care services. These are traditional birth attendants (TBAs) and village health workers, collectively known as community health workers. TBAs and village health workers may possess some medical skills which they gained not through the formal education system. The communities comprise of 10-20 villages and each village has about 500 to 600 households. In each village there are three to ten TBAs. Village health worker serve at least 150 to 200 households. Community health services are more dominant in rural and semi-urban communities than in urban

communities. Data collected by village health workers are reported to the village government and a health center or dispensary in their community. Village government is the political administration part of the community. Data collected by TBAs are reported to the district by district health managers.

In the healthcare structure, the Health Management Information System (HMIS) which is named MTUHA in Kiswahili coordinates all the activities for data collection and reporting within Tanzania mainland. In this system, data are collected routinely as well as non-routinely from communities, health centers, dispensaries and hospitals. The flow of data reporting is bottom-up from the community to the ministry, while the flow of resources is top-down as presented in Figure 3-2.

Furthermore provision of healthcare services within the MoHSW is subsidised by vertical programs. These are entities of donor-funded projects such as malaria, HIV, tuberculosis and leprosy. The vertical programs work with only their areas of interest and they operate at all levels of the health care hierarchy in provision of healthcare services and collection of data.

3.2. *Maternal and Child Health Services*

Maternal and child health services were established in Tanzania in 1974. Services that are provided to women include Antenatal care (ANC), delivery, Postnatal Care (PNC), prevention of malaria, Prevention of Mother-to-Child Transmission of HIV (PMTCT), nutrition and family planning. Services provided to children include immunisation, Integrated Management of Childhood Illness (IMCI), nutrition and prevention and management of malaria. This study has focused on the provision of ANC, delivery and PNC to women and provision of immunisation, IMCI and nutrition services to children.

3.2.1. Status of Women Health

Under normal circumstances, it is recommended that a pregnant woman gets at least four ANC checkups. Statistics indicate that, in Tanzania, 94% of pregnant women make at least one ANC visit, and of these 62% have four or more ANC visits. However, only 14% of pregnant women start ANC during the first trimester (NBS and ORC 2005). Recent survey (NBS and ICF 2011) indicates that women in urban areas are more likely to have at least one ANC visit as compared to women in rural areas.

According to the 2010 survey (NBS and ICF 2011), 50% of deliveries occur in health facilities. This number has increased from 47% as noted in the 2004. Births in rural areas are more likely not to be conducted in health facilities as compared to urban areas. Major reasons

for fewer births in health facilities include provision of poor emergency obstetrics care, difficulty in accessing health facilities due to long distances, poor infrastructure and high transportation costs, and traditional socio-cultural beliefs and practices.

Postnatal care is a mandatory service given to mother and child from birth to 42 days. The service focuses on providing regular checkups for treating birth complications and providing health education to the mother about caring for herself and the baby. Studies indicate that most maternal and neonatal deaths occur within the first two days after delivery. In Tanzania, 65% of women do not receive a postnatal checkup (NBS and ICF 2011). In this case also, urban women are more likely to receive PNC as compared to rural women.

3.2.2. Status of Children Health

Health status of children in Tanzania indicates that, one out of 20 children dies before reaching their first birth day and one out of 12 dies before reaching their fifth birthday. Most of these deaths are due to malnutrition, malaria, pneumonia, diarrhea, HIV and AIDS. However, surveys conducted between 1992 and 2010 indicate significant reductions in infant and under-five mortality rates. Infant mortality rate has reduced from 88 per 1,000 live births in 1992/1996 to 51 per 1,000 live births in 2006/2010. Under-five mortality rate has reduced from 137 per 1,000 live births in 1992/1996 to 81 per 1,000 live births in 2006/2010 (NBS and ICF 2011). These reductions have been due to immunisation and malaria prevention initiatives established by the ministry.

Despite these reductions, 66% of children are fully immunised during their first year of life with the highest percentage (86%) of children in urban areas as compared to 73% in rural areas (NBS and ICF 2011). A similar pattern in nutrition has also been noted whereby 45% of children in rural areas are more likely to be stunted as compared to 32% in urban areas (ibid).

3.3. Data Collection at the Community Level

At the community, the provision of maternal and child health services include following-up health status and clinic attendance of pregnant women in antenatal care, during delivery and postnatal care after delivery. For children, their nutrition and vaccination status from when they were born until five years of age are followed-up. As indicated previously, these activities are done by TBAs and village health workers in collaboration with health facility workers and district health managers. Provision of these services is done together with data collection for the purpose of record keeping, following-up and reporting. Figure 3-3 and Figure 3-4 present the pictures of TBAs and village health workers consecutively.



Figure 3-3: TBAs



Figure 3-4: Village health workers

TBAs conduct deliveries and record outcomes of the mother and the baby in a delivery register. The registers are supplied by district health managers who are supposed to visit them and record what they collected, and eventually report the data to the district. The TBAs' coordinator is a district health manager who is supervising all the TBAs activities.

Services provided by village health workers through household visits and gatherings include: family planning (educate community and distribute birth control pills and condoms), integrated management of childhood illness (registering babies under five years of age, follow-up on their growth status and childhood diseases), home based care (monitoring health status and medication intake of HIV/AIDS patients), mobilising and monitoring immunisation status of pregnant women and children, and reporting maternal and child deaths and disease outbreaks. They refer women and children with complicated conditions to a nearby dispensary or health center in the village. Village health workers also educate their communities on general healthy practices, preventive measures against malaria, sexually transmitted diseases and environmental issues during village gatherings. Activities of village health workers are supervised by district health managers known as village health workers' coordinators, and health facility in-charge in the village they operated. Figure 3-5 and Figure 3-6 present pictures of the TBAs' coordinator and village health workers' coordinator consecutively.

To keep records on the provision of the services, village health workers use different registers and notebooks. Since most of their services were managed and controlled by vertical programs, village health workers report the data collected both to the health facility and to the vertical programs.



Figure 3-5: TBAs' coordinator (sitting in front of TBAs)



Figure 3-6: Village health workers' coordinator (giving instructions to village health workers)

3.4. Data Collection at the Health Facility Level

At the health facility level, the maternal and child health data are collected by health facility workers using paper-based registers and cards. The health facility workers include nurses, medical doctors and laboratory personnel. The collection of data was done hand in hand with the provision of the services which involved collaboration between different entities within and outside of the health facility. These entities consist of maternal and child health clinics (antenatal care, delivery, postnatal care and childcare), other clinics (Prevention of Mother to Child Transmission, Care and Treatment Center and Out Patient Department), laboratory, and entities outside the health center (mother and community members). The clinics and laboratory can belong to one health facility or different health facilities. Within and between these entities verbal and written information is exchanged both in formal (using standardised data collection tools) and informal (using improvised data collection tools) manner.

The focus of this study is on the exchange of information between maternal and child health clinics (antenatal care, delivery, postnatal care and childcare) within one health center, mothers, and the community within which the mother and baby belong. In this setting, provision of the services was done by nurses who are medical professionals. Figure 3-7 indicates a nurse recording data while providing service to children and Figure 3-8 depicts clients waiting to receive the service.



Figure 3-7: Nurse recording data on registers and cards while providing service



Figure 3-8: Clients waiting to receive the service

The following paragraphs provides a detailed description on the data collection tools used and procedures applied in provision of ANC, delivery, PNC and child health. These tools are described in Paper IV.

In provision of ANC, data are collected using RCH4 card and ANC registers. These are standardized tools used within the MoHSW and they are developed and managed by the HMIS. The card is given to a pregnant woman during her first visit to the clinic, a new card is given for each pregnancy and it is kept by the woman. It keeps records on check-ups, vaccination given and medications taken following the attendance of four ANC visits (under 16, between 20 and 24, between 28 and 32, and between 36 and 40 weeks). The ANC register is used to register women from their first ANC visit to their last visit of pregnancy. This register is owned by the clinic. The card and the register are recorded simultaneously by the nurse. In addition to the standardised registers, the nurses also use their own improvised registers for recording necessary information for reporting and for client follow-up.

Data collection tools used for recording delivery information are RCH4 card, delivery registers and labour record forms. The card is the same as the one used in the ANC. The delivery register resides at the health center and it keeps records of mother's information before, during and after delivery, and delivery outcome for the mother and the baby. The record of labour form is used in labour rooms to record the delivery progress. In this form, the nurses record every minute of labour (presented in a patom graph) and a summary of child information after delivery.

The data collection tools used for recording PNC activities are the RCH4 card (same as the one used during ANC) and PNC registers. The card keeps records for following-up the attendance of four visits (24 hours, day 7, day 28 and day 42) on check-ups, vaccination status, medications taken, status of the baby and family planning. The PNC register keeps records on the attendance at the PNC clinic. This register resides at the health facility.

Data collection tools used in child health management are the RCH1 card and daily children register. The card is given to a child during their first contact at a health facility and it is used until they are five years old. This card is used for growth monitoring, follow-up on immunisation and morbidity, and it keeps records on the attendance of eighteen visits. The first four visits (48 hours, day 7, day 28 and day 42) are based on thorough check-ups and vaccination status, and the other visits (3 months to 5 years) focus on growth monitoring.

In sum, the registers, and the cards keep record of similar but not the same information. The registers focus on administrative data that is useful for further reporting and managerial activities. The cards focus on personal details for the sake of continuation of provision of care and follow-up when a woman/child returned or attended a different health facility or clinic. Also the presentation of the cards is quite different from the presentation of the registers as described in Paper IV. To generate the reports, most of the information is acquired from the registers and some of the information from the cards. Since the cards are not stored at the health center, the necessary information from the cards that is needed for reporting is recorded in nurses' improvised registers.

Reports generated at the health facility are sent to the districts where the data are entered into a computer database named District Health Information Software Version 2 (DHIS2). DHIS2 is HISP's software standard that is used to aggregate data from paper-based reports collected from health facilities, and to generate different reports and data displays necessary for the district health managers and other health stakeholders and for further reporting to the regions. On the writing of this thesis, in Tanzania, DHIS2 was operating from the district level where data were aggregated and sent electronically to regions and then to the ministry level.

Based on the HISP's experience from different countries, research has shown that, the completeness and accuracy of data within the HIS can be improved by extending the use of DHIS2 to the health facility level where patient-based data (not aggregated) collected in the health facilities and communities can be captured in DHIS2. In this accord, a DHIS2 module named DHIS Tracker (an electronic medical record system) was developed.

DHIS Tracker

The DHIS Tracker is a generic software module which when adapted it is customised to fit with the local requirements. The customisation involves designing data structures and interfaces to support the local setting. This customisation is done by setting parameters in the existing software and by adding new code. The addition of new code is limited to some functionality whereby local innovations can be added but the structure of the software cannot be modified. The software can be used for case-monitoring, reporting and planning. As a case-monitoring tool, it can be used to support timely service delivery and monitoring of individual case/client. This functionality can also be extended to be provided by a mobile phone client. As a reporting tool, it enables aggregation of individual case data and import them into the district based module of the DHIS2. DHIS Tracker can also enable planning of activities (weekly, monthly) for community outreach activities (HISP).

DHIS Tracker has been customised in several countries in the HISP network for different purposes. For example, in Malawi, India and Vietnam for monitoring and following-up service delivery to pregnant women and children. In Guinea Bissau, it is used for monitoring and following-up service delivery to pregnant women, children and TB patients. In Ghana, it is used for monitoring and following-up service delivery to pregnant women, children and TB patients and in Kenya for death registration. In India, DHIS Tracker is used for supporting routine health facility reporting by involving community health workers who send reports from the community using mobile phones. This study aimed at customising the DHIS Tracker for supporting complete and accurate collection of maternal and child health data in rural communities and timely reporting to health facilities and further to the districts. The DHIS Tracker was also aimed to be used by the health facility workers as a tool for monitoring and following-up service delivery to pregnant women and children.

To get a broader understanding of medical record systems used in other settings, I visited other places in Norway, Malawi, KCMC hospital in Kilimanjaro in Tanzania and Mt. Meru regional hospital in Arusha, Tanzania. In Norway I studied the national wide birth registration system. In Malawi I studied the Baobab's OpenMRS system that was rolled-out in rural health facilities. In the KCMC hospital, I studied the birth registry system used at the hospital. At the Mt. Meru Hospital, they had experiences of using a computerised system for MTUHA before DHIS2 was implemented. This was an electronic medical record system that operated in parallel with the paper-based system at the regional and ministry levels since 1997.

CHAPTER 4: Research Methodology

In this chapter, I present the research methodology employed in this study. The chapter is divided into four sections. The research design is presented in the first section. In the second section, I present the research approach used and describe the data collection and analysis methods applied. The third section presents the study limitations and the ethical issues are presented in section four.

4.1. Research Design

This research was done as part of a maternal health project which aimed at proposing strategies that will contribute to the reduction of maternal and child mortality in Tanzania and Malawi. The research was also part of the global network for HIS research and development, HISP, as mentioned in Section 1.3.2., and it was built upon the ongoing action research initiatives in HISP. HISP started in South Africa in 1994 and thereafter it was extended to other developing countries such as Ethiopia, Vietnam, India, Botswana, Tanzania, Malawi, Nigeria and counting. In all the countries, the primary goal of HISP is to design, implement, and sustain HISs to support local management of health care delivery and information flows (Braa et al. 2004). In Tanzania mainland, since 2002, HISP has undertaken a number of activities such as standardization of data sets, redesigning of data formats and standards, adaptation of the DHIS2 software standard, and institutionalisation of these standards at the district, regional and ministry levels of the healthcare hierarchy. However, when conducting this study DHIS2 was not established at the health facility and community levels which were the main focus of my study.

Fitting my research in this setting, I focused on exploring ways of improving reporting of maternal and child health data to the health facilities through the involvement of TBAs and village health workers from the community levels. And hence conduct an intervention to improve reporting of the data. To fulfil this, there was an urgent need for understanding the TBAs and village health workers' practices in collection, recording and reporting of maternal and child health data at the community level. This understanding was essential for planning a solution or solutions for under-reporting of the data and hence conducting an intervention.

Since the use of DHIS2 was already established as a software standard for supporting data collection and reporting within the HIS in Tanzania, I was required to adapt the DHIS Tracker as one of the solutions. In this accord, the knowledge gained from this study was also used to define requirements for customisation of the DHIS Tracker for the Tanzanian setting. The

customised DHIS Tracker in this study was named maternal and child health application, which I will be referring to throughout the thesis.

In this study, the maternal and child health application was planned to be implemented at the health facility and the community levels. In this plan, a database was going to be in a computer at the health facility whereby the nurses could enter and manage the health facility data and community health workers could use mobile phones to enter and retrieve data from the database. Since the purpose of this study was to facilitate reporting of maternal and child health data from the community level, the system design however could not support that. This was because while conducting this study, the DHIS Tracker was in its infant stages of development and most of the functionalities were not fully developed or not developed at all. In this accord, there was a need for designing the database for the health facility that was going to facilitate collection of data from the community. At this point, I shifted my focus to collect requirements for the health facility, design the database and implement it. Meaning that, the implementation at the community had to wait until the database was working at the health facility.

Since the HISP global team was responsible for developing and upgrading the generic software, DHIS Tracker, they collected requirements from local customisations and incorporated them in the software. This was to ensure coordination in software development and to avoid forking. Thus the global development team prioritised the development activities of the software and new or modified features could not be incorporated in the software design at the local levels. In this way, the pace of customisation and implementation at the field depended upon the pace of collaboration and communication with the global team and other implementations within the HISP network. There were constant tensions between what is needed to fulfil urgent local requirements and what the global team could offer. Due to such tensions and a limited amount of time for completing my fieldwork, the maternal and child health application was only implemented at the health facility level. In this study, some of the system functionalities were not fully explored and tested.

Working in this setting, I played different roles in this study. At the community level, I worked with TBAs, village health workers, health center nurse in-charge and district health managers in designing standardised data collection registers and re-organising work practices around data collection and recording. At this level, I worked as a researcher, a facilitator (organiser of training and meetings), and a consultant (sharing my knowledge and experiences). At the health facility level, I worked as a designer with a programmer and

nurses in designing the maternal and child health application. The programmer was a member of the HISP Tanzania team. My other roles at the health facility level were researcher, implementer (trainer, supervisor) and facilitator (organiser of training and workshop).

4.2. *Research Approach*

Based on the research design, to fulfil my research objectives this study took an action-case approach. This is a hybrid approach whereby I conducted case studies and action research jointly. The approach has been used in IS research whereby the success of an intervention is steered by a deep understanding of the case (Braa and Vidgen 1999, Stenmark 2002). The choice of this approach was to gain insights on understanding the context and the phenomena under study while engaging in an intervention to bring about changes.

As an action research, this study followed the five phases as described by Susman & Evered: diagnosing, action planning, action taking, evaluation, and specifying learning (Susman and Evered 1978). And the research aimed at solving an immediate problem situation while carefully informing theory and practice as described by (Baskerville and Myers 2004). Due to the research design however, the study was not conducted following a one directional sequence of activities between the phases. There was a constant need for engaging in negotiations and taking advantage of arising opportunities. This led to back and forth movements between the phases. Also due to a crucial requirement of understanding the context and health workers' practices who operated in a domain that was foreign to the researcher, case studies were conducted in some phases of the action research to gain these insights. Hence, learning was specified from the case studies conducted in these phases. This learning also contributed to back and forth movements between the phases.

Due to the research design, two action-cases were conducted in this study. The first action-case aimed at facilitating collection of standardised data from the community and re-organising information practices around these activities so as to develop realistic requirements that will improve reporting of maternal and child health data from the community level. The second action-case aimed at customising the DHIS Tracker and implementing it at the health facility for capturing and management of health facility data as well as data from the community. In each action-case, one cycle of action research was conducted. In the initial stages of this study, only one action-case (the first case) was planned to be conducted. However due to the need for designing the health facility database as described in section 4.1, the second action-case was conducted. In the next two sub-sections, I present the action-cases followed by research methods used for data collection and analysis in each case.

4.2.1. The Case of Implementing a Paper-based Solution at the Community Level

This action-case study was conducted in two districts, Kibaha and Bagamoyo, of Pwani region from November 2009 to April 2011. The case aimed at understanding the nature and complexity of information practices of TBAs and village health workers around collection, recording and reporting of maternal and child health data. The unit of analysis was work practices around TBAs, village health workers and health facility workers in collecting, recording, reporting, analysing and using maternal and child health data. In the fieldwork I worked with TBAs and village health workers in the community, health facility workers, and district health managers.

Informed by a comprehensive case study, an intervention was conducted to design standardised paper-based data collection and reporting registers for TBAs and village health workers and to empower them to collect and record maternal and child health data. These actions aimed at improving completeness, accuracy and timely reporting of the data.

i. Action Research Phases:

The phases through which this action-case study was conducted are depicted in Figure 4-1.

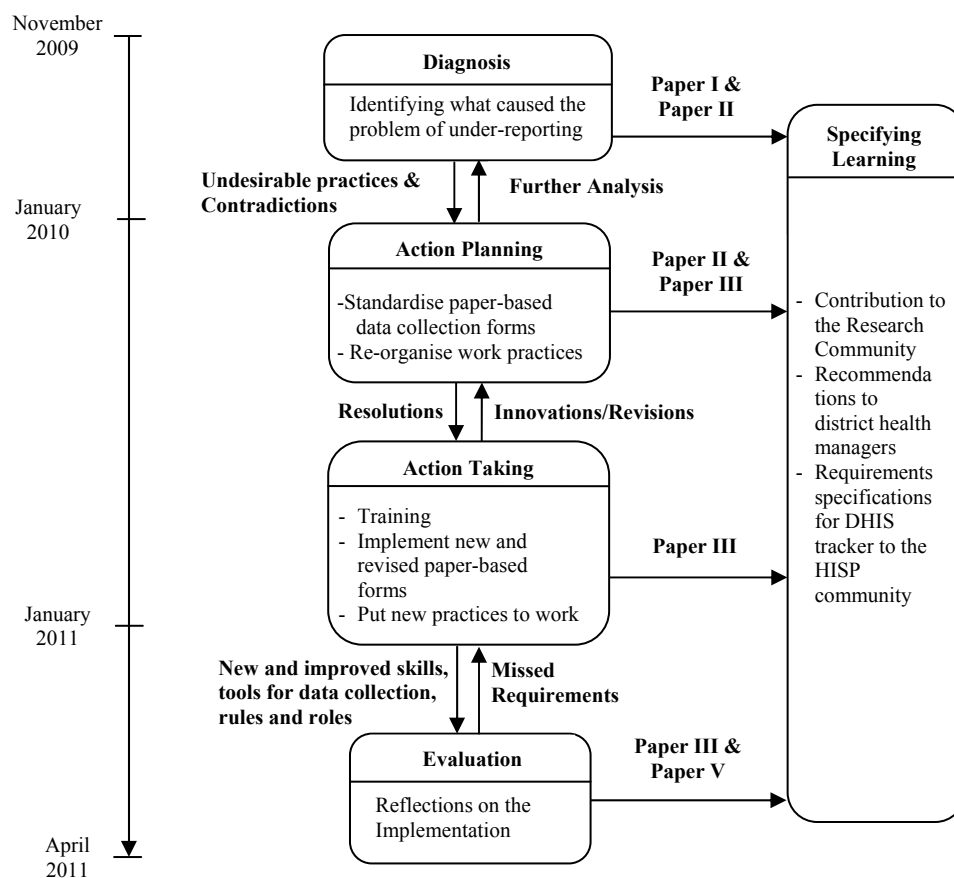


Figure 4-1: Phases and timeline of the study at the Community Level

The timeframe presented in Figure 4-1 demonstrated the period when the activities were undertaken to give a general picture. In particular there were back and forth movements between the phases and sometimes different phases were conducted at the same time. Also in-between the phases, I spent a total of eleven months in the field.

As summarized in Figure 4-1, during the diagnosis phase, I identified the root causes of under-reporting of maternal and child health data from the community. By applying the Activity Theory's concept of structure of activity (Engeström 1987), I was able to understand information practices of TBAs and village health workers which were intertwined with their motives, tools used for data collection, skills, rules enforced and behaviours. From this phase, the presence of undesirable work practices and contradictions (Engeström 1987, Engeström and Sannino 2011) that manifested in the activity of data collection and recording were identified as major causes of under-reporting of the data. These are presented in Paper I and Paper II consecutively. I spent the entire period from November 2009 to January 2010 in the field except one week in December 2009 during the Christmas and New Year holidays.

In the action planning phase, I worked cooperatively with TBAs, village health workers, health center nurse in-charge, TBAs' coordinator and village health workers' coordinators. We planned how to intervene the situation by improving skills, designing standardized registers and introducing an incentive. This phase was conducted together with the action taking phase. The actions planned for the interventions are presented in Paper II and Paper III.

The actions were performed in the action taking phase. TBAs and village health workers received training from the district health managers and the new paper-based system that included new registers, skills, regulations and division of labour were implemented in one village from January 2010. The standardised data collection registers were put to work and the new organisation of work practices started to take course. New innovations and revisions identified during the implementation were put back to the action planning phase. Innovations and revisions identified as missing requirements were channeled to the district health managers who suggested how to go about them and their recommendations were put into action planning. What transpired during the intervention is presented in Paper III. In this phase I spent a total of six months in the field from January – April 2010, then from November 2010 – January 2011. During my absence all the activities were coordinated by the health center nurse in-charge and the TBAs' and village health workers' coordinators.

In the evaluation phase, the implementation was evaluated by reflecting on the changed practices after the implementation. The first evaluation was done one year after the

intervention (January 2011) and the second evaluation was done one and a half years after the intervention (June-July 2011). From these evaluations knowledge was obtained and also missed requirements were identified. The missed requirements were fed-back to action taking phase. Detailed descriptions of the outcomes of the intervention are presented in Paper III and Paper V.

In the specifying learning phase, knowledge gained from the intervention was used to inform the research and practice. This knowledge was gained in all phases of the action-case as depicted in Figure 4.1. The specified knowledge specifically contributes to the HIS for community health workers on how to understand and change the community health workers' information practices. This study also provides practical knowledge to district health managers on ways of improving maternal and child health data reporting from the community. These recommendations include the adaptation of standardised paper-based registers, and improvements on provision of support, supervision and incentives to TBAs and village health workers. Furthermore, this intervention adds knowledge for further development of the DHIS Tracker based on the requirements identified for the community level.

ii. Data Collection:

In this action-case, the mixed method approach was used for data collection. Using this approach, qualitative data were collected in all phases of the action-case. I also adapted a concurrent nested design (Creswell 2003) whereby, qualitative and quantitative data were collected and analysed concurrently during the evaluation phase whereby priority was given to qualitative data. This approach was chosen to help me attain the research objectives by confirming, cross-validating, corroborating my findings and integrating the results obtained from qualitative and quantitative data as a way of strengthening the knowledge claims of this study.

Qualitative data can provide valuable insights on understanding people and the social-cultural contexts within which they live (Myers 1997). This is because they can be collected by getting closer to the people under study whereby a researcher can understand how they create and give meaning to their social experiences. With these qualities, it was necessary to prioritise the collection of qualitative data in order to understand the problem of under-reporting of maternal and child health data from the TBAs' and village health workers' point of view. And hence answer the RQ1. Quantitative data were collected for the purpose of

providing further evaluation of the results obtained after the intervention. Therefore, they supported me in confirming the results obtained in the evaluation phase.

To collect the data different data collection methods were used in each phase of this action-case. Table 4-1 presents the description of the methods used.

Phase	Interviews	Observations		Focus Groups	Document Reviews
		Passive	Participant		
Diagnosis	√	√			√
Action Planning			√		
Action Taking		√	√		
Evaluation	√		√	√	√

Diagnosis Phase

In this phase, data were collected using interviews, observations and document reviews as presented in Table 4-1.

Interviews:

The details of the interviews conducted are summarised in Table 4-2. These interviews were conducted in Kiswahili language between November 2009 and March 2010.

Place		Village health worker	TBA	Public Health Nurse	Nurse-Midwife	Village health workers' Coordinator	TBAs' Coordinator
Community	Village A	6	7				
Health Facilities	Health center A			1	1		
	Hospital A			3			
	Mwembengozi dispensary			1			
	Arumeru District Hospital			3			
District	Kibaha District Council					2	1

At the community, interviews were conducted to TBAs and village health workers with two main objectives: to understand data collected at the community, how and where it was reported and to identify challenges they faced in collection, recording, transferring and storing the information. Formal interviews were conducted to TBAs and village health workers. TBAs were interviewed in individual sessions where the questions were semi-structured. Village health workers were interviewed in groups of two to three using semi-structured questions. These interview sessions were recorded on a voice recorder and they took an average of thirty minutes each.

Health facility workers were interviewed with an objective of understanding how they worked with TBAs and village health workers, and how they supported and supervised them in their daily activities. Informal interview sessions were conducted to health facility workers and

semi-structured questions were used. These interviews were informal because it was difficult to fit myself in their tight schedule, so I would pop-in the health facility during break time or after work and ask a few questions then continue some other day or time. These interviews were conducted to individual health facility workers and were recorded in field notes.

TBAs' and village health workers' coordinators were interviewed on informal sessions using semi-structured questions. The objectives of interviewing this group were to understand how they perceived, valued and supported the contribution of community efforts in reporting maternal and child health data from the community and to assess procedures used for providing support, supervision and feedback to TBAs and village health workers.

Observations:

The aim of conducting observations was to understand activities taking place in the everyday setting in collecting and recording maternal and child health data. During the diagnosis phase I assumed the role of a passive observer whereby without interfering the work I observed activities that were taking place, the environment within which village health workers, TBA and health facility workers operated and the data collection tools they used. In particular, I observed practices in recording information used by village health workers while they were doing household visits, and compiling monthly reports. These observations were conducted in a total of five days with an average of two hours in each day.

Observations were also conducted during interview sessions. The data obtained were recorded in field notes, video camera and still pictures. This information was used to complement the data collected from interviews. With observations, I was able to capture what people were doing that they did not tell during the interview sessions.

Document Reviews:

To further improve the richness of data collected in interviews and observations, several documents were reviewed in the diagnosis phase, these are summarised in Table 4-3. These documents were reviewed to get an understanding of the problem domain, guidelines for collecting and reporting maternal and child health data, what data were collected and reported at different levels and different roles and responsibilities of TBAs, village health workers, health facility workers and district health managers in accomplishing collection, recording and reporting of maternal and child health data. While reviewing the documents, quantitative data was also collected.

As indicated in Table 4-3, at the community level, I reviewed data collection registers used by TBAs and village health workers. In particular, I reviewed twenty TBAs’ delivery registers, 11 village health workers’ notebooks and other registers. At the health facility level, documents were reviewed in one health facility (Health center A). To get a further understanding of the problem domain, at the district level, I reviewed epidemiological and demographic survey reports specifically on maternal and child health. I further reviewed curriculums for training community health workers to get an understanding of what skills they were given and how.

Table 4-3: Documents Reviewed in Diagnosis Phase		
Place	Documentation	Sub-type
Community	Registers	TBA’s delivery register
		IMCI Register
		Family Planning register
		Village health workers’ notebooks
		Village register
Health Facilities	Registers	Ante Natal Care Register
		Delivery Register
		Post Natal Care Register
		Children register
		Family Planning Register
	Client cards	Mother’s Ante Natal Care card (RCH4)
		Child clinic card (RCH1)
		TT immunisation card
		Family Planning card
	Reports	PMTCT for ANC
		PMTCT Maternity (Labour & Delivery)
		PMTCT Child Follow-up
		PMTCT Care
		Family Planning Report
		Indicators Report
		Summary report from ANC Register
		Summary report from Delivery Register
		Summary report from PNC Register
		Summary report from Children Register
Summary report from Children Growth Assessment		
Summary report from Children Immunisation Status		
Summary report from DTC Register		
Districts	Reports	Epidemiology reports
		Country demographic survey reports
	Guidelines	Ministry of Health curriculums for training CHWs

Action Planning Phase

As indicated in Table 4-1, data were collected in the action planning phase by using observations.

Observations:

As a participant observer who was conducting observations while engaging in different activities under study, I assumed a role of a consultant whereby I was involved to share my

knowledge and experiences in this phase. Particularly, I was involved in designing new data collection registers where I contributed on what data should be collected and how they should be presented on the registers. The usage of new data collection registers also involved re-defining rules and roles in the division of labour regarding data collection and recording. These activities were performed by the TBAs' and village health workers' coordinators and the nurse in-charge of Health center A, in collaboration with TBAs and village health workers. I recorded these observations in my field notes.

Action Taking Phase

In the action taking phase, data were collected using observations as indicated in Table 4-1.

Observations:

As a participant observer in this phase, I attended training sessions where I was involved in different discussions where I contributed my views while gaining knowledge. As a consultant, I participated in training sessions where training was conducted to village health workers and TBAs by TBAs' and village health workers' coordinators and Health center A's nurse in-charge. In the TBAs' training sessions, twenty TBAs attended and the training took five days with six hours every day. Village health workers' training sessions included eleven village health workers and they were trained for three days with nine hours every day. The aim of the training sessions were to improve TBAs' and village health workers' skills on collecting and recording maternal and child health data and provision of health services to pregnant women and children. To record the observations made, I used field notes.

In this phase, I also assumed the role of a passive observer whereby without interfering, I observed the training sessions. During these sessions, I observed how training was conducted based on the methods used and the delivery of the instructions from the trainers. I also observed how TBAs and village health workers responded from the training and learning outcomes during the training sessions. Field notes, still pictures and videos were used to record the observations made.

Evaluation Phase

In the evaluation phase, qualitative and quantitative data were collected. Using interviews, observations, focus groups and document reviews as indicated in Table 4-1, I collected qualitative data. Quantitative data were also collected through document reviews by taking counts on the birth registrations and referral cases of delivery made by TBAs.

Interviews:

These sessions were conducted to the same interviewees in the diagnosis phase. The details of the interviews conducted are presented in Table 4-4.

Place		Village health worker	TBA	Public Health Nurse	Nurse-Midwife	Village health workers' Coordinator	TBAs' Coordinator
Community	Village A	6	7				
Health Facility	Health center A			1	1		
District	Kibaha district council					2	1

At the community level, formal interviews were conducted to TBAs and village health workers using semi-structured questions. The objectives of the interview were; to investigate changes/improvements experienced in recording and collecting data after the intervention, and to gather their views on applying new skills gained after training, using new registers and adhering to new roles and regulation in collecting and recording the data.

At the health facility and district levels, informal interviews were conducted using semi-structured questions. Interviews were conducted for the second time in only one health facility (Health center A) that belonged to the village where training was conducted to TBAs and village health workers. The objective was to understand experienced changes after the intervention both on reported data on maternal health and referral cases made by TBAs. At the health center, the nurse in-charge shared with me her observations on how TBAs and village health workers used the new registers given, and adhered to their roles and regulations set during the training. The nurse identified changed behaviours of TBAs in referring women to the health center and recording deliveries and births in the new registers provided after the training. Village health workers also changed their behaviours on working with TBAs, timely reporting, documenting findings and following-up pregnant women. The health center nurse in-charge also used these findings to identify TBAs and village health workers who deserved to be rewarded for good performance after the training.

TBAs' and village health workers' coordinators were interviewed in this phase with two main objectives; to understand how they conducted support and supervision to TBAs and village health workers after the intervention, and to investigate what they learned from the intervention and how they will apply this knowledge in other villages in their district.

Observations:

As a participant observer, I attended meetings where I was involved in different discussions and I contributed my views. I attended two meetings, on the 22nd January 2011 (one year after the intervention) and on 18th June 2011 (one and half year after the intervention). These meetings were conducted at Village A with the aim of evaluating the work done by village health workers and TBAs. In these meetings, the health center nurse in-charge who was assigned the role of supervising village health workers and TBAs in a new organisation of work, gave an overview of what transpired since the implementation of standardised paper-based registers. In these meetings village health workers and TBAs were given incentives and those identified to have outstanding performance were given more incentives. Using field notes, I recorded my observations.

Focus Groups:

One focus group session was conducted in this case to collect data for evaluating the intervention. In this group, there were 9 village health workers where I introduced discussion topics on evaluating their work and the work of TBAs. In the discussion I was able to collect data on changed behaviours and practices among village health workers and their collaborations with TBAs and health facility workers. Data collected in focus group discussion were recorded on my field notes and on the voice recorder.

Document Reviews:

Documents reviewed in this phase are presented in Table 4-5. Findings obtained from these documents were recorded in my field notes and on still pictures.

Place	Documentation	Subtype
Community	Registers	TBA's delivery register
		Children register and referrals
		Village register
Health Facilities	Registers	Ante Natal Care Register
		Delivery Register
		Post Natal Care Register
		Children register
	Reports	Summary report from ANC Register
		Summary report from Delivery Register
		Summary report from PNC Register
		Summary report from Children Register

At the community level, I reviewed similar registers (twenty TBAs' delivery and village register) as the ones reviewed in the diagnosis phase. I also reviewed an additional register (Children register and referrals) that was given to twenty TBAs and eleven village health workers after training, for registering births and referral cases. From the TBAs' registers

(delivery registers and children register and referrals), I noted the number of deliveries recorded, births registered and delivery referrals made from January to December 2010. This was the period after the intervention. I also noted the number of deliveries recorded in the delivery registers from January to December 2009. This aimed at evaluating the application of knowledge gained after the training and re-organisation of practices for data collection and recording.

At the health facility level, documents were reviewed in two health facilities (Health center A and Health center B). I specifically reviewed registers and reports (Monthly and Quarterly) from January to December 2009 and from January to December 2010. In Health center A, where training was provided to village health workers and TBAs, I aimed at spotting out reported deliveries conducted by TBAs, frequency of women attendance at the health center, and accuracy and timeliness of reports from village health workers. In the second health center, Health center B, where no training was provided, I reviewed their reports with an objective of comparing reported deliveries conducted by the TBAs and those done at the health center.

iii. Data Analysis:

In this action-case qualitative and quantitative data were analysed. This analysis guided me in drawing conclusions from the data. To increase validity and reliability of the research as well as richness, depth and scope of the findings, qualitative data were analysed in all phases of the action-case study. I used data reduction, data displays and verifications method as presented by (Matthew et al. 1994). Qualitative data were also analysed using the Activity Theory's concepts of structure of activity (Engeström 1987) during the diagnosis phase and contradictions (Engeström 1987, Engeström and Sannino 2011) during the action planning and action taking phases. The analysis included data recorded on field notes, field diary, voice recorder, videos and still pictures.

The first step in my analysis was to transcribe voice-recorded and video-taped information into written transcripts. The voice-recorded interviews were re-played and notes were taken and written into transcripts. Since most of the interviews used Kiswahili language, I translated them into English while writing the transcripts. By analysing the transcripts, they helped me to question on how much the collected data were answering my research question. This realization gave me a way forward on making follow-up on what was overlooked or what was not clear. In addition to the transcripts, I used my field notes to get a summary of the interviews on what were the main issues discussed, interesting points made, what questions

need to be re-phrased for the next time and what were my reflections. Still pictures taken and field notes recorded during observations, meetings, training sessions and discussions were also analysed. From the transcripts and the summaries I was able to create different categories of my data. These categories defined the main stakeholders, their activities, tools they used and how they used them, the roles they played and their goals.

In the second step of data analysis, I identified themes and trends emerging from the identified categories. Themes identified were: the sequence of activities, flow of information, work practices, supportive supervision, and motivation. In this step I also adopted the Activity Theory to help me define trends and themes from the findings. Using the theoretical concept of structure of activity (Engeström 1987), I elaborated individual components of activity systems for data collection and recording done by TBAs and village health workers (*subject, tools, object, rules, division of labour and community*).

In the third step of data analysis, I identified explanations and different patterns emerging from the themes and trends. Explanations such as weak link in the flow of birth information from the community to the district level, desirable and undesirable work practices, lack of motivation, and health workers' expectations and the reality on the ground. Furthermore, by using the concept of contradictions (Engeström 1987, Engeström and Sannino 2011) I identified manifestations of contradictions within and between the identified components of the activity systems and between activity systems.

In the second and third steps of data analysis, I created different data displays which helped me in organising and presenting my findings in a meaningful way. These displays are presented in Paper I, II and III.

Quantitative data were analysed concurrently with qualitative data by creating summaries of data from field notes and still pictures. This analysis was done during the evaluation of the intervention whereby summaries of data such as the number of deliveries conducted at the health centers as compared to those conducted by TBAs were presented. These summaries were used to support generalisations made on qualitative explanations based on the changes made in information behaviours of TBAs and village health workers towards data collection and recording.

4.2.2. The Case of Implementing a Computer-based Solution at the Health Facility Level

This action-case study was conducted in two districts, Kibaha town council and Bagamoyo, in Pwani region from May 2009 to April 2012. This case aimed at understanding the complexity of work practices of nurses and inscribing them in designing the maternal and child health application. The unit of analysis was the nurses' work practices around collection and recording of maternal and child health data. The actions performed included customisation, implementation and evaluation of the maternal and child health application at the health facility level. These actions aimed at improving the quality and availability of maternal and child health data to support appropriate follow-up on pregnant women throughout pregnancy, delivery and post-natal, and registration of births and follow-up growth status of children up to five years old.

This intervention was conducted following the Participatory Design (PD) tradition whereby nurses were involved in the system design. The design of the maternal and child health application focused on ensuring its usability, promoting desirable work practices, highlighting invisible work and empowering the nurses to utilise the data. To achieve this, I worked cooperatively with the nurses in defining the system requirements that reflected their daily lived practices. These requirements were guided the customisation of DHIS tracker. To facilitate the customisation process, I also worked with a programmer who did the programming work. My role was to collect all the necessary requirements on the field, work with the programmer to put them in the application, train the nurses, test the application with the nurses and collect more requirements as the application was used.

This intervention was done as a pilot implementation where the system was installed in one health facility (Health center C) and it was used in parallel with the current paper-based system. In the pilot site data were entered by nurses after their working hours and not on direct encounters with their clients. The system could operate at the point of service delivery; however it was not used as intended because of its infant stage in development. Furthermore, with a high number of clients, recording both on paper and on the computer could compromise provision of the health services. In this regard, data were entered into the computer application one week to one month after the provision of the services.

i. Action Research Phases:

In this action-case, the study followed four phases as presented in Figure 4.2.

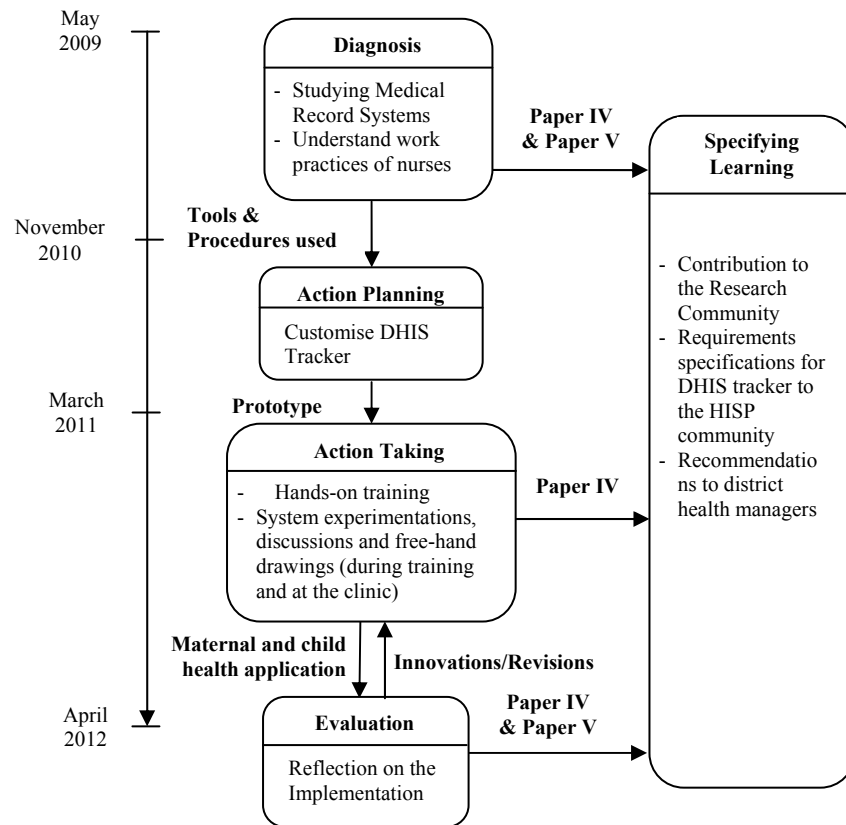


Figure 4-2: Phases and the timeline of the study at the Health facility Level

Figure 4-1 demonstrates a general picture of the period when the activities were conducted in the field. There were overlaps and back and forth movements between phases. I also detached myself from the field occasionally. Particularly, I spent a total of fourteen months in the field.

In the diagnosis phase, I aimed at gaining a broader understanding of electronic and paper-based medical record systems used in different contexts. I also aimed at understanding the work practices of nurses in providing maternal and child health care in health facilities in Tanzania by focusing on what data were collected, and registers and procedures used around these activities. In this situation the case study approach was employed to get an understanding of the practices from the nurses' perspectives and their own language. This diagnosis also incorporated results obtained from the first action-case. Paper IV and Paper V present results obtained from this phase. I performed activities in this phase while attending lectures in Norway and Malawi, and conducting the first action-case.

In the action planning phase, an intervention was planned to improve the problems identified in the diagnosis phase. In this phase, I started customisation of the DHIS Tracker whereby a system prototype was designed from November 2010 to March 2011. The prototype did not

represent the fully functional system, some functionalities were planned to be incorporated at a later stage of the fieldwork. These functionalities included the use of a mobile phone client to collect data at the community level and the functionality of sending SMS messages to clients. These functionalities were planned to be implemented after the database was fully operational with all the necessary requirements in-place. The prototype was designed in collaboration with a programmer from the HISP Tanzanian team and it was based on the preliminary study conducted that described the ideal system.

In the action taking phase, as described in Paper IV, hands-on training was conducted to fourteen health facility workers from two health facilities. The application was planned to be implemented in the two health facilities, however due to time limitations and the large amount of work to be done in both refining the system design and providing support and supervision, the application was implemented in one health facility (Health center C). From Health center C, seven health workers attended the training. These were four nurses, one health center doctor in-charge and two HMIS focal persons from the district. Of the seven health workers, I continued to work with four nurses at the health center. These nurses were the main staff providing the maternal and child health services. Since this was the first time for most of the trainees to use computers, this training included basic computer training before the prototype was introduced. During the training, the trainees experimented with the system prototype to exercise computer skills gained and to learn how to use the system. In addition to system experimentations, prompted reflections technique was used to initiate discussions and creation of free-hand drawings to demonstrate lived practices in provision of the service. These experimentations, discussions and free-hand drawings continued at the Health center C after the training when the nurses were using the system. The demonstrations of these techniques are presented in Paper IV.

After the training, a maternal and child health application was designed. The application was a revision of the prototype that incorporated insights gained from the trainees. These insights described how work was actually done as opposed to the ideal system that was represented in the prototype. The application was then installed to be used at a maternal and child health clinic in Health center C. At the clinic, I continued to provide close support and supervision to the nurses, and to learn from the nurses about how their work was and how it should be represented in the system. In this manner, the design of the application was undergoing revisions as the nurses were becoming more familiar with the technology. In this phase, users were also given incentives to facilitate their participation in the implementation and

encourage them to use their spare time to experiment with the system. In this phase, I spent a total of ten months in the field; from March – April 2011, June-July 2011 and November 2010 – April 2012.

The reflections on the implementation were done in the evaluation phase. This evaluation focused on assessing the system design based on how it represented the nurse’s work. When new innovations or revisions on the application were identified, they were fed-back into the action taking phase. If these innovations and revisions were identified as missing requirements in the core design of the DHIS tracker, they were sent to the global HISP team for further development. Missing requirements identified to be misunderstood practices on the ground that needed to be re-studied were sent back to the action taking phase. In particular, the application was undergoing design and testing at the same time. Further details on what transpired in this phase are presented in Paper IV and Paper V.

From the intervention, learning was specified to the research community and practice not only after the evaluation of the intervention but also throughout this action-case study as presented in Figure 4-2. This study contributed to the PD community on the application of different techniques to support mutual learning. The learning outcomes were also requirements specifications for designing the maternal and child health application for the Tanzanian context, which were presented to the HISP global team for further development of the DHIS Tracker. This intervention also illustrated a practical example to the district health managers of using a technology that can facilitate the nurses in providing maternal and child health services.

ii. Data Collection:

In this action-case qualitative data were collected. This approach was taken in order to gain insights on the clinical work and knowledge gained throughout the design and implementation of the maternal and child health application. According to Myers, qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live (Myers 1997). Table 4-6 summarises different methods for data collection employed in each phase of this action-case study.

Phase	Focus Groups	Interviews	Observations		Document Reviews
			Passive Observations	Participant Observations	
Diagnosis	√	√	√	√	√
Action Taking				√	
Evaluation		√			√

Diagnosis Phase

In this phase data were collected using focus groups, interviews, observations and document reviews as indicated in Table 4-6.

Focus groups:

In this phase, data were collected using focus groups which were formed during a workshop session. The aim of this workshop was to gather different views from health workers at the regional, district and health facility levels on how they collaborated in reporting, supervision, support, provision of feedback and handling referral cases in maternal and child health care. The workshop was held in January 2010 and the participants were selected by the districts management to whom I sent the letters to request for participants. This workshop was crucial for the success of this study because it was the platform for me to introduce my study, getting to know who to work with and the prospects for conducting the study. Table 4-7 presents the summary of participants of the workshop.

Table 4-7: Workshop Participants	
Place	Participants
Pwani Region	
Regional Office	1. Regional In-charge
Kibaha District Council	
District Office	2. Aggregated Reproductive and Child Health Coordinator
	3. Aggregated District Nurse Officer
	4. District Cold Chain Officer
	5. Aggregated District IECD
Health center A	6. Nurse Midwife –Nurse in-charge
Health center D	7. Nurse Midwife – Enrolled Nurse
	8. Data Clerk
Mkoani Town Council	
Health center C	9. Public Health Nurse
	10. Public Health Nurse
	11. Doctor in-charge
Bagamoyo District Council	
District Office	12. Aggregated Reproductive and Child Health Coordinator
	13. Aggregated District Nurse Officer
	14. Aggregated District IECD
Hospital A	15. Public Health Nurse
	16. Public Health Nurse
Health center E	17. Nurse Midwife – Enrolled Nurse

Each focus group had three to four participants where there was a mix of a nurse, doctor and district manager. I prepared discussion topics based on aspects of service provision, data collection and reporting, handling referral cases and provision of support, supervision and feedback from district health managers to health facility workers. Findings from these discussions were recorded on my field notes, flip charts and videos. The findings were also used in designing the system prototype.

Interviews:

Interviews conducted in this phase are summarised in Table 4-8. All the interviews were conducted using Kiswahili language with exception of the ones conducted in Norway. The interviews were conducted between May 2009 and March 2010 and were recorded in field notes.

Place		Public Health Nurse	Doctor In-charge	Data Clerk	HMIS Focal Person	Developer/ Technical Support
Health Facilities	Health center C	4	1			
	Hospital A	3				
	Mt. Meru Regional Hospital				1	
	KCMC hospital			1		
Districts	Mkoani Town Council				2	
	Bagamoyo District Council				1	
	Arumeru District Council				1	
Norway	Medisinsk fødselsregister - Bergen					2

At Health center C and Hospital A, interview sessions were conducted to the same nurses who participated in the workshop, as depicted in Table 4-8. These were informal interviews whereby semi-structured questions were used. Interviews were conducted with an objective of understanding work practices of the nurses in recording data on different clinic visits and management of these visits, what data collection tools were used, and procedures employed in retrieving information for follow-up and provision of care. The main focus was to understand the interplay between formal (defined by the MoHSW) and informal (locally defined) routines and tools used by the nurses in their daily routines.

At Mt. Meru Regional hospital, HMIS focal person who was the link between the region and the ministry was interviewed to gain their experiences on using and managing manual and electronic systems that operated in parallel. At the referral hospital, KCMC, they had a working medical record system for birth registrations that was used for over a decade. I interviewed the data clerk in-charge of the system with the objective of understanding how the system was designed, implemented, sustained, evaluated, what works and what doesn't work. Furthermore, I interviewed the developers and technical support personnel of the system who were situated at the medical birth registry in Bergen, Norway.

At the district level, HMIS focal persons were involved in informal individual interview sessions which had semi-structured questions. These were the staff responsible for data collection and management for the district. The objective of conducting these interviews was to investigate how they used DHIS2 to aggregate reports from health facilities and utilize the

data, and their views on the implementation of maternal and child health application at the health facility level.

Observations:

In this phase, observations were conducted with the aim of understanding work practices of nurses. I also aimed at understanding development, implementation and management of electronic medical record systems. At the health facilities, as a passive observe, I observed activities that nurses performed together with the tools and procedures they used to accomplish these activities. I observed the nurses during provision of maternal health services in antenatal, postnatal and children clinic sessions. The objective was to understand their practices in interviewing mothers, recording data while providing services and referring mothers and/or children to hospitals.

I also conducted observations in Malawi whereby I observed the developers at their office and when they provided training, support and supervision to users in health facilities where the Baobab's openMRS system was operating. Similar observations were done at the KCMC birth registry section. To document these observations, I used field notes, videos and still pictures to capture events, notice board articles and interesting displays on walls.

During the diagnosis phase I also assumed the role of a participant observer during the workshop session. As a workshop facilitator, I organised and conducted all the workshop activities. In this workshop I was involved in discussions where I shared my knowledge and experiences. Data were recorded in my field notes and videos.

Document Reviews:

Documents reviewed in this phase are presented in Table 4-9. Using still pictures and field notes, findings obtained were recorded.

Table 4-9: Documents Reviewed in Diagnosis Phase		
Place	Documentation	Sub-type
Health center C	Registers	Ante Natal Care Register
		Delivery Register
		Post Natal Care Register
		Children register
		Family Planning Register
	Client cards	Mother's ANC card (RCH4)
		Child clinic card (RCH1)
		TT immunisation card
		Family Planning card
	Reports	PMTCT for ANC
		PMTCT Maternity (Labour & Delivery)
		PMTCT Child Follow-up
		PMTCT Care
		Family Planning Report
		Indicators Report
		Summary report from ANC Register
		Summary report from Delivery Register
		Summary report from PNC Register
		Summary report from Children Register
Summary report from Children Growth Assessment		
Summary report from Children Immunisation Status		
Summary report from DTC Register		
Ministry	Guidelines	Ministry of health guidelines for data entry

As summarised in Table 4-9, documents reviewed at the Health center C were formal tools that were used in all public health facilities in the country. Registers ranged from old to new registers. When this study was conducted the MoHSW was revising the current registers to accommodate new requirements. The nurses received training on the new registers but they were not supplied to the health center. When I started my fieldwork, I reviewed the old registers (that were in use) the new registers were reviewed in the later stage of the fieldwork. The new registers were introduced by the ministry as a pilot implementation in January 2011 and they started to be used in January 2012. I also reviewed locally improvised registers that were created by nurses to be used locally. The improvised registers were only known and understood by the nurses who designed them.

Pregnant women and children clinic cards were also reviewed at the health center. These cards contained personal information which the clients moved with them and no other similar record was kept in the health center. I also reviewed monthly and quarterly reports generated at the health center and other reports created by the nurses for local utilization of their data.

At the ministry level, I reviewed guidelines for entering data in each register and report forms. These were in-line with the DHIS2 guidelines. They indicated what data to be entered and the

minimum and maximum values allowed for each entry. The guidelines were incorporated in designing the prototype.

Action Taking Phase

In this phase data were collected through observations as indicated in Table 4-6.

Observations:

As a participant observer, I collected data during the training sessions. The aim of this training was to familiarise health facility workers with the system prototype and to evaluate its design. This training was a hands-on training where the health facility workers started to learn how to use computers and the prototype. When they encountered misrepresentations of their work in the system and system breakdowns, discussions were conducted and free-hand drawings were created to clarify how things were done and to describe different scenario. Similarly, for technical matters I took charge to provide explanations. These discussions led to a mutual understanding which was taken as a benchmark for designing the maternal and child health application. Data collected during the participant observations were recorded in field notes.

Evaluation Phase

In this phase, data were collected using interviews and document reviews as indicated in Table 4-6.

Interviews:

Table 4-10 presents a summary of interviews conducted. These sessions were conducted to the same, but not all, interviewees during the diagnosis phase. These interviews were conducted in January 2012 and the findings were recorded in my field notes.

Table 4-10: Interviews Conducted in Evaluation Phase				
Place		Public Health Nurse	Doctor In-charge	HMIS Focal Person
Health Facilities	Health center C	4	1	
District	Mkoani Town Council			2

Informal individual interviews that used semi-structured questions were used at Health center C. These interviews were conducted after the implementation of the maternal and child health application with an objective of investigating what was learned by the nurses and doctor in-charge from the implantation.

At the district level, HMIS Focal Persons were interviewed in informal sessions that used semi-structured questions. The objective was to obtain their views on the use of the application at the health facility level.

Document Reviews:

Documents reviewed in this phase were locally improvised register for data entry. This was a register created by the nurses, after the intervention to support them in bridging the gap between several registers they used and the data entry form in the computer. This register merged all the other registers they used. I used still pictures to record these findings.

iii. Data Analysis:

In this action-case, I analysed qualitative data collected by using data reduction, data displays and verifications method as described by Matthew et al. (1994). This method helped me to organise and present my data in such a way that I could draw strong conclusions from the data. However due to time limitations, not all the data collected were analysed, the analysis done focused on providing insights on the process of requirement specifications for designing and further revising the maternal and child health application.

In this analysis, I created categories by summarising field notes recorded during focus group discussions, interview sessions, observations, and document reviews, and from still pictures, videos and flip charts. One category was the divisions of stages (time intervals) and specific check-ups, vaccinations and medications provided in each stage. This analysis led to the specification of data elements required for designing the data structure and interfaces. Another category was the collaborations between the designers and the nurses through the application of different techniques in system development. This analysis highlighted the knowledge gaps and language differences between the designers and the nurses.

The identified categories showed trends emerging from the data. The major trend noted was how and when designers and users learned individually and mutually through the application of different techniques in the development of the maternal and child health application. Data display on the identified trend is presented in Paper IV.

4.3. Study Limitations

The methodology applied in this study has influenced interpretation of the results and generalisations made in the findings. In particular, the research design and action-case study approach applied have posed some limitations in this study. These are described in this section.

Particularly in conducting this study in the community segment of the healthcare hierarchy it was challenging to work with TBAs and village health workers. This is because they were informally and politically recognised by the health facility workers and district health

managers, and most of the work was done using informal procedures and informal standards. It was also difficult to get them for discussions and meetings without the consent of the health facility workers, village government and district health management. These constraints limited the information they shared with me, and how often and for how long we could meet.

Also the informal and political nature of TBAs' and village health workers' work made it difficult to pin-down their exact roles and motives for collecting and recording maternal and child health data. Even though I tried to understand their work, this study is convinced that some of the work they did has remained invisible.

Furthermore, the research design created limitations towards requirements specification for the maternal and child health application designed. The decision for adapting a specific software standard, DHIS Tracker, was already established before understanding the local requirements and information needs of the health workers. Since the identified requirements were guided by what the system could offer, much more about the nurses' practices could not be openly and fully explored in this study.

The adapted research approach has also posed limitations in conducting this study. While I was leading the intervention in Tanzania, I also had other commitments as a PhD student such as to publish papers, write thesis and attend lectures, and participate in international conferences and workshops. To accomplish these activities I needed to detach myself from the fieldwork from time to time. As a result, some of the activities stopped in my absence during the second action-case study. In that action-case, I could not be fully present in the fieldwork during the action taking phase. Consequently, when I went back the nurses had forgotten their passwords, meaning that they never used the system in my absence. Similarly, when I completed the time for my fieldwork, the project came to a halt.

Based on these experiences, I think that the application of action-case study can be beneficial if a researcher has enough time to conduct the research and to immerse herself in the process. The full essence of the actions and their outcomes can likely be missed from the detachments. On the other hand, I had a different experience from the first action-case study where my absence did not affect the intervention activities. In that case, I was not the only one driving the process, the intervention was also led by the health center's nurse in-charge and the TBAs' and village health workers' coordinators. It may be appropriate to conduct an action-case study where the intervention activities are steered by both the researcher and the practitioners.

4.4. Research Ethics

To maintain scientific ethics in conducting this research, I acquired a research permit from the National Institute for Medical Research (NIMR). The copies of the research permits are appended in Appendix 6. Also the purpose of the research was made clear to all the involved parties before I started the research.

In addition, I maintained the health worker's trust by presenting them and their health facilities anonymously in this research.

CHAPTER 5: Empirical Findings

In this chapter I present the findings of this study. The chapter is divided into two sections. The first section provides the summary of findings as described in the papers. In the second section I present the summary of key findings that answer my research questions.

5.1. Summary of Papers

Table 5-1 provides a brief summary of the papers whose findings were derived from different phases of the action-cases conducted.

Action-cases	Diagnosis	Action Planning	Action Taking	Evaluation
Community Level	Paper I & Paper II	Paper II & Paper III	Paper III	Paper III & Paper V
Health Facility level	Paper IV & Paper V		Paper IV	Paper IV & Paper V

5.1.1. Paper I

Ngoma, C., Chawani, M. S., Herstad, J. (2010). Adaptation of Mobile Application to Improve Flow of Birth Information from the Community to the District Level. *2nd International ICST Conference on E-Infrastructure and E-Services for Developing Countries: AFRICOMM 2010*. R. Popescu-Zeletin et al. Cape Town, South Africa, Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. 64: 79-92.

This paper provides an overview on the management of maternal and child health data at the community level. It presents current practices of TBAs, village health workers, health facility workers and district health managers in collecting, recording, storing and transferring the data from the community level. The paper also presents the underlying problems that constrained proper collection and reporting of the data and propose recommendations to improve the situation.

Findings indicate that most of the current practices hindered flow of the data from the community to the rest of the HIS. Undesirable practices such as provision of insufficient support, supervision, and feedback from health facility workers and district health managers to TBAs and village health workers, late reporting of data collected by village health workers, non-reporting of births from TBAs and the use of un-standardised registers among village health workers enhanced under-reporting of the data.

Findings also specify potentials of using mobile phones as a tool for data recording, transferring and for strengthening the provision of reliable and timely support, supervision and feedback to TBAs and village health workers. The paper proposes that, improvements and formalisation of using mobile phones among and between TBAs, village health workers, health facility workers and district health managers can create opportunities for fast and timely transfer of information, and strengthen communication channels for providing support, supervision and feedback. This is also perceived to motivate TBAs and village health workers to collect accurate and complete data, and report it on time.

This paper also presents envisioned potentials for village health workers to use mobile phones to record individual-based information on births conducted by TBAs and send it to a database (medical birth registry) placed at the health center. By having all the data stored in the database, health facility workers can compile aggregated (monthly, quarterly, yearly) reports for their own utilisation and for further reporting to the district by sending them electronically and/or manually. The database can also provide opportunities for sharing the data with different stakeholders such as district health managers, district and referral hospitals, district registrar of births and deaths for vital registration, and vertical programs.

5.1.2. Paper II

Ngoma, C. and F. T. Igira (2012). Contradictions in Collecting and Recording Maternal Health Data at the Community Level: A Case study from two Districts in Tanzania. *Journal of Health Informatics in Developing Countries*, 6(2): 509-520.

From the previous study (as presented in section 5.1.1.) that identified the presence of undesirable practices among TBAs, village health workers, health facility workers and district health managers, this paper provides new knowledge on how to improve collection of complete, accurate and timely reporting of maternal and child health data in the health information system by changing these practices. The paper underscores what hindered TBAs and village health workers from collecting, recording and reporting of the data by identifying contradictions that manifested in performing these activities.

The results indicate manifestations of contradictions through double binds, dilemmas, critical conflicts and conflicts hindered the TBAs and village health workers to collect and record the data. The resolutions of these contradictions are described to be a springboard for improving reporting of the data. The manifestations of contradictions and their proposed resolutions are summarised in Table 5-2.

Table 5-2: Manifestations of Contradictions and their Proposed Resolutions			
Manifestation	Features	Indicative Findings	Proposed Resolution
	TBAs and village health workers faced unacceptable alternatives in recording and collecting maternal health data	Inadequate and/or lack of means to perform the activity such as not having delivery registers, use of un-standardised registers, not having reading, writing and medical skills, limited stationeries, unreliable transport means and receiving no incentives.	<ul style="list-style-type: none"> - Introduce new and improved <i>tools</i> (standardised registers, stationeries, transport means and incentives) - Ensure adequate supply of the <i>tools</i> - Provide training to improve skills
Dilemmas	TBAs and village health workers faced incompatible evaluation on whether to recording and collecting maternal health data or not	<ul style="list-style-type: none"> - TBAs were torn between helping women and gaining income, and recording deliveries. -Village health workers were torn between voluntary workers with no income, and recording and reporting information as a responsibility of a village health worker 	<ul style="list-style-type: none"> - Translating the directed goals for performing the actions to a motivating goal by rewarding TBAs and village health workers to record data instead of ordering them to record - Re-defining the <i>rules</i> enforced and distribution of roles in the division of labour
Conflicts	Unpleasant working relation between TBAs and health facility workers	TBAs referred women with critical conditions to the health center and when confronted, they stopped referring women and also did not record deliveries	Re-defining the roles in the <i>division of labour</i> and <i>rules</i> to open-up communication among and between TBAs, village health workers, health facility workers, women and village members whereby the use of mobile phones is one thing that can facilitate the communications.
Critical Conflicts	TBAs and village health workers were unmotivated to perform any actions in their activity systems	Inadequate and irregular provision of support, supervision and feedback to village health workers and TBAs by health facility workers and district health managers	Re-defining the roles of health facility workers and district health managers in providing support, supervision and feedback

Contributing to research on HIS in developing countries, this paper describes the importance of using Activity Theory to understand the underlying problems that lead to poor collection and under-reporting of maternal and child health data. And hence derive resolutions to improve reporting of the data from the community level. Through the analysis of the *tools* used, *rules* enforced and organisation of roles in the *division of labour* by TBAs and village health workers, one can gain insights on how the data are collected, contradictions that manifest therein that hinder the flow of work and propose their resolutions.

5.1.3. Paper III

Ngoma, C. and Igira, F. T. (Forthcoming). Re-organising Collection and Recording of Maternal and Child Health Data through an Intervention of Resolving Contradictions. *Submitted to an International Journal*.

This paper presents an intervention study that aimed at re-organising work practices of community health workers and health facility workers in collecting and recording maternal

and child health data in the community. Building on Paper I and Paper II, the proposed resolutions of the contradictions guided the intervention. This re-organisation was accomplished by the introduction of new and improved *tools*, and new and redefined *rules* and roles in the *division of labour* in the activity of data collection and recording. The intervention also included empowering TBAs and village health workers to collect and record the data.

The intervention comprised of training, designing data collection registers, and introducing an incentive mechanism to TBAs and village health workers. Results indicate that TBAs and village health workers adapted new information practices, which led to improvements in recording and reporting of births, deliveries, follow-up on pregnant women and an increase of referred women for deliveries to the health center. However no efforts were made towards recording data in the village register.

Contributing to the HISs in developing countries, this paper suggests that, a change in data collection and recording practices of TBAs and village health workers can be achieved by creating a motivation towards collecting and recording maternal and child health data. Reflections on the intervention indicate that, to improve their performance and confidence in capturing and communicating these data, TBAs and village health workers should be provided with standardised data collection registers, appropriate skills through training, and creation of appropriate means for sharing information among district managers, health facility workers, TBAs and village health workers. These attributes signify creation of a new context where new/changed practices can take place. In this new context, reporting of maternal and child health data can be improved.

Concerning data collection registers for TBAs and village health workers, this study points to a special consideration on the design of the registers. Findings indicate that, unlike ordinary registers, these registers should focus not only on collecting data for reporting purposes but also on recording their work performance. This will enable them to show their contribution in a way that it can be measured and rewarded by the health facility workers and district health managers.

5.1.4. Paper IV

Ngoma, C. (Forthcoming 2014). Mutual Learning in Designing a Maternal and Child Health Application: A case of One Health Center in Tanzania. *Accepted for Publication in the Scandinavian Journal of Information Systems*, 21(1).

This paper presents an intervention conducted at a RCH clinic in one health center. This intervention included customisation of DHIS Tracker, training to use computer and the maternal and child health application and implementation of the application in the clinic. Findings of this study indicate that the design and implementation of the application was challenged by wide knowledge gaps between designers and users. Designers had little knowledge about the domain and the nurses had little knowledge about the technology. To close these gaps, this paper proposes the use of techniques that will support users to learn IT skills, designers to learn about users' work and promote a mutual development of a vision of a new system. This study also proposes prerequisites to be followed in order to achieve mutual learning as well as potential periods during system development where mutual learning should be supported when there are wide knowledge gaps.

By applying techniques such as interviews, observations, focus groups, document reviews, hands-on training, system experimentations and prompted reflections findings indicate that learning occurred during system design, implementation and post-implementation periods. The nurses gained knowledge on how to use the system, the designers gained an understanding of nurses' tasks and work practices, and together they cooperatively learned how the nurses' work should be represented in the system. A more concrete knowledge was acquired during the post-implementation period as compared to the system design and implementation periods.

Findings also indicate that, it is difficult to achieve mutual learning when there are wide knowledge gaps between users and designers. In this study mutual learning was achieved through the application of prompted reflections technique. This technique was possible to be used after two things happened. First the nurses received hands-on training and had started to experiment with the system in a real-life environment. Second, the designers have become aware, to some degree, of the users' tasks and work practices. This knowledge was acquired during the system design and post-implementation periods. This approach was different from the traditional way presented by Kensing (1998) and Bødker et al. (2004) whereby the technique was used during system analysis and design.

Furthermore, the paper presents that ethnographic techniques and prototyping did not support mutual learning. Using ethnographic techniques, the designers gained an understanding about how the nurses' work was supposed to be done, which was far from the reality on the ground. Also due to the fact that the nurses' did not have basic IT skills, they could not be involved in designing the prototype together with the designers. Hence this paper describes that in a

setting where there are wide knowledge gaps between the designers and the users, it is necessary to support mutual learning not only during system analysis and design, as proposed by PD literature, but also during and after system implementation.

Moreover, this paper shows an innovative attempt whereby the nurses designed a paper-based register that they used as an intermediary register between the computer and the registers they used. Since the data entry interface on the computer combined all the data elements used in different registers, the nurses' design integrated all the registers to simplify data entry. This innovation calls for a need for further research on computerising paper-based systems. Particularly in designing intermediary representations that can bridge multiple registers with one data entry form on the computer.

5.1.5. Paper V

Ngoma, C., H. Kimaro, et al. (2012). Challenges in Implementing a Computerized Name-based Information Tracking System: Practical Experiences from Maternal Health Care. *IST-Africa 2012 Conference Proceedings*. P. Cunningham and M. Cunningham. Zanzibar, Tanzania, International Information Management Corporation.

This paper provides an overall summary of my research with a specific focus on presenting challenges faced by the researcher in requirements specification, designing and implementing the maternal and child health application. These challenges were; understanding the complexity of local healthcare practices and how they related with standardised and improvised data collection registers used, application of localised and standardised procedures in healthcare provision, replacing the paper-based system and lastly nurses' gradual learning curve during the implementation.

From the experiences gained on the field, this paper provides knowledge to information system designers and implementers. It recommends a critical necessity of acquiring an understanding of the real life work practices of health workers at community and health facility levels. These practices can reveal how work is done since health workers provide healthcare services while adhering to standardised (formal) and localised (informal) procedures.

Findings also indicate that health workers rely on the use of improvised registers in performing their daily activities. In designing system to support the lived practices the improvised registers must be taken into account because they reflect the daily practices better than the standardised data collection registers.

5.2. Summary of Key Findings

Table 5-3 presents the summary of key findings that answered the research questions. These are presented in details in Chapter 6.

Table 5-3: Summary of Key Findings		
Research Question	Paper	Findings
RQ1: What are the underlying contradictions in collecting and recording maternal and child health data at the community level and how can they be resolved?	Paper I	Collected and managed of maternal and child health data are at the community level – Tools used, stakeholders involved and activities and goals
	Paper II	Using the Activity Theory to analyse the practices identified in Paper I, the findings presents manifestations of contradictions and their proposed resolutions.
	Paper III	The resolutions suggests creation of a new work context with motivating and facilitating conditions where new/changed practices for data collection and recording can take place. In this context, TBAs and village health workers should be empowered to collecting and recording maternal and child health data. They should also be provided with standardised data collection tools, appropriate skills through training, and appropriate means for sharing information among district health managers, health facility workers, TBAs and village health workers
RQ2: Which participatory design techniques will support mutual learning where wide knowledge gaps exist between users and designers?	Paper IV	<p>Nurses in their daily practices adhered to the use of standardised (formal) and localised (informal) procedures and data collection tools. In this manner their work involved detours and work-arounds to accommodate provision of services with available personnel, medications and vaccines.</p> <p>Through PD approach in designing and implementing the system, the domain knowledge and technology gaps between designers and users were bridged. This can be possible through the application of techniques such as hands-on training, system experimentation and prompted reflection in a particular sequence. For the success of prompted reflections, users should first be given hands-on training and then experiment with the system.</p> <p>To support mutual learning when there are wider knowledge gaps, post-implementation learning should be encouraged to help users and designers to cooperatively develop a mutual vision of the future system</p>

CHAPTER 6: Discussion and Contribution

I conclude my thesis in this chapter by discussing the results and my research contribution. The chapter has two sections; the first section presents answers to the research questions, and the second section presents the research contributions.

6.1. Answering Research Questions

In this section, I provide answers to the posed research questions. The section is divided into three sub-sections; first I answer the two research questions then I provide the summary of the section.

6.1.1. RQ1: What are the underlying contradictions in collecting and recording maternal and child health data at the community level and how can they be resolved?

In IS research, according to Orlikowski & Baroudi (2002), work practices are social realities that are “understood to be reproduced through ongoing interactions” (Orlikowski and Baroudi 2002). These interactions can be recognized not only through individuals’ lived activities, but also through the artifacts they use, purposes for performing the activities, and other related activities and people in the setting. With an Activity theory perspective that people and activities they perform cannot be understood without understanding the context in their everyday actuality (Kuutti 1996, Kaptelinin and Nardi 2006), this study brings knowledge to the IS community on understanding how maternal and child health data are collected and managed in rural communities and hence improve reporting of the data.

The collection and management of data in HIS has been reported by previous research in a similar context (Kimaro 2006, Kimaro and Twaakyondo 2006, Igira 2008). These studies have shown that at the health facility levels data collection and management is engrained in practices of health workers who have poor skills for data collection and management, who are overworked and unmotivated, and the disparities between the changing requirements whose implementation was delayed. These practices deterred the quality of data. These studies however have overlooked the fact that data collected in the health facilities also comprises of the data collected from the community levels, particularly in rural communities. Understanding how data are collected and managed at the community level will necessarily bring insights on improving its quality.

To build on previous research this study emphasizes the necessity of strengthening the quality of data collected at the community level as a way of improving the quality of health facility

data by specifically considering the nature of provision of maternal and child health services in rural communities. I have shown ways that can be used to identify what causes under-reporting of data from the community level and propose ways of improving reporting of the data. Specifically, I answer this RQ1 by describing manifestations of contradictions that hindered collection and recording of the data and the proposed resolutions. The resolutions are established as ways of changing information behavior towards data collection and recording.

i. Contradictions in Recording and Collecting Data:

Findings of this study, as presented in Paper I, indicate a state of poor collection and under-reporting of maternal and child health data at the community level. This was a result of complex relationships that existed between the data collectors (TBAs and village health workers) and other stakeholders who were involved in facilitating and supervising the activities of TBAs and village health workers. To understand these relationships the Activity Theory's concepts of structure of activity (Engeström 1987) and contradictions (Engeström 1987, Engeström and Sannino 2011) were used to analyse the work of TBAs and village health workers. In this analysis, I identified components of the activity systems of data collection and recording as it was carried out by TBAs and village health workers. Furthermore, I identified manifestations of contradictions within and between the components of activity systems, and between the networks of activity systems.

Results as presented in Paper II and Paper III indicate that in the activity systems of TBAs and village health workers, there were multiple views about the *tools* used (who controls the means for performing the activity), the *division of labour* (who does what and when), and *rules* enforced on the activity of data collection and recording. In retrospect, the *tools* used, the *rules* enforced and the *division of labour* were produced by a management activity system, the Health Management Information System (HMIS). As a result, the TBAs and village health workers were driven by two incompatible goals (motivating and directed) in collecting and recording the data. The motivating goal was to gain income and to help women for the case of TBAs and to gain reputation for the case of village health workers. The directed goal for the TBAs was to have records on the deliveries conducted and for the village health workers was to record and report the data. This was a goal directed to them by the HMIS activity system

Consequently, the multiple views together with the incompatible goals in collecting and recording maternal and child health data led to contradictions which were manifested through double binds, dilemmas, critical conflicts and conflicts (Engeström and Sannino 2011). Figure 6-1 depicts a summary of the identified contradictions.

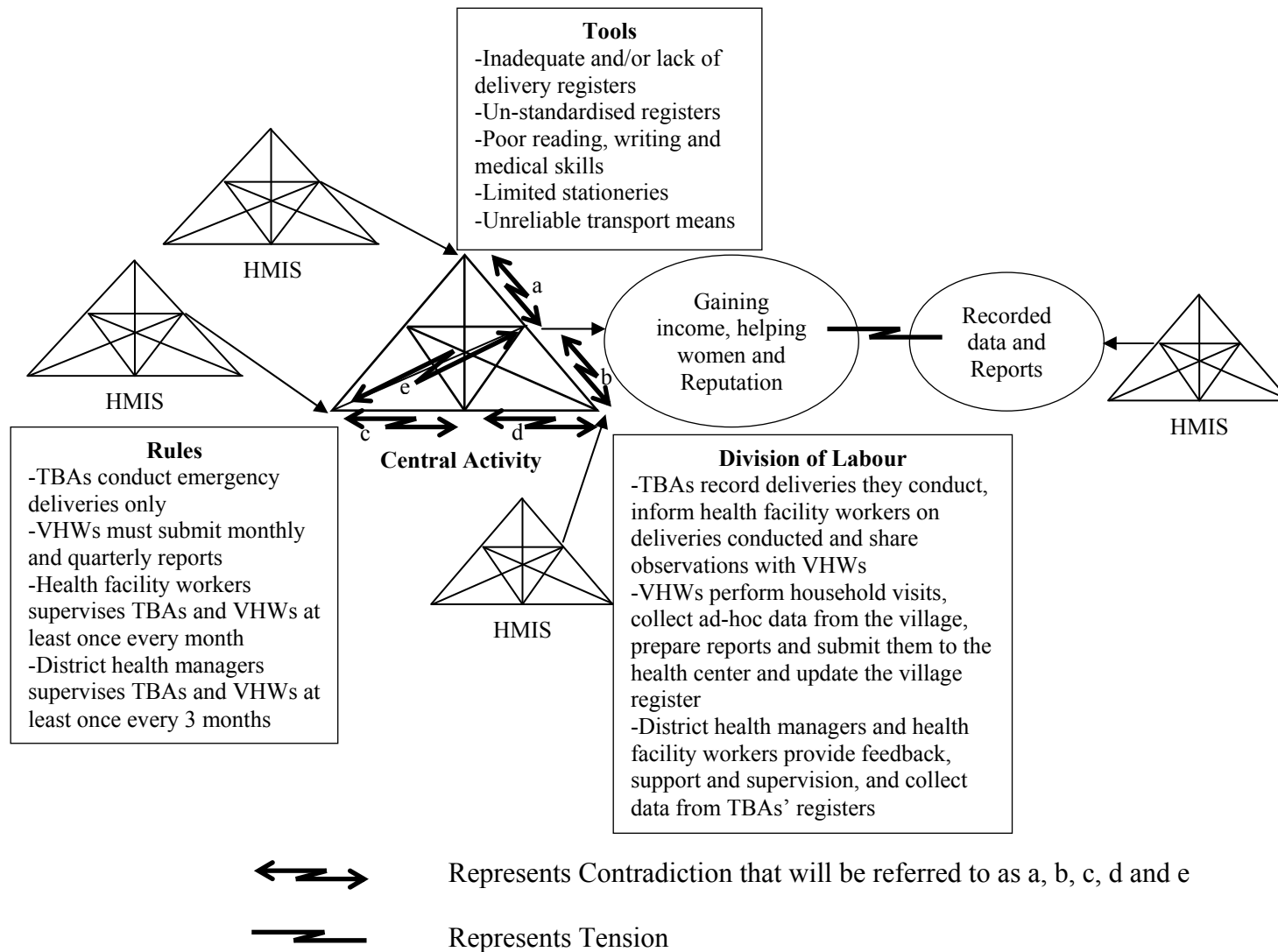


Figure 6-1: Contradictions in Collecting and Recording the Data at the Community Level

As depicted in Figure 6-1, the central activity represents the activity systems of TBAs and village health workers in collecting and recording maternal and child health data. Analysis indicated that in recording and collecting the data, tensions emerged between the *object* of the central activity system and the *object* of the HMIS activity system. These resulted into primary contradictions that were identified within the *object* of the central activity system. The contradictions were manifested through dilemmas whereby TBAs and village health workers had to choose to record the data or not. In cases where they chose to record the data, findings indicate that they were faced with unacceptable conditions (double binds) and critical conflicts that discouraged them to record the data.

The double binds and critical conflicts were a result of available *tools* to perform the activity, established *rules* and regulations, and organization of roles in the *division of labour* that hindered them to perform the activity. Hence, secondary contradiction emerged between the components of the central activity system (depicted as a, b, c, d and e in Figure 6-1). Another primary contradiction was identified within the *division of labour* in the TBAs' activity system. This contradiction manifested as a conflict between TBAs and the health facility workers when TBAs brought women in critical conditions to the health center after failing to help them.

The presence of primary and secondary contradictions identified showed that the TBAs' and village health workers' activity systems of collecting and recording maternal and child health data were not operating at their full potential. Thus, the data was under-reported to the health center and there was an urgent need for resolving the contradictions. According to Virkkunen and Kuutti (2000) an activity can be brought back into balance by re-mediating it. However in this study, re-mediation alone was not enough especially in resolving the primary contradictions within the *objects* of the TBAs' and village health workers' activity systems; whereby the *objects* comprised of conflicting motives. Since the desire to perform an activity is driven by motives (Kuutti 1996), this study introduced motivating actions that directed behavior towards performing an activity as a way of resolving such contradictions.

ii. Resolutions of the Contradictions:

Initial findings (Paper I) indicate potentials for using a mobile phone technology at the community level. The identified contradictions however, indicated an urgent need for restoring order in the current paper-based system before introducing such a technology. This study has shown that the resolution of contradictions transformed the data collection and recording practices of TBAs, village health workers, district health managers and health

facility workers. This transformation was enhanced by the willingness of health facility workers and district managers to empower TBAs and village health workers to improve their performance and confidence in capturing and communicating the data.

Results as presented in Paper III illustrate that the TBAs and village health workers were empowered to collect and record data after providing them with standardised registers for collecting data and for keeping records of their performance with a goal of receiving a reward. Though other studies have demonstrated the importance of providing community health workers with standardised registers (Kanjo 2012, Damtew and Moges 2013), they have not shown how these registers should be designed in order to improve data collection. This study has shown that, different from the traditional registers, TBAs' and village health workers' registers should not only be designed as *tools* for collecting and reporting data upwards, but also a *tool* for demonstrating their performances. Such registers can motivate them to record the data because they expect to receive a reward (Luoma 2006; Roth 2007) after collecting and recording the data.

Along with the standardised registers, this study has also shown that the improvements of medical skills, provision of incentives and stationeries to support data recording in the TBAs' and village health workers' activity systems resolved the manifestations of double binds and critical conflicts. Consequently, new *rules* and new organization of roles in the *division of labour* emerged. As described in Paper III, these attributes re-mediated the TBAs' and village health workers' activity systems and led to creation of a new work context (Virkkunen and Kuutti 2000) and a new meaning (Castelloe and Watson 1999) for collecting and recording maternal and child health data. TBAs and village health workers started to view data collection and recording not as a demand from the higher authority but as a way of demonstrating their performance. Also the health facility workers and district health managers started to support, supervise and provide feedback as a way of facilitating data collection and communication rather than a means for inspection. Eventually the manifestations of dilemmas and conflicts were resolved.

TBAs and village health workers directed their behavior towards data collection and recording because they were empowered to perform the activity and they felt that someone cared (Franco et al. 2002, Luoma 2006, Mathauer and Imhoff 2006) about their performance. The acquired skills through training gave them knowledge on how to respond (Nadler 1970, Kuutti 1996, Ngoma 2007) in different situations when providing the services and recording

the data. And the application of acquired knowledge was established by the incentives which promised TBAs and village health workers a payoff for collecting and recording the data.

It has been argued that the quality of data can be measured by factors such as: its completeness, accuracy, availability on time and comparable on the same data definitions (Shreastha and Bodart 2000, Heywood and Rohde 2002), and its accessibility, security and interoperability.(Wang et al. 1996) This study has shown improvements in data recording by TBAs and village health workers and referral cases for delivery to the health center made by TBAs as attributes that contributed to the completeness and accuracy of the maternal and child health data at the health center.

Despite the success of this intervention, results also indicate that no improvements were made by village health workers to record data in the village register. Though this outcome was not further explored, it is my speculation that it was influenced by the presence of political tensions between the village health workers and the village government head. For instance, one village health worker mentioned that:

“I have all the data needed to update the register but I am not willing to share my findings with the village government head because we do not see eye to eye in most things.”

This illustration raised concerns for further research to understand the social and political relations between the *subjects* and the members of the *community* and how to resolve arising contradictions. Understanding such relations can bring more insights on improving the quality of data at the community level.

6.1.2. RQ2: Which participatory design techniques will support mutual learning where wide knowledge gaps exist between users and designers?

In this study, the development of a computer application to support provision of maternal and child health services was done by the designers who had no skills on clinical work in collaboration with the nurses who had no IT skills. It was found necessary to bridge these knowledge gaps in order to define appropriate system requirements. Previous research on developing computer applications with clinical workers emphasize on the significance of mutual learning in gaining the first-hand experience of their work (Bjerknes and Bratteteig 1987, Karasti 2001). This is because they have gone through years of training and have gained tremendous practical experiences, and their work involves a lot of tacit work that can be difficult for an outsider to understand. To demonstrate clinical workers' practices, Symon et al.

(1996, p. 3) describe that they often rely on informal ways of doing things because they “are traditionally accepted as enabling the work”.

Thus the nature of clinical work therefore demands a special consideration on understanding the dynamics of work as it unfolds through the tools used for data collection and procedures applied in performing tasks. This knowledge is significant in defining system requirements when developing computer systems to support clinical work. On the other hand, the users also require IT skills to be able to participate in system development as well as to use the system. To answer RQ2, I illustrate how an understanding of the clinical work and IT skills were constructed in this study. First I indicate manifestations of contradictions that were a result of the knowledge gaps that existed between the designers and the nurses. Then I describe the PD techniques employed to support mutual learning as a way of bridging the knowledge gaps through resolving the contradictions. I also show preconditions that were necessary to fulfil before mutual learning took place.

i. Knowledge Gaps:

Findings presented in Paper IV indicate the presence of complex relationships between the procedures and data collection tools used by the nurses that were not clearly understood in early stages of the system development. With the *object* of developing a system that represents the nurses’ actual work, the nurses lacked IT skills and the designers lacked skills on clinical work to engage in designing the system. To initiate a dialog with the nurses in order to define system requirements, the designers developed a prototype and introduced it to the users by first training them how to use the computers then the system prototype. Hands-on training technique was used in conducting the training. As the nurses were experimenting with the system, they gradually gained confidence on using computers as well as the system.

While the nurses experimented with the system during and after the system implementation, they continued to understand the technology and to realize how their work was represented or misrepresented in the system design. As a result, the nurses identified tensions that existed between their understandings of the domain and how it was misrepresented by the designers. The tensions are presented in Figure 6-2.

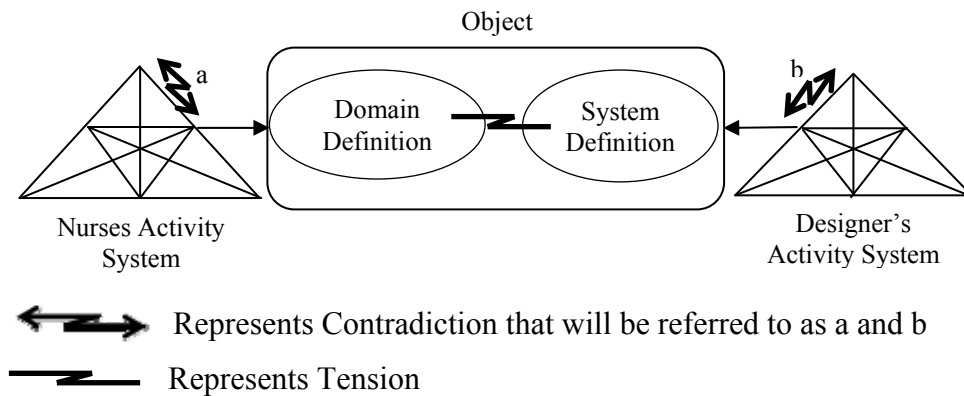


Figure 6-2: Secondary Contradictions

At this point the designers introduced the prompted reflections technique and the tensions identified were used as the prompts to open-up discussions. The tensions prompted the nurses to reflect on their practices and the designers to reflect on the system design. To elaborate an accurate representation of their work, the nurses were asked to draw free-hand drawings and to discuss how their work is actually done and how it should be presented in the system design. The tensions resulted into secondary contradictions (depicted as a and b in Figure 6-2) that identified misfits of the design as compared to how work was actually done.

For instance, the guideline for providing antenatal care described that pregnant women with normal conditions should have at least four visits to the health facility (under 16, from 20 to 24, from 28 to 32 and from 36 to 40 weeks). Based on this description and designers' lack of first-hand experience on executing this task, the prototype was designed to support data entry within these intervals and the intervals were named stages. However, after wrong data entries into the system, the nurses described how they understood and used the two words (visits and stages) through discussions and free-hand drawings as presented in Paper IV. Their understanding was different from the designers' understanding which was presented in the system design. The knowledge developed in these discussions was very important in refining the system design to reflect on appropriate domain definition.

Another tension was a result of the nurses' concerns about having a computer system that may not accommodate their work setting. They indicated apprehensions about the possibility of entering data in the computer whereby only one data entry form represented multiple registers some of which they did not keep at the clinic (client cards). Based on their domain understanding and lack of IT skills and capacity to change the system design, the nurses designed an improvised register that mimicked the data entry form in the computer to bridge

the paper based system (multiple registers and cards) and the computer. This was an innovation (Dahlbom and Mathiassen 1993, Carroll 2004) that demonstrated the system requirements from the users' point of view. This innovation calls for further research on the necessity of developing paper-based representations when computerising paper-based systems.

Other tensions also emerged between the nurses' practices and the management (HMIS) protocols. These tensions led to manifestations of quaternary contradictions as depicted in Figure 6-3.

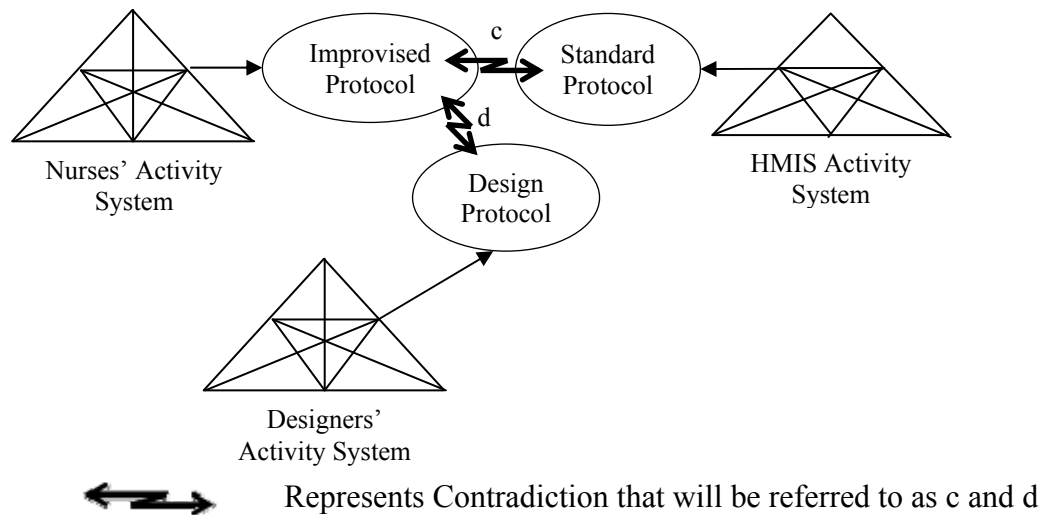


Figure 6-3: Quaternary Contradictions

As indicated in the findings, the HMIS activity system produced and monitored standards (procedures and registers) used by the nurses in provision of maternal and child health services. The designed system also created a new design protocol to be followed by the nurses. For instance, Paper IV describes that the designed prototype allowed the nurses to record check-ups done, vaccines and medications given on particular intervals and in specific visits as described by the standard protocol. However the nurses indicated that they followed an improvised protocol in performing these tasks. The improvised protocol was dictated by the availability of staff, vaccines and medication in the clinic. Consequentially, the system design which followed the standard protocol contradicted with the actual practices of the nurses. As a result quaternary contradictions were manifested between the *object* of nurse' activity system and the *object* of the HMIS activity system (depicted as c in Figure 6-3). As well as between the *object* of the nurses' activity system and the *object* of the designers' activity system (depicted as d in Figure 6-3).

In the following sub-section I discuss more on how mutual learning addressed the identified contradiction. I focus on the application of several techniques from system design to post-implementation periods.

ii. Techniques for Mutual Learning:

Applying techniques such as hands-on training, system experimentations and prompted reflections, findings of this study, as presented in Paper IV, indicate how the techniques supported mutual learning in this context and at the same time addressed some of the identified manifestations of contradictions. A combination of these techniques applied during system design, implementation and post-implementation periods enabled the nurses to gain competence on how to use the computer and the system, and designers gained domain knowledge and together they created a mutual understanding on how to represent the nurses' work in the system design.

Analysis indicates that, during the early stages of system design ethnographic techniques were used to support the designers to acquire domain knowledge. The techniques applied were interviews, observations, document reviews and focus group discussions. However, these techniques did not provide an understanding about how the nurses' work was actually done but how work was supposed to be done. Hence, the application of ethnographic techniques partially resolved contradiction b (as depicted in Figure 6-2).

During and after the system implementation, hands-on training and system experimentation techniques were used to support the users to acquire IT skills and competence on using the system. As the nurses gained this knowledge, they started to question about how their work was represented in the system design. Consequently, the designers gained more domain knowledge. This is contrary to the PD tradition whereby mutual learning (users gain IT skills and designers gain domain knowledge) is supported through the application of prototyping technique (Bødker and Grønbæk 1991, Mörtberg et al. 2010).

Furthermore, during and after the system implementation periods, the prompted reflections technique was applied together with system experimentation techniques which further supported mutual learning between the nurses and the designers. During these periods, the nurses gained more IT knowledge and the designers gained more knowledge about the tasks and work practices of the nurses. While the nurses and the designers were engaging in free-hand drawings, discussions and reflections the tensions between the system definition and the domain definition (as depicted in Figure 6-2) started to reduce. Thus the gained knowledge through mutual learning re-mediated the nurses' and the designers' activity system as presented in Figure 6-2 and hence contradictions a and b (as depicted in Figure 6-2) were resolved.

As the nurses and the designers together continued to develop a mutual view of the system contradiction d (as depicted in Figure 6-3) was also resolved. Eventually, a common *object* of creating a system that represents the nurses' actual work (as depicted in Figure 6-2) was realized. However due to time limitations, this study did not address contradiction c (as depicted in Figure 6-3) because it needed consensus building and dialog with the HMIS activity system. Further research is needed to demonstrate how such contradictions can be addressed.

Despite the difficulty of achieving mutual learning as reported in literature (Bratteteig 1997, Mörtberg et al. 2010), this study has shown that mutual learning was successfully supported during and after the system implementation. These results contribute to the PD community that mutual learning should not only be supported during system analysis and design but also during and after system implementation. Results indicate that mutual learning in this study took place after the users have received hands-on training and have started to experiment with the system in a real-life environment, and the designers have become aware, to some degree, of the users' tasks and practices. These can be considered as pre-requisites for supporting mutual learning in this context.

Mutual learning has also been described to support the involvement of users in designing computer systems (Bødker and Grønbæk 1991, Greenbaum and Kyng 1991, Trigg et al. 1991, Blomberg et al. 1993, Kensing 1998, Bødker et al. 2004, Lyng and Pedersen 2011, Hansen 2012). Furthermore, this study have shown that as a result of mutual learning, the nurses designed an intermediary paper-based register to support them to transfer data from paper records to the computer application. In a setting where there are multiple representations of data in paper records, such designs may be necessary when computerising paper-based systems.

6.1.3. Summary

This thesis has presented practical example on how to develop an understanding of elements of work practices concerning maternal and child health and to translate them into system design. I have shown valuable lessons learned in the process of identifying system requirements and translating them into design through customisation, training and post-implementation activities in designing the maternal and child health application. The process was challenged by understanding the complexity of local healthcare practices within the community and at the health center as well as correlating them with standardised and improvised data collection tools used. Another challenge was the adaptation of a generic

software, DHIS Tracker, whose development (what requirements to incorporate into system design, what features need to be prioritised) was controlled by the global development team.

At the community level, the informal nature of community health workers' practices of collecting and reporting data required this study to understand their practices through the involvement of district health management, health center nurse in-charge and the village government. It was also necessary to understand how their practices were affected with the involvement of other stakeholders. On the other hand, the nurses' practices at the health facility level seemed formal and standardised but their improvised nature obscured their understanding. This study was challenged by the nurses' practices of observing improvised instead of standardised protocols. Since the improvised protocol determined how work was actually done, there was a need for understanding and accommodating improvised protocols into the system design without compromising the standards of healthcare provision.

In addition to the practices which were alongside data collection, this study was also challenged by the presence of multiple registers ranging from old to new, and standardised to improvised which were part-and-parcel of everyday practices of the nurses. The registers also had different presentations. Thus in designing data entry forms to cater for these disparities it was found essential to include all the necessary data that was needed for reporting and for local utilisation. In general, the flexibility of the system design that supported the accommodation of standard and improvised protocols was essential.

Further challenges were also experienced in customisation of the generic software whose development was managed by the global team. Mediating the development activities between the local implementation in the field and the global development, I constantly faced tensions between the local needs and what the software could offer because the global team controlled the design decisions on which requirements to be incorporate into system design and what is the priority. These tensions compromised how the system requirements were defined and which functionalities were designed and implemented in this study.

In general, this was a learning process for me and for the nurses, and the knowledge was constructed through resolving contradictions. It is the emphasis of this study that the resolution of contradictions should be viewed as a continuous learning process since "contradictions are instigations of change" (Dahlbom and Mathiassen 1993) (p. 111) and when resolved they bring back the order and eventually new ones will emerge. This learning should be supported in the post-implementation period in system development.

6.2. Research Contribution

This section presents the contributions of this study to the body of knowledge.

6.2.1. Contributions to PD community and their Implications to Practice

To the PD community, this study contributes to the evaluation of different techniques to promote mutual learning in system development. These techniques include ethnographic techniques (interviews, document reviews, focus groups, and observations), prototyping, hands-on training, system experimentation and prompted reflections. I specifically position my contribution in work settings where users lack basic IT skills and designers lack domain knowledge as well as the non-western setting.

This study contributes that, the application of ethnographic and prototyping techniques in early stages of system development cannot support mutual learning in this setting. In this study, results show that during this period, the application of ethnographic techniques did not provide insights on how work was actually done but narratives on a standard way of performing work. These narratives lacked the demonstrations of the improvisations used in performing work that reflected on the nurses' first-hand experience (Bjerknes and Bratteteig 1987, Suchman 1995, Nardi and Engeström 1999, Star and Strauss 1999) whose understanding is essential in IS development.

Concerning the use of prototypes, this study has shown that, they cannot be developed with users to support mutual learning. In this setting, techniques such as hands-on training and system experimentations supported the users to gain IT knowledge regarding using computers and the system under design, and the designers to gain domain knowledge as the users experimented with the system. The domain knowledge gained by the designers through hands-on training and system experimentation was more concrete than what was learned through the ethnographic techniques.

Furthermore, this study has shown that the application of prompted reflections technique supported mutual learning in this setting when it was applied during the system implementation and post-implementation periods. Contrary to PD proposition of applying the technique during the system analysis and design (Kensing 1998, Bødker et al. 2004), in this study the application of the technique was successful after the fulfilment of two pre-conditions. First the users have gained IT skills and they have understood the technology through hands-on training system experimentations. Second the designers have gained a basic understanding of the users' work through ethnographic techniques and observing the users

while they experimented with the system. As the nurses were experimenting with the system, they revealed tensions between how they did their work and how it was represented in the system design. Such tensions opened-up discussions and creation of free-hand drawings that demonstrated how work was actually done. The prompted reflection technique supported the designers together with the nurses to develop knowledge on how to represent lived practices in the system design during and after the system implementation.

In the presence of wide knowledge gaps between the designers and the users, this study has shown that, post-implementation learning should be promoted. This is because at this stage the users have gained substantial skills on how to use the system and to reflect on how their work is represented in the system design. Similarly, the designers have gained substantial domain knowledge to be able to establish a meaningful dialog with the users.

Furthermore, this study contributes to the PD community the necessity of developing paper-based representations to bridge data entry from paper-based records. This is evident from an nurses' innovation when they designed a paper-based form that enhanced them to enter data obtained from different registers into one data entry form on a computer. Such representations may be necessary when computerising paper-based systems in this setting.

6.2.2. Contribution to HIS in Developing Countries and its Implications to Practice

With a specific focus on maternal and child health services, this study contributes to the HIS in Developing Countries community by demonstrating the implication of changing information practices of community health workers in improving the quality of data. TBAs and Village health workers have been acknowledged to be a crucial link between the community level and the rest of the HIS (Kanjo 2012, Smith et al. 2000, Ray and Salihu 2004, Sibley et al. 2004, Darmstadt et al. 2009), but their involvement on improving the quality of maternal and child health data has not been demonstrated in research.

This study has shown that, the quality of maternal and child health data can be improved by empowering TBAs and village health workers to direct their behavior towards collecting and recording the data. This can be done by providing them with data collection registers that are different from the traditional registers. While supporting them to collect and record the data, their registers should keep records of their performance with a goal of receiving a reward based on the performance. In this manner, they will collect and record data not only to fulfil the demands of reporting the data upwards, but also to demonstrate their performance on how much they have contributed in reporting the data.

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Appendices

Appendix 1: PAPER I

Ngoma, C., Chawani, M. S., Herstad, J. (2010). Adaptation of Mobile Application to Improve Flow of Birth Information from the Community to the District Level. *Proceedings of the 2nd International ICST Conference on E-Infrastructure and E-Services for Developing Countries: AFRICOMM 2010*. R. Popescu-Zeletin et al. Cape Town, South Africa, Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. 64: 79-92.

Adaptation of Mobile Application to Improve Flow of Birth Information from the Community to the District Level

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Abstract. This paper presents current practices used by village health workers, traditional birth attendants, health facility workers and district health managers in collection, recording, storing and transferring birth information in the health information system. Envisioned potentials of using mobile application as a tool for data recording, transferring and strengthening the weak support structure have been foreseen to bring improvements in the flow of birth information in the Health Information System.

Keywords: Village health workers, Traditional birth attendants, Health managers, Mobile phones, Supportive supervision, Feedback and Medical birth registration.

1 Introduction

In sub-Saharan countries, studies have pointed out under-reporting of maternal health data; and the data reported indicates a high rate of maternal and child mortality [1, 2]. This situation is prominent in rural communities where many women deliver their children at home assisted by traditional birth attendants. In Tanzania, 46-60 % of births take place in the community [1, 3]. The information about these births may neither be recorded nor reported in the Health Information System (HIS) and these children may live without a trace of their existence. Hence the availability of accurate and complete information on all births within the community is one of the main concerns within the HIS.

Registration of new born children which is the main concern of this study, is done in health facilities where details of a child's birth and his/her medical condition if any or death, and the parents' vital information and medical conditions of the mother if any are captured. This data is useful for epidemiological purposes such as monitoring surveillance of birth defects and other prenatal health problems and for analysing quality assurance on health services related to pregnancy, childbirth and the neonatal period. As such, these records can provide the best answers on the rate of maternal/child/neonatal mortality for a health facility, a community and a country population at large.

The objective of this study was to find ways of improving birth registration in the community through facilitating communication of birth information between community health workers in the community, health facility workers in the health facilities and district health managers in the district. To attain this objective, this study will answer the following questions: 1. What are the current practices used by village health workers, traditional birth attendants, health facility workers and health managers in collecting, recording, storing and transferring birth information? 2. What are the opportunities provided by the envisioned mobile application to communicate birth information from the community to the district level?

1.1 Research Context

This is an ongoing research study taking place in Tanzania and Malawi as part of a project aimed at improving the availability and quality of maternal health data in the HIS. The study is taking place in Kibaha and Bagamoyo districts which are located in the Coastal region of Tanzania. This paper presents findings from Kwala ward which is one of the nine wards of Kibaha district. The Kwala ward consists of four villages and it has one dispensary and one health center.

HIS Information Flows. In the health information system, data is collected routinely as well as non-routinely from communities, health facilities (health centers and dispensaries) and hospitals (district, regional, national and referral hospitals). The flow of routine data reporting is bottom-up from the community to the ministry, while provision of support and feedback is from top-down. Figure 1 presents hierarchy of data reporting and provision of support and feedback in the HIS.

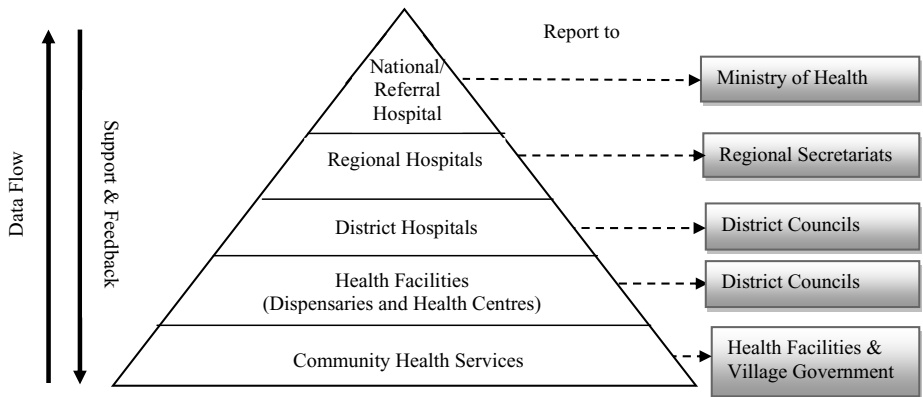


Fig. 1. Hierarchy of Health Information System [4]

Mother and Child Health (MCH) Services. At all levels of the HIS, MCH services provided include antenatal care, delivery, postnatal care, child health management, immunisation and family planning with different intensities of specialisation. These services are provided by various groups of health professionals such as nurses, midwives, MCH aides, medical doctors, and clinical officers. Some MCH services are

also provided as part of community health services by non-medical professionals such as trained and untrained traditional birth attendants and village health workers. Data on maternal (mother and child) health is collected and recorded hand in hand as the services are provided.

Maternal health data collected at the community level was individual-based data which could be traced back to a particular individual however the identifications used were not unique. The data is then aggregated at the end of the month and/or quarter and reported to the health facility in an aggregated format. At the health facilities individual-based data is also collected and reported in an aggregated format together with the data reported from the community. The aggregated data contains combined sums of individual data; it eliminates presenting data in individual-based format.

This study concentrated on the registration of births/new born babies at the community and health facility levels which is highly related to the process of capturing delivery outcomes for both the child and the mother. In this paper, Community Health Worker (CHW) is used as a group term referring to village health workers and traditional birth attendants.

2 Literature Review

This section presents literature and theoretical concepts on HISs in developing countries in order to show existing practices in data collection, recording and transferring. Theoretical concepts on ways of motivating performance of CHWs in order to improve data reporting are also presented in this section. Furthermore, we present opportunities for using mobile phone applications in HISs.

2.1 Health Information Systems in Developing Countries

In most developing countries, HISs do not function properly especially at the community level which is the main source of data while the main goal of the HIS is to collect complete and accurate data, report it on time and utilise it. To achieve this goal at the community level, Lippeveld [5] argues that, health managers need to find ways of involving CHWs and improving their performance. According to Rowe et al. [6], health managers can promote certain practices among health workers by first understanding “*the existing and often evolving influences that promote desirable and undesirable practices.*” Studies conducted in developing countries indicate that CHWs’ performance on desirable practices can be improved by motivating them [7-11].

2.2 Motivating the Performance of CHWs

Motivation is “*an individual's degree of willingness to exert and maintain an effort towards organisational goals*” [9]. For the HIS to be able to collect and report information on births taking place in the community, CHWs need to be highly motivated to fully participate in this exercise because they are closer to the community than health facility workers are. Empirical studies present different approaches that can be adapted to motivate performance of CHWs such as provision of supportive supervision, feedback, incentives, training etc.

Supportive Supervision. Supportive supervision is one of the determining factors of CHWs' success as it provides a way of reducing/avoiding mistakes and updating their knowledge and skills [8, 9, 12]. It is a system whereby supervisors can provide guidance on the technical aspects of the services by going through a checklist. As a way of improving the quality of data collected, HIS need to set up a strong support structure that will ensure provision of reliable and timely support to CHWs in accomplishing their tasks.

For instance, health workers in Kenya and Benin who were rarely and irregularly supervised indicated that “*supervision provides the feeling of being cared for and of appreciation*”[9]. Furthermore, Franco et al. [9] add that good supervision should include “*adequate technical support and feedback, recognition of achievements and good communication.*” These attributes will make supervision a way of motivating health workers and improving desirable work practices in the HIS.

Meaningful Feedback. Provision of meaningful feedback to health workers is a way to showing appreciation and it is one the most important motivating factor [10]. However most CHWs received little or no feedback from their supervisors. In the study conducted in Kenya and Benin, Mathauer & Imhoff [8] indicated that when health workers received feedback, it was based on shortcomings and mistakes on the different aspects of service provision. This kind of feedback was like a punishment to health workers, instead of improving their performance, it demotivated them.

2.3 Mobile Applications in the HIS

The use of mobile applications for health services and information transferring and sharing is rapidly growing in developing countries mainly due to a high diffusion of mobile phones [13, 14]. The use of mobile applications has proven to be beneficial in several areas of health service delivery such as: capturing and transmission of health data on public health programmes and routine epidemiological data from remote clinics to regional health centres [15]; submission of child nutrition data via mobile phone SMS for monitoring children nutrition [16]; capturing patient-level data when providing home-based care to HIV/AIDS patients [17]; and improving cooperation among hospitals [18].

Additionally, another interesting area of mobile application use is the collection and transmission of child birth data for vital statistical purposes. In Kenya a Nokia data gathering application was used to collect child birth data from the community and to send it to the ministry of home affairs for vital registration [19]. Similar applications have also been implemented by PLAN International in Thailand, Sri Lanka and Cambodia.

Opportunities for using Mobile Applications. The use of mobile phones in the HIS in developing countries has been observed to present opportunities in data transfer from remote communities and opening up communication channels between CHWs and their coordinators/supervisors in the districts [20]. Through these communications, mobile phones can be used for calling and sending text messages (SMS) for the purpose of supporting, supervising and giving CHWs feedback on their activities.

According to Chetterjee et al. [20] “*the extent of temporal mobility of the user will positively affect the use of a mobile device within the healthcare context.*” Contrary to the paper-based system where transfer of data and communication need a physical presence of both parties in a fixed location, users of mobile phones can transfer data and communicate in a timely manner from different places. It is therefore no surprise that Iluyemi and Briggs [21] indicate that supporting CHWs with mobile applications should be considered as a top priority in developing countries.

Regardless of these various mobile application implementations, there is, however, limited research on the use of mobile phone by CHWs for reporting birth information in the HIS. Thus our research aims to fill this gap as it explores the adoption of mobile applications to support and improve medical birth registration.

3 Research Methodology

In this study, qualitative research methodology was employed and data was collected using detailed interviews, document reviews and observations. These are presented in this section.

3.1 Interviews

Structured and unstructured interviews were conducted to six village health workers, seven traditional birth attendants, two health facility workers and three health managers from the district. Six village health workers interviewed were among the eleven in the Kwala ward. They were interviewed in groups of two to three using structured questions. Among twenty traditional birth attendants in the Kwala ward, seven were interviewed using one-to-one interview where the questions were open-ended. Interview sessions conducted to village health workers and traditional birth attendants were tape recorded at an average of thirty minutes each. Objectives of the interviews were to understand information they collected in the community regarding births, how and where it was reported and challenges they faced in collection, recording, transferring and storing the information.

Interview sessions conducted to health facility workers at the Kwala health center were one-to-one and open-ended questions were used. These health workers were the two personnel in-charge of the health center. The objective of interviewing this group was to get an understanding on how health facility workers worked together with CHWs (Village health workers and Traditional birth attendants) and how they supported CHWs in their daily activities.

Health managers, from Kibaha district were involved in one-to-one interview sessions which had open-ended questions. They were interviewed with the objective of understanding how they perceived, valued and supported the contribution of CHWs in reporting births taking place in the community. Another objective was to assess procedures used for providing feedback and supportive supervision.

3.2 Observations

Observations and participatory observations were conducted in this study. Participatory observations were done during training sessions, formal and informal

discussions and meetings. The objective of the participatory observations was to acquire an understanding of how CHWs performed their activities and the challenges they faced. The other objective was to understand CHWs' perspectives on using a mobile phone application in reporting data they collected.

This research also participated in training conducted to CHWs by health managers from the district by engaging in several discussions. The training had the objective of improving CHWs' skills and knowledge on data collection, recording and storing. The training took eight days where twenty traditional birth attendants and eleven village health workers participated.

Several observations were made at the health center during Antenatal, Postnatal and children clinic sessions. The objective was to understand the practices of health workers in interviewing mothers, recording data while providing services and referring mothers and/or children to hospitals.

3.3 Document Reviews

To further improve the richness of data collected from the interviews and the observations, this study reviewed several documents. These included epidemiology reports, country demographic survey reports, Ministry of Health curriculums for training CHWs and data collection tools including different village registers.

4 Findings

This section presents findings on current practices in birth registration and the involvement of different stakeholders in data collection, recording, transferring and storing.

4.1 Stakeholders and Activities

This study identified five different stakeholders that were involved in communicating birth information directly and indirectly from the community level to the district. These were village health workers, traditional birth attendants, health facility workers (Nurse Midwife and MCH aid), district health managers (village health workers' coordinator and traditional birth attendants' coordinator) and village government. All the stakeholders were directly involved in the HIS except the village government. This paper presents findings on directly involved stakeholders. Table 1 shows activities of each stakeholder in communicating birth information from the community to the district level.

The main goal of traditional birth attendants in the HIS was to ensure that records were available when their coordinator from the district went to supervise them. They recorded individual-based data in standardised registers on deliveries including the name of the mother, father and village head, gender of the baby, condition of the baby and the mother if any, and reasons for death (Mother, Child) if any. Although traditional birth attendants could not read and write, they used village health workers or anyone close to them to write for them in the registers. Despite of all the information collected and recorded, six out of seven traditional birth attendants

Table 1. Activities Done by Each Stakeholder

Activity	Stakeholder			
	Traditional Birth Attendant	Village Health Worker	Health Facility Worker	District Health Manager
Data Collection	- Assist deliveries in their home or client's home	-Household visitations -Observations -Gather observations from traditional birth attendants	-Health center client visitations -Outreach Activities -Gather reports from village health workers	-Gather paper based reports from health facilities and traditional birth attendants
Data Recording	-Record data on Paper-based registers	-Record data on Notebooks	-Record data on Paper based registers, Report forms and Tally forms	-Enter data into District Health Information Software (DHIS)
Data Transfer	-Nowhere	-Present a quarterly report to health facility nurse in-charge	-Present quarterly reports to the district	-Manually and electronically through DHIS to the region
Data Storing	-in home cabinets	-Personal files at home	-File reports, tally forms and registers in cabinets	-Electronically in the DHIS database

indicated that no one had read nor supervised their data recording in their registers since they were given the registers in 2006. The recorded data was therefore not transferred anywhere.

Health managers as one of the stakeholders had to ensure that complete and accurate data was collected from traditional birth attendants and health facilities every quarter and entered into the DHIS. This research found out that collection of data from traditional birth attendants had never been done with the exception of one traditional birth attendant who could read and write, and whose work was supervised over mobile phone communications. Health managers worked with only aggregated data.

Village health workers were driven by two main goals. The first goal was the same as that of traditional birth attendants, to ensure the availability of records when they were supervised. The other goal was to present monthly and quarterly report on all births that took place in the community to the health facility nurse in-charge and the village government. Village health workers did not use standardised registers for data collection and reporting, they used notebooks. Data was recorded in individual-based format then it was aggregated every month and quarter for reporting. Unlike most of the traditional birth attendants who were aged women (40 – 80 years) and could not read, write and use mobile phones, village health workers could read, write, use a mobile phone and owned one. Furthermore, findings indicate that data reported by village health workers to the health facility was not incorporated in the health facility reports all the time. The nurse in-charge explained that sometimes the information was not complete. As a result this information remained in the village health workers' notebooks. Health facility workers also indicated that they provided support to village health workers on how to go about different observations. Most of this support was provided using their mobile phones.

Health facility workers who were medical professionals, worked in health centers and dispensaries collectively named health facilities. Their main goals were provision of health services, recording and reporting complete and accurate data timely. Reports were sent to the district and sometimes the district health managers picked up reports from health facilities. At the health facilities, data was collected and reported using standardised tools such as registers, tally forms and report forms.

4.2 Supportive Supervision and Feedback Provided to CHWs

This study also aimed to investigate how CHWs were motivated by health managers to improve their performance in the provision of health services, and in data collection, recording, storing and transferring, by looking at the provision of feedback and supportive supervision. According to the ministry of health and social welfare regulations, CHWs were supposed to be supervised by their coordinators from the district at least once every quarter. This supervision was meant to collect reports and ensure that they were accurate and complete, to distribute supplies (medical and stationary), to present reminders and announcements on mobilisation activities prevailing at that time and to ensure that everything was in order. However the supervisors did not have a checklist on what to supervise, they only checked what they remembered to check. Health managers also indicated to be constrained by budget allocated for supervision and many responsibilities which hindered them to provide regular supervision. One said,

“We only supervise them when there is a budget supporting that”

Due to the constrained budget and unmet needs of village health workers such as sufficient skills, adequate supply of stationeries (notebooks, forms, standardised registers, pens, calculator and folders), technical support on provision of services and sufficient means for transportation to all households; village health workers faced difficulties in data collection, recording, storing and transferring. One village health worker said,

“Households in my village are far from each other and others are very remote and I don’t have a bicycle to use but I walk anyway to make sure I collect accurate data in all my households”

However this was not the case for traditional birth attendants, with the exception of one, because they operated as private providers. Nevertheless, the health managers at the district provided them with registers for recording data on delivery outcomes for the mother and the baby. The health manager who was the traditional birth attendant coordinator did not provide attention on the data recorded and supervision provided to traditional birth attendants was highly neglected.

As long as there were few or no supervisions and support provided to CHWs, there was also few feedback given. Village health worker indicated that they never received feedback on their performance in data they had collected and reported based on maternal health. They received feedback on other activities they performed for parallel programs. Traditional birth attendants indicated that the only feedback they received were warnings when they did something wrong. However one traditional birth attendant indicated that she was receiving feedback based on her performance in reporting of data and provision of services through her mobile phone.

5 Analysis

Analysis of the findings reveals that, at the community level, individual-based data was collected and recorded by village health workers and traditional birth attendants.

Village health workers recorded the data in notebooks and aggregated it at the end of the month and quarter and reported it upwards to the health facility where it was compiled in health facility's reports and further reported to the district. Data from traditional birth attendants, which was recorded on standardised registers, was reported to the district in individual-based format. However only one out of seven traditional birth attendants was reporting the collected data. Figure 2 presents a visualization of the sequence of activities in the flow of birth information among different health stakeholders from the community to the district level.

The diagram depicts a weak link (dotted arrows) in the flow of maternal health data from the community to the district level. Despite the fact that the data were not properly reported, they were recorded in traditional birth attendants' registers and village health workers' notebooks. The state of under-reporting was led by several practices among stakeholders in the HIS. These practices included a poor support structure as indicated in the findings that CHWs received unreliable support, supervision and feedback on their work performance from district health managers and health facility workers.

To improve the state of poor reporting, this study has perceived the use of mobile phones at the community level as an opportunity to bridge the gap in data flow in the HIS and to strengthen the weak support structure. Looking at the mobility nature of work of village health workers' activities and the capability of a mobile phone to support this as presented by Chetterjee et al. [20], this study proposes a mobile phone application infrastructure that could be implemented to support the work practices in the HIS. Figure 3 presents the envisioned mobile phone application infrastructure.

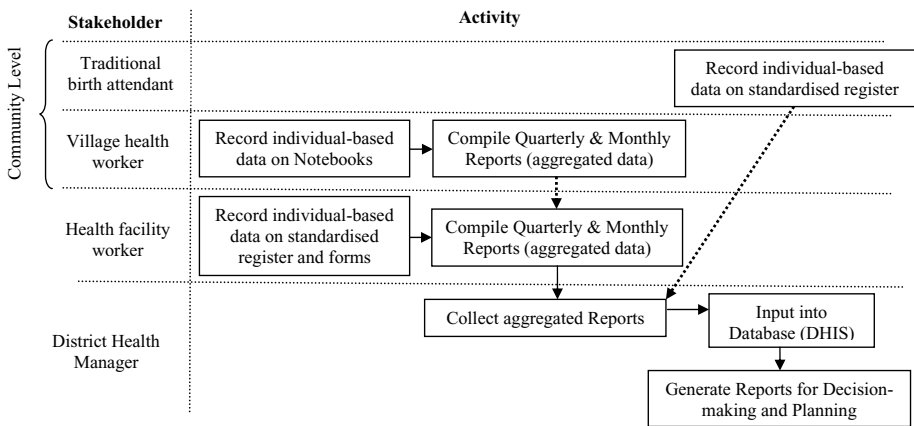


Fig. 2. Sequence of Activities in the flow of birth information from the community to the district level

With this infrastructure in place, the broken link in the flow of information as indicated in Fig. 2 between the community and the health facility levels would be bridged. Village health workers would be reporting data they recorded and data from

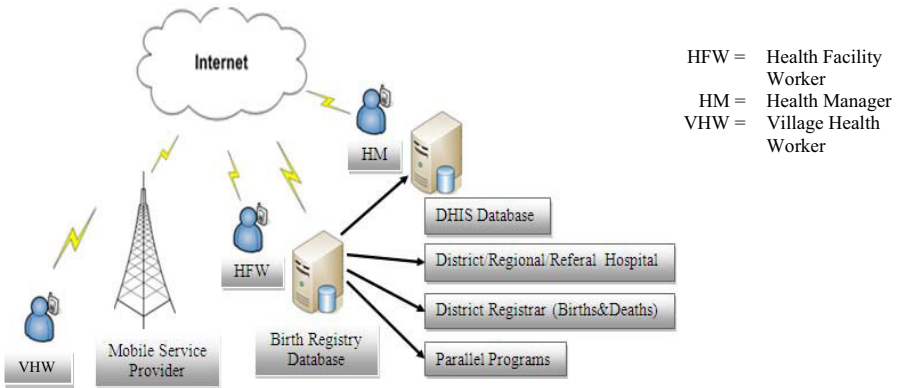


Fig. 3. Envisioned Mobile Phone Application Infrastructure

traditional birth attendants' registers to the health facility through the mobile application. This application would also present opportunities for health managers and health facility workers to support, supervise and present feedback to community health workers remotely, without travelling to meet them in remote areas as was done with one of the traditional birth attendants. This might promote desirable practices in collecting, recording, storing and transferring maternal health data in the HIS.

6 Discussion and Conclusion

This section presents the discussion based on the findings and theoretical reflections, and concluding remarks on answering the research questions.

6.1 Current Practices

As presented in the findings, current practices indicate lack of backward flow of information in the form of feedback with the exception of one traditional birth attendant whom health managers could communicate with through a mobile phone. Village health workers and traditional birth attendants were also provided with very little support and this went hand in hand with provision of little or no feedback. This situation has also been observed in other developing countries [8, 10] and it created reluctance in reporting and thus hindered the flow of information.

Desirable and Undesirable practices. This section presents current practices among stakeholders categorised as desirable and undesirable practices as presented in Table 2.

Table 2. Desirable and Undesirable Practices

	Stakeholder	Desirable Practice	Undesirable Practice
Data Collection	Village Health Worker	-Eager to go house to house to get complete and accurate data	-Remote households could not be reached on time
	Health Facility Worker	-Gathered reports from VHWs which contained community data	-No feedback provided to VHWs on the data gathered from their reports
	Health Manager	-Gathered reports from health facilities and traditional birth attendants	-Provided no transport mechanisms to VHWs for household visitations and reports presentation to the health facility -Irregular supervision provided to VHWs and TBAs on data collection -No collection of data from TBAs' registers
Data Recording	Village Health Worker	-Noted all observations possible -When they needed assistance they called the HFWs (using mobile phones and/or physically meet) for support	-When out of stationary data was recorded later sometimes the observations were forgotten -Using un-standardised register – VHWs recorded what they thought was necessary
	Health Manager	-Provided technical support to a TBA through a mobile phone	-Provided VHWs with inadequate stationeries for recording the collected data -Little/No supervision was provided to VHWs and TBAs on data recording -No checklist for provision of supervision -Provided negative feedback only
Data Transferring	Village Health Worker	-Ensured the completion of monthly and quarterly reports	-Late reporting to the Health facility
	Traditional Birth Attendant		-Not reporting the data recorded
	Health Facility Worker	-Ensured the completion of monthly and quarterly reports	
	Health Manager	-Provided feedback on reports to a TBA through a mobile phone	-Providing no transport means to VHWs to send reports to the health facility
Data Storing	Village Health Worker		-Not keeping reports for their own data utilisation or further reference
	Traditional Birth Attendant	-Stored their registers	
	Health Manager	-Stored data electronically where it was readily accessible and sharable	

Findings indicated that current practices which were undesirable among village health workers, traditional birth attendants, health facility workers and health managers in the HIS fuelled challenges in data collection, recording, transferring and storing. Undesirable practices also contributed in creating the gap in the flow of birth information from the community to the health facility and further to the district level. Furthermore, the weak support structure was often provoked by the way supportive supervision was conducted without having a checklist of what to supervise and low/no budget allocation for supervision, transportation and stationeries necessary for data recording, reporting and storing. Rowe et al. [6] indicate that, health managers need to understand these practices and this will give them an insight on which practices to enforce and which to abolish among health workers. In light of studies conducted in developing countries [7-11], motivation has been used to enforce desirable practices.

6.2 Adaptation of a Mobile Application

The communication gaps in communicating birth information in the HIS can be bridged by the use of mobile applications as the case in other studies in developing countries [16-21]. According to Chatterjee et al. [20] the adaptation of mobile

applications can support communication because of the mobility characteristic of using devices such as mobile phones. The use of mobile phones has also been observed to be beneficial in resource constrained areas [22]. Despite the fact that CHWs are accustomed to work in a paper-based system (using paper, pencils, pens, erasers) [23], findings indicated opportunities in using mobile phones to improve communication in the HIS that would enhance provision of reliable and timely supportive supervision and meaningful feedback.

Support in Collection, Recording and Transferring of Information. Provision of support has been observed as one of the factors for motivating CHWs to improve their performance in many developing countries including Kenya, Benin, Vietnam and Mali [7-11]. Support also offers health workers a helping hand in the completion of their tasks by improving knowledge and skills in performing tasks which may lead to avoidance and/or reduction of mistakes [8, 9, 12]. Rowe et al. [6] further indicate that in most developing countries provision of supportive supervision to CHWs offers a connection link between the community and the rest of the formal HIS. Findings indicated the possibility of using mobile phones to provide support and supervision to CHWs who had mobile phones. If this practice could be formalised and improved, there would be improvements in accuracy and completeness of data collection and recording from the community. In this regard, a mobile phone could be adopted as a tool to strengthen the present weak support structure in the HIS and this would motivate CHWs to collect and report accurate and complete information [9].

Support also includes the provision of meaningful feedback to CHWs. Health managers and health facility workers could use mobile phones to send feedback to CHWs as a way of enforcing desirable practices. Provision of feedback also opens doors for good communication between CHWs and their supervisors and this would motivate CHWs because it would create a feeling that their achievements are recognised [9] and appreciated [10].

Envisioned Mobile Application. This section presents the envisioned mobile application (as presented in Fig. 3) which will be implemented in a later stage of this research. Based on the current practices and the infrastructure in the HIS, this application is perceived to improve flow of birth information from the community to the district level by providing opportunities for fast and timely transfer of information and by creating communication channels between health managers, health facility workers and village health workers for provision of supportive supervision and meaningful feedback to provoke desirable practices in data collection, recording, storing and transferring.

For data collection and recording, mobile phones will be used by village health workers to record individual-based information on births collected in their notebooks and traditional birth attendants' registers and send it to a database (medical birth registry) placed at the health center through the internet. The data will be recorded in standardised registers on a mobile phone and every individual will be uniquely identified in the system. Upon the reception of the information, the database will automatically send a feedback (notification of receipt) through SMS. All the information sent to the medical birth registry will be approved by the health facility nurse in-charge before it is committed to the database. At this point the health facility

nurse in-charge will use a mobile phone to call or send an SMS to the respective village health worker for further clarification if needed.

From the medical birth registry, the information will be compiled (aggregated) monthly and a report will be sent electronically to the DHIS database at the district. The aggregated reports will also be given (as a print out) to individual village health workers based on the data they reported to the health center in that particular month and/or quarter. At the district, the information will be approved by health manager and then saved into the DHIS database. At this point, the information will be readily available to be shared by different stakeholders such as district health workers, district and referral hospitals, district registrar of births and deaths for vital registration, and parallel programs.

The undesirable practice of late reporting of data collected by village health workers, as observed in the findings, will be eliminated because data will be transferred to the database right after recording it and there will be no need of manual preparation of monthly and/or quarterly reports. This will also reduce the transportation costs for transferring data from the community to the health facility.

Furthermore, in the envisioned system, the weak support structure in the HIS will be strengthened whereby instructive support on technical aspects in the provision MCH services which affects in one way or the other, data collection, recording, storing and transfer, will be provided to village health workers by health managers and health facility worker whenever needed through calling and/or sending SMS. Health managers and health facility workers will also be urged to provide meaningful (constructive) feedback after the completion of tasks and on the performance of village health workers and traditional birth attendants on monthly bases and whenever necessary. To facilitate supportive supervision, the mobile application will also provide health managers and health facility workers checklists to be used for providing regular supervision.

The envisioned use of mobile phones as a tool to facilitate communication of birth information between community health workers in the community, health facility workers in the health facilities and district health managers in the district, is perceived as a rewarding mechanism [24] which will promote desirable work practices in the HIS.

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Appendix 2: PAPER II

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Contradictions in Collecting and Recording Maternal Health Data at the Community Level: A Case study from two Districts in Tanzania

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Abstract. The objective of this study is to improve completeness, accuracy and timely reporting of maternal health data in the health information system. This will improve the availability of reliable data for making appropriate decisions, planning and interventions. We aim at recording new knowledge on how to improve the collection and recording of maternal health data at the community level. To do so we underscore what hinders community health workers from collecting, recording and reporting of maternal health information by drawing on the concept of contradictions from Activity Theory. The results indicate manifestations of contradictions through double binds, dilemmas, critical conflicts and conflicts hindered the activity of data collection and recording. The resolution of these contradictions is perceived to be a springboard for improving reporting of the data.

Keywords. Work practices, activity theory, community health workers, contradictions, maternal health data

Introduction

In sub-Saharan countries, there is under-reporting of maternal health data and poor indicators of maternal and child mortality (1, 2). Under-reporting has been pointed out to be prominent in places where most women deliver at home assisted by traditional birth attendants (3-6). For instance, in Tanzania, 46-60% of births are conducted by traditional birth attendants (7, 8). Like most developing countries, Tanzania is challenged to meet the Millennium Development Goals (MDGs) 4 and 5 which aim at reducing maternal and child mortality. These goals are measured against the number of live births, many of which are not reported. This is where our focus is, to promote reporting of information made on delivery outcomes both for the baby and the mother.

Community health workers will necessarily play a central role in adding community data that is collected outside of the health facilities. By reporting data on

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clients who do not seek services in health facilities, births that take place outside of the health information system could be reported through community health workers.

This study will elaborate the underlying causes of the problem of under-reporting of maternal health data from the community level by focusing on the work practices of community health workers. To do so we draw on the concept of contradictions to elaborate the manifestation of under-reporting. These contradictions are not “observed directly”, but they are “identified through their manifestations” (9).

Data Collection and Recording at the Community Level

In their study, (10) indicate that, in Tanzania most of the maternal health data collected at the community level by VHWs and TBAs was not reported to the district level. This under-reporting was led by provision of unreliable support, supervision and feedback from district health managers and health facility workers. Similar studies in Malawi (11) and Ethiopia (12), indicate that most of the data collected at the community level is incompletely reported to the health facility.

In Malawi, through household visits, community health workers collect data on vital events such as deaths, births and other population variables, and disease outbreaks. The collected data is reported to a health facility. The community health workers were challenged by work overload, long distances to travel to households, and large populations to be covered (11). These variables constrained the completeness and accuracy of data.

In Ethiopia, at the community level, data are also collected by community health workers. In this context, community health workers provided services through household visits and at a health post (the lowest health administration unit). Services provided include family planning, provision of anti-malaria drugs and first aid. In Ethiopia, community health workers were also challenged by long distances between the health posts and remote households to collect data and to send reports to the district office. These issues led to questionable reliability of data collected at the community level (12).

In this regard, studies from developing countries’ contexts indicate that the completeness and accuracy of data collection and recording at community level has been constrained by factors such as; management issues (10, 13, 14), health policy and politics (11) and infrastructure (12). This study explores the work practices of community health workers in the activity of data collection and recording so as to understand what is hindering them in performing this activity. This knowledge will be useful in designing solutions/practices that will improve reporting of maternal health data from the community level. This knowledge can be useful in addressing the problem of under-reporting in similar contexts.

1. Activity Theory: A Framework to Understand Human Activity

Activity Theory is based on the fact that, the basic unit of analysis is the human activity. According to Engeström (15), a human activity contains components such as *subject*, *object* and *tools/instruments*, *rules*, *community*, *division of labour* and *outcome*. Between and within these components, there is an ongoing construction, negotiation, tension and there are multiple voices and viewpoints (16).

The *subject* represents “who is involved in the activity?” The *object* answers the question “why is the activity taking place?” The *object* can be tangible (plan, report and recorded data) or intangible (idea). *Tools* represent the means used by *subject* to perform the activity. *Tools* can be physical artefacts (register books, computers, mobile phones, and harmer), skills (medical, reading, writing skills), language, culture etc. *Rules* represent a set of conditions that determine how and why individuals may act. *Community* is the environment in which the activity takes place. *Division of labour* is the allocation roles among *subjects* and members of the *community*. *Outcome* represents the desired result for carrying out the activity.

According to Leont’ev an activity has a collection of actions with a shared *object* and each action has a goal/motive (17). Kaptelinin & Nardi define this motive as “the object which stimulates, excites the subject” to attain something, “however, human activities are not directed straight toward their motives” (18). In performing actions, individuals are always directed towards motivating goals (objects that attract them) and directed goals (objects at which their activities are directed for instance by higher authority). *Subject(s)* may develop a complex relationship between different and/or conflicting motives. Eventually, incompatibilities among motives may create tensions that can lead to neglectation of all actions to be performed and the “activity may face a breakdown”.

1.1. The Concept of Contradictions

Contradictions can be denials, conflicts or inconsistencies that manifest themselves within and between components of an activity system that interfere the flow of work. Understanding contradictions in an activity system is important in pointing out weaknesses/threats and eventually direct possibilities for change/improvement or transformations in work practices (19-21). In analysing contradictions, (9) propose a model of four types of discursive manifestations of contradiction; double bind, dilemma, critical conflict and conflict.

Double binds are “processes in which actors repeatedly face pressing and equally unacceptable alternatives in their activity system, with seemingly no way out”. For example, when a *subject* is forced to perform an activity with the absence of necessary *tools*. Dilemma is “an expression or exchange of incompatible evaluations, either between people or within the discourse of a single person”. Critical conflicts are “situations in which people face inner doubts that paralyze them in front of contradictory motives unsolvable by the subject alone”. And conflict “take the form of resistance, disagreement, argument and criticism”. This study will elaborate how the activity of data collections and recording unfolds within these manifestations of contradictions.

The concept of contradictions has been used in different studies as a way of analysing problems/hindrances in the flow of work (20, 22, 23). In their study of health care organisation in Zanzibar, (22) used the concept of contradictions to elucidate complex work practices in activities of designing and implementing information systems. Engeström (20) used the concept of contradictions in re-organising work in children’s hospital to uncover things that hindered the flow of work between different parts of the hospital. To understand the role of information sharing in a large-scale implementation of e-learning, (23) also used the concept of contradictions. In these studies, the concept of contradictions has guided them to unpack complexity of ideal systems, which gave way on directing a change.

2. Research Context and Methodology

2.1. Research Context

This is an ongoing study in Kibaha and Bagamoyo districts in the Coastal region of Tanzania. The provision of health care services in Tanzania goes hand in hand with data collection and reporting whereby the health care structure is divided into four levels; the community, district, regional and national level. In the district, region and national levels, services are provided by medical professionals.

At the community level, which is the focus of this study, preventive health care services are provided by non-medical professionals. These are village health workers (VHWs) and traditional birth attendants (TBAs), collectively known as community health workers. Each VHW serves at least 150 to 200 households and they report to the village government and a health facility in their village. TBAs assist women in delivery at home and they are regarded as private practice in the community. One village can have three to ten TBAs. Both TBAs and VHWs provide these services as volunteers.

2.2. Research Methodology

This paper presents a qualitative case study conducted in Tanzania from November 2009 to April 2010. The case aims at understanding the nature and complexity of work practices of TBAs and VHWs around collection, recording and reporting maternal health data. We chose a case study to get closer to TBAs, VHWs, health facility workers and health managers' perspectives in order to get answers on how and why certain events occur (24). This approach has been used in other studies (11, 12, 22) in similar contexts to get deeper understanding of complexities around data collection and reporting.

2.2.1. Data Collection

Interviews

Interviews were conducted between January and March 2010 to 6 VHWs, 7 TBAs, 2 health facility workers and 3 district health managers. VHWs were interviewed in groups of two to three using semi-structured questions. Individual interviews were conducted with TBAs where the questions were also semi-structured. These interview sessions took an average of thirty minutes each, they were recorded on a voice recorder, and transcribed thereafter.

Individual interviews were conducted to health facility workers whereby semi-structured questions were used. These interviews were informal because it was difficult to fit in the tight schedule of health facility workers, so we would pop-in during break times or after work and ask a few questions then continue some other day or time. The district health managers were also interviewed informally with semi-structured questions.

Observations

The aim of conducting observations was to understand activities taking place in the everyday setting in collecting and reporting maternal health data. Through observations we captured what people were doing that they did not tell in interviews. We played a

role of outside observers and participant observers. Observations were also made while conducting interviews and attending training sessions.

Document Reviews

To further improve the richness of data collected in interviews and observations, this study reviewed several documents. Documents reviewed at the district were epidemiology reports, country demographic surveys and ministry of health curriculums for training community health workers. In the health centre we reviewed data collection register (5 Reproductive and Child Health registers) and reports (Monthly and Quarterly reports from January to December 2009). In the community, data collection tools used by TBAs and VHWs, and village register were reviewed.

2.2.2. Data Analysis

In this study data were analysed through data reduction, data displays and verifications as described by (25). Using this method, the voice recorded information was transcribed into written transcripts together with information gathered during observations. From the transcripts, different categories on the data were identified. Then themes and trends emerging from categories were identified using the activity theory concepts. Using the theoretical concept of activity systems (15), we elaborated its individual components (*subject, tools, object, rules, division of labour and community*). The concept of contradictions (9) was also used to analyse manifestations of contradictions within components of the activity systems. Then data displays that elaborated the activity of data collection and recording, and manifestations of contradictions therein were created. Finally the data displays helped us to draw conclusions from the data collected.

3. Work Practices at the Community Level

3.1. TBAs' Activity System

TBAs conducted deliveries and they were supposed to record the outcomes of the delivery, and condition of the mother and the baby. Table 1 presents a description of the TBAs' activity system.

Table 1: TBAs' Activity system

Component	Description	
Subject	A group of TBAs	3 to 10 in one village
Object	Record of delivery information for supervision/investigation	Motivating goal - to gain income and reputation from their society
		Directed goal - to have records on deliveries conducted
Tools	Delivery Registers	2 out of 20 did not have the register
	Reading and writing skills	6 out of 7 could neither read nor write
	Medical skills	- Modern skills – acquired through training - Traditional skills- acquired through apprenticeship
Community	VHWs	Helped TBAs to record deliveries and perform further follow-up
	Health facility workers	Trained TBAs when they brought women with complications to the health centre
	TBAs' Coordinator	Never collected data from TBAs delivery registers
Rules	TBAs conduct emergency deliveries, must record all deliveries conducted, and must report these deliveries immediately to a health centre	Most TBAs did not adhere to these rules
	TBAs' Coordinator must provide support and supervision at least once every quarter	Provided support and supervision at least once in a year or in two years. This was due to shortage of budget to travel long distances from the district to the TBAs' homes
Division of labour	-TBAs record deliveries they conduct, inform health facility workers on deliveries conducted and share observations with VHWs -TBAs' Coordinator collect data from TBAs' delivery registers, and provide support and supervision to TBAs	These roles were either not fulfilled at all or they were incompletely done

TBAs with no reading and writing skills sought help from VHWs, their relatives and children or anyone to help them record deliveries. However, one TBA was skeptical about using health facility workers to record deliveries for them because of the experience she encountered. She said,

“I never got back my register when I brought it to the health facility worker to record a delivery I conducted”

Health facility workers as members of the *community* were expected to ensure that TBAs did not conduct deliveries at home. However they were not able to control what TBAs can and cannot do. On other occasions, health facility workers blamed the TBAs for bringing women to the health centre when they were in critical conditions to avoid being blamed for either the death of the mother, the baby or both. We also observed that TBAs that conducted many deliveries were not collaborating well with health facility workers.

3.2. VHWs' Activity System

VHWs, provided services such as; family planning, integrated management of childhood illness, home based care, mobilisation and monitoring immunisation, reporting maternal and child deaths to the health facility, and reporting disease outbreaks. Table 2 presents an illustration of the VHWs' activity system.

Table 2: VHWs' Activity System

Component	Description	
Subject	A group of VHWs	2 in each village
Object	Records for reporting and follow-up	Motivating goal - to gain reputation from their society Directed goal - to record and report data
Tools	Note books	Un-standardised – lead to no uniformity on recorded and reported data
	Reading, writing and basic mathematics skills	All VHWs possessed these skills
	Medical skills	Inadequate
	Mobile phones	Each owned one
	Pen, pencil, ruler and calculators	Inadequately supplied
	Bicycles	Not all had a bicycle
Community	TBAs	Share findings with VHWs for the purpose of recording and following-up
	Health facility workers	Collaborated with VHWs on following-up mothers and children
	VHWs' Coordinator	Inadequately coordinated support and supervision of VHWs' activities and provision of resources (transport means, stationeries and financial)
	Village government	Poorly collaborated with VHWs to update the village register
	Vertical programmes	Worked with some VHWs in collecting and reporting data and provided them with necessary resources
Rules	VHWs collect data on women from pregnancy up to 42 days after delivery and on children from birth until 5 years, and must submit monthly and quarterly reports to the health centre	Most VHWs did not adhere to these rules because of a large number of households to visit and no motivation for doing so
	Health facility workers must provide support and supervision at least once every month	Provided support and supervision when necessary
	VHWs' Coordinator must provide support and supervision at least once every quarter	Provide support and supervision at least once in a year or in two years
Division of labour	-VHWs perform households visits, collect ad-hoc data from the village, prepare monthly and quarterly reports and submit them to the health centre, and gather observations from TBAs - VHWs' Coordinator and health facility workers provide feedback, support and supervision to VHWs	These roles were either not fulfilled at all or they were incompletely done

VHWs indicated that medical skills enable them to conduct medical observations on mothers and children, also to understand what is recorded by medical professionals in mothers' and children's clinic cards. However, VHWs claimed to have inadequate medical skills. As a result, they encountered difficulties in collecting medical information from mothers' and children's clinic cards, and interpreting it accurately so as to provide appropriate services.

As depicted in Table 2, VHWs used mobile phones to communicate with the health facility workers on requesting directives for conducting diagnosis on mothers/children when something out of the ordinary was observed, reporting their findings when they could not go physically to the health centre. Health facility workers also distributed tasks to be done over mobile phones, for example a need to follow-up on a certain woman/child. Furthermore, findings indicate that inadequate supply of stationeries and transport means led to portions of necessary data on maternal and child

health to be incompletely collected by VHWs, especially those who did not receive support from vertical programs.

The village government, as a member of the *community*, was supposed to receive quarterly reports from VHWs based on births, deaths and other environmental issues which were recorded in the village register. Findings indicate that the village government did not receive any reports relating to mother and child health from VHWs and the village register was last updated in the year 2003.

The activity system of VHWs indicate that, they did not have the necessary tangible tools, skills, means for travelling to reach remote households and a standard for receiving incentives for providing the services to the community. To collect and report mother and child health data, VHWs felt that their role was not recognised because they hardly received any motivation. However, they felt honored to work for their villages despite of all the neglections. One VHW commented that:

“The last time I was paid was two months ago when we were distributing mosquito nets for under five children in every household. However, I feel obliged to work for my village”

4. Manifestations of Contradictions in Collecting and Recording Data

In the activity systems of TBAs and VHWs, findings indicate the presence of multiple viewpoints between TBAs, VHWs, health facility workers, district health managers, village government and vertical programs. Findings also indicate that TBAs and VHWs were collecting and recording maternal health data with two conflicting goals, motivated goal and directed goal. These complex relationships created contradictions that were manifested through double binds, dilemmas, critical conflicts and conflicts. This section presents further analysis and discussion of the findings.

4.1. Double Binds

In this study, double binds as unacceptable alternatives that faced *subjects* (TBAs and VHWs) and left them no way out in collecting and recording data were identified. Analysing the history of the *tools* used, we identified how they led to impossibilities in collecting and recording the data.

TBAs who did not have registers could not collect and record deliveries. Also TBAs who depended on other people around them to record for them, when no one was found, no deliveries were recorded. Although the action of conducting delivery was accomplished, the action of recording deliveries was not done in most cases.

In the VHWs' activity system, the use of un-standardised registers created no coordination of the data collected and reported by VHWs. Even though VHWs had recorded data for reporting, they could not assure its completeness. With the usage of un-standardised registers, VHWs were facing a double bind whereby the *tools* they used made it impossible to accomplish their roles and to attain *object* of the activity.

Findings also indicate that VHWs had little skills on medical data collection and recording and further analysing data so as to make proper follow-up on mothers and children. This made it was impossible to collect complete and accurate information where they were supposed to observe medical conditions. In such cases, the *object* of having recorded data for follow-up was either not attained at all or it was attained

halfway. Also with poor medical skills VHWs encountered difficulties in performing their roles of collecting data and preparing reports.

Furthermore, findings indicate that VHWs did not receive adequate stationery facilities, transport means and necessary incentives to support them in performing household visits. Working in this condition, VHWs constantly faced difficulties in performing their roles in the *division of labour* and attaining the *object* of the activity.

According to (18), when an individual cannot attain a desired motive, “the activity does not have a direction until the object of an activity is defined”. In this case, the directed goals could not be attained and eventually the *object* of the activity became ineffective. Even though TBAs and VHWs’ own goals were attained, the activity of data collection and recording was facing a break down. According to (9) double binds can be resolved through transformative and collective action and not by an individual alone. Similarly in this case, findings indicate that double binds could not be resolved by TBAs and VHWs alone. There is a need of a collective effort especially from the district managers to provide adequate supply of the *tools* (register books, skills, stationeries, transport means and incentives) necessary to enable data collection and recording.

4.2. Dilemmas

These are situations that faced TBAs and VHWs in moral reasoning about whether to engage in the activity of recording and collecting data or not. Findings indicate that TBAs were forbidden to conduct deliveries unless it was an emergency. This rule contradicted itself given the nature of the context where there are long distances between the women’s villages and a nearby health facility, inadequate availability of health facility workers and equipments in health facilities and unpleasant attitudes of overworked health facility workers. These issues forced many women to seek delivery services from TBAs and as a result most TBAs found it intolerable to keep the *rules* because they were helping a woman even though they were breaking the law.

TBAs also considered conducting deliveries as a source of income because they received some form of payment from the mothers after providing their service. At the same time, TBAs were bound by the *rule* of conducting emergency deliveries only then record and report them to the health centre. This *rule* enforced TBAs to be accountable on how many deliveries they recorded in their registers. With the fear of raising an alarm on their reputation when they recorded many deliveries, TBAs were in constant dilemma between helping a woman and gaining income or recording deliveries. This led to neglecting recording of non-emergency deliveries for the sake of helping women and/or gaining some income.

VHWs are voluntary health workers who did not receive a salary. At the same time, VHWs wanted to keep their identity in the community by providing services to the people. Also VHWs were bound by the *rule* of presenting monthly and quarterly reports to the health facilities and village government. In this manner, they faced a dilemma because they were desperate to get salary, which they did not, while there was a *rule* enforcing them to present monthly and quarterly reports.

This study indicates that the manifestation of dilemmas encouraged TBAs and VHWs’ to choose to perform actions with motivating goals over the actions with directed goals. According to (9), dilemmas cannot be resolved but rather reproduced through denial or reformulation. This study indicates that dilemmas can be resolved by translating the directed motive for performing actions to a motivating goal. TBAs and

VHWs can be motivated to record deliveries by rewarding them for doing that instead of ordering them to record.

4.3. Critical Conflict

These are reactions that emerge when a *subject* creates a feeling of being neglected. Findings indicate that when TBAs and VHWs felt that they were neglected and no one cared about what they were doing for their society, critical conflicts emerged and the activity of collecting and recording data paralysed. Findings indicate that the health managers and health facility workers provided TBAs and VHWs inadequate and irregular support and supervision, and little meaningful feedback. According to (26), it is important to provide meaningful feedback to data collectors because “they will begin to appreciate the value of data and will therefore take appropriate steps to improve the quality and timeliness of the data”.

According to (9), critical conflicts can be resolved by “finding new personal sense and negotiating a new meaning”. This study suggests that a new meaning for improving recording and collecting maternal health data can be created among health managers, TBAs, VHWs and health facility workers. Health managers and health facility workers have to realise the contribution of TBAs and VHWs in both reducing maternal and child mortality and improving reporting of maternal health data. This realisation will encourage them to provide support, supervision and feedback to TBAs and VHWs and thus improve reporting as also suggested by (26).

4.4. Conflict

Conflicts are interferences of actions among *subjects* and /or *community* members that create contradictions. Findings of this study indicate manifestation of conflicts between health facility workers and TBAs when TBAs brought women to the health facility for delivery with critical conditions. In this situation health facility workers described that TBAs failed to help the women and were afraid to be blamed for their death or the death of the baby so they refer the women in critical condition which could be too late to be handled by health facility workers. In such situations a TBA’s register was taken by a health facility worker and never handled back to the TBA. This conflict led to further neglecting of reporting deliveries from the TBA.

In the manifestation of conflict, this study indicates that the motivated goal in the TBAs actions took preference over the directed goal. The consequences may have not only jeopardised recording of the data but also the lives of women and children attended by the neglected TBAs. Findings suggest that this conflict can be resolved by finding a compromise that will open up communication among TBAs, VHWs, health facility workers, women and village members. Health facility workers need to strengthen their communication ties with TBAs on what should be done, when and how in order to save lives of women and children. Also opening up communication between VHWs, TBAs and mothers together with other members in the village on handling emergency deliveries by defining who should be notified, when and how.

Complementing with the work of (6) who argue that, the use of mobile phones will enhance communication between community health workers and health facility workers and improve collection and reporting of maternal health data. There is a need of first understanding contradictions that hinder data collection and recording. This study has shown that they are intertwined in the daily practices of community health

workers. This understanding can guide creation of solutions that will re-orchestrate multiple voices in the activity of data collection and recording as a way of improving under-reporting of the data. Whereby introducing the use of mobile phones is part of the solution.

5. Conclusion

This study has indicated a need for redefining *object* of the activity systems of TBAs and VHWs in collecting and recording maternal health data. We therefore recommend that, to improve reporting of maternal health data at the community level, one needs to understand how the data are collected and recorded through the identification of contradictions that manifest therein. These can be identified through understanding the history of the *tools* used, *rules* enforced and organisation of roles in the *division of labour*.

The acknowledgement and hence resolution of contradictions can lead as a stepping stone in designing a solution for identified weakness in the system. This study has indicated that the manifestation of double binds can be resolved by a collective effort between the district managers, and TBAs and VHWs whereby district managers should ensure provision of adequate supply of tools necessary for data collection and recording. Dilemmas can be resolved through reformulating motives of TBAs and VHWs by rewarding them to record deliveries instead of ordering them to record. Critical conflicts that crippled the activity systems can be resolved when health managers and health facility workers appreciate the contribution of TBAs and VHWs in improving recording and collecting maternal health data. Conflict can be resolved by strengthening communication ties among TBAs, VHWs, health facility workers, women and village members on how to disseminate information, who to be contacted, when and how.

This work is relevant for developing countries because it addresses issues of under-reporting of data which are critical in the health information systems as stated in previous studies (3-6, 11, 12). In addition we propose another way of understanding the problem by exploring conditions that lead to the presence of double binds, dilemmas, critical conflicts and conflicts that are contextually grounded in the work practices of community health workers. We also propose ways of resolving these contradictions as a collective effort between the community health workers, health facility workers and health managers.

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Appendix 3: PAPER III

Ngoma, C. and Igira, F. T. (Forthcoming). Re-organising Collection and Recording of Maternal and Child Health Data through an Intervention of Resolving Contradictions. *Submitted to an International Journal.*

Empowering Community Health Workers to Collect and Record Maternal and Child Health Data by Resolving Contradictions

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Abstract:

Background

It was noted that traditional birth attendants, village health workers and health facility workers to a substantial extent failed at collecting and recording maternal and child health data in the community.

Methods

This is a qualitative study and data were collection using interviews, observations, participant observations, focus groups and document reviews. To analyse the data, we used the concept of contradictions from the Cultural Historical Activity Theory (CHAT) as an analytical tool to understand manifestations of contradictions that hindered collection and recording of the data.

Results

Based on the analysis, results indicate that, traditional birth attendants and village health workers were empowered to adapt new information practices, which led to improvements in recording and reporting of births, follow-up on pregnant women and an increase of referred women for deliveries to the health center.

Conclusion

This study demonstrates that traditional birth attendants and village health workers' information practices can be changed through understanding and resolving manifestations of contradiction that hinder them to collect and record maternal and child health data. This study also indicates that, traditional birth attendants and village health workers should be empowered to improve their performance and confidence in capturing and communicating these data.

Key Words: information practices, empowerment, transformation, community health workers, contradictions.

1. Introduction

Sub-Saharan countries are challenged with higher rates of maternal and child mortality which results from different factors. Studies have shown that it is difficult for most developing

countries to meet the Millennium Development Goals (MDGs), especially goals 5 and 6 that stress on the improvement of maternal and child health. There is evidence that, involving community-based health workers in capturing and communicating community health data is a crucial step to achieve the health related MDGs [1-4].

Community health workers provide preventive healthcare services to the majority of the population in rural communities in most developing countries. They are the first contact of women and children before the health facilities. However, research indicates that they lack appropriate skills and they are hardly motivated [1-3, 5, 6]. In this regard, research has emphasized the need for empowering community health workers in order to improve the collection of complete and accurate data from the community level.

The availability of reliable data is specifically important for local management as well as overall management of Health Information System (HIS) [7]. In provision of maternal and child health, information on checkups made, vaccinations and medications provided to pregnant women and children, and information on births is crucial for health workers because it enables and facilitates management and provision of continuous care to women and children [5, 8]. However, in most developing countries, the reliability of maternal and child health data is questionable. To improve production of and access to reliable information in HISs in this context, research emphasise on using Information Technology (IT) [9-13]. But still little is understood about how to develop technologies that will be suitable in the developing countries' context.

Research on information systems development within healthcare in developing countries critically emphasise the need for understanding the context where the technology will be used [14-19]. Due to the nature of healthcare provision, that involves complex procedures and social relations, research has proposed to use of Cultural Historical Activity Theory (CHAT) to understand the context in order to be able to identify requirements, to inform system development, that reflect the lived practices of health workers [14, 15, 17, 18, 20]. CHAT provides analytical lens to focus on people's daily activities, tools they use in those activities, the social and contextual relationships established by rules and division of labour among the people collaborating in those activities.

Korpela et al. (2013) describe that context can be understood by understanding the context of health providers, technology providers and the people who receive the services. A systemic view of these stakeholders is crucial in providing insights on tension and misfits in their daily practices. Focusing on health workers, Igira (2012) describe that to understand

their practices, special consideration on how the work practices are affected by the dynamics of everyday life must be taken into account. Igira emphasizes a holistic understanding of tensions that face health workers in providing health services, data collection, management and reporting, and managing the health facility logistics. Considering the fact that communities and health facilities are the major sources of health data in the HIS, research however, has put more emphasis on understanding information practices of health workers at the health facility levels than at the community levels. Understanding the community health workers' information practices is highly important specifically on improving the quality of maternal and child health data within the HIS. Since the completeness of health facility data highly depends on the data reported from the communities. This paper covers this gap in literature by describing a case that involves re-organisation of work practices of traditional birth attendants and village health workers which led to improvements in referral cases of pregnant women to health facility and recording of births they conducted.

Furthermore, research also emphasises on the importance of putting work processes in place before the implementation of IT [21]. Few studies, example Freitas and Byrne (2006) have demonstrated how to do this. This paper also contributes to the IS development community by demonstrating the necessity of re-organising the existing paper-based system and changing information practices among stakeholders involved as a way of developing information systems to facilitate collection and recording of maternal and child health data. To elaborate and analyze the work practices, we have adapted the concept of contradictions as conceptualized in CHAT [22]. CHAT emphasizes the collective nature of human activity and view organizational change as a sequence of events around which practices are transformed, following a process of resolving contradictions [23, 24].

In this paper we will answer the question: How to change community health workers' information practices in order to improve reporting of maternal and child health data from the community level?

The organisation of the rest of this paper is as follows. Section 2 presents the literature review; particularly focusing on discursive manifestations of contradictions and their contribution in transformation of work practices. Furthermore, the section presents related approaches in organizational learning. Section 3 presents research approach and data collection methods. Section 4 presents the empirical material, data analysis and discussion. Section 5 presents concluding remarks.

2. Literature Review

In this section, we describe literature review on CHAT's concept of contradiction to describe manifestations of contradiction and their resolutions as a way of establishing balance in an activity system. We also describe the concept of motivation and training to elaborate their importance in creating actions that can empower individuals to direct behavior towards performing their activities.

2.1. The Concept of Contradictions

CHAT describes that, to understand context, one must understand the relationship between individuals and their daily activities. These are cultural-historical influences that can be understood by examining tools used, rules enforced and organization of roles in the division of labour [25]. The tools, rules and division of labour mediated the interactions between individuals and their daily activities [18, 23, 26, 27]. The mediators have the power of enabling and restricting the interactions. Engeström (1987) describes that an activity is a "system of collaborative human practice" whereby each component of an activity can be a product of other activities as demonstrated in Figure 1. Thus an activity can be analysed in relation with other activities connected to it. This analysis can be guided by identifying contradictions within and between the activity systems.

Contradictions constitute a key concept in CHAT and are characteristic of activity systems [23, 28]. They are not simply conflicts or problems, but are "historically accumulating structural tensions within and between activity systems" Contradictions are important, not in and of themselves, but because they can result in change and development [28]. In analyzing human activity Engeström (1987) propose four levels of contradictions; primary, secondary, tertiary and quaternary. As presented in Figure 1 (numbers 1-4);

1. Primary contradictions appear within each component of an activity system
2. Secondary contradictions appear between components
3. Tertiary contradictions appear between object of the central activity and object of a more advanced central activity
4. Quaternary contradictions appear between the central activity and other activities in the network.

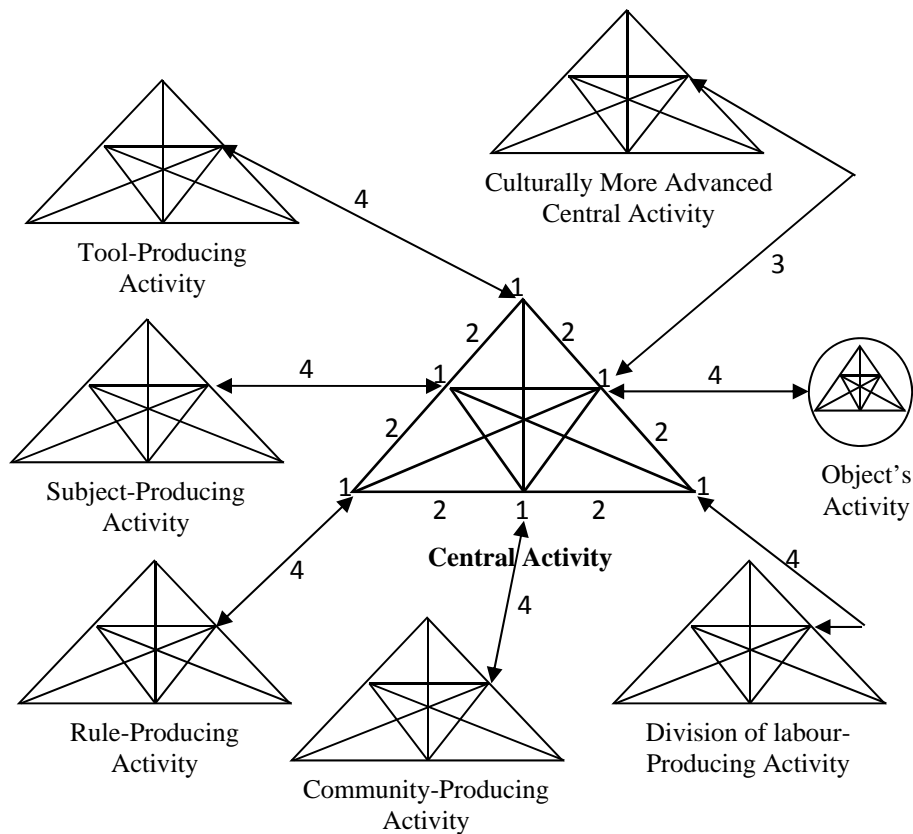


Figure 1: Network of Activities [23]

According to Engeström and Sannino (2011) these contradictions can be understood through their manifestations. They argue that in current organizational literature and research, the meaning of the term contradiction is commonly left vague and ambiguous [22]. In this regard, they clarified this vagueness and ambiguity by identifying four types of discursive manifestations of contradictions: dilemma, conflicts, critical conflict and double-bind.

Dilemmas are incompatible evaluations on whether to perform the activity or not. Tensions that take form of dilemmas are rather difficult choices that lead to selecting one of two alternatives [29]. Dilemma is more hesitations such as on one hand and the other hand type of condition. A dilemma is typically reproduced rather than resolved, often with the help of denial or reformulation [22].

Conflicts are resistance, disagreements, arguments and criticisms. It occurs when a divergence of interests take place. Conflicts are typically resolved by means of finding a compromise or submitting to authority or majority (ibid).

Critical conflicts arise from neglects that paralyse people from performing the activity. In social interaction context the person in critical conflict feels isolated, guilty and

even silenced [30]. Critical conflicts are resolved through finding new personal sense and negotiating new a new meaning for the initial situation [22].

Double binds are pressing and unacceptable alternatives faced in performing an activity. They involve circumstances of being under enormous pressure and cannot be resolved by an individual alone. A double bind is resolved through practical transformative and collective action that goes beyond words (ibid).

The analysis of the four discursive manifestations of contradictions serves as the basis for planning steps to be taken in resolving contradictions and thus bringing transformation. This is like putting a mirror before an organisation and reflect on the reality and from there learn how people encounter “impossible tasks, stress and failure” [31] in performing their daily activities. Since we can hardly detect contradictions we need to uncover them by using their potential manifestations.

The resolution of contradictions brings back order in an activity system. CHAT demonstrates this as a re-mediation or re-organisation of an activity system whereby the relationship between the components will change and a new context with new practices will emerge. Despite of the fact that CHAT emphasise on re-mediating activity to bring about transformation, CHAT does not describe how individuals can change their behavior towards engaging in an activity. Literature on empowerment can brings more insights on this matter.

2.2. Health Workers’ Empowerment

According to Castelloe & Watson, “empowerment occurs when people come to critically understand, then act to change, their personal, social, economic, political, and cultural situations” [32]. This can be realized when individuals participate in activities that are likely to be driven by goals that promise some type of pay-off such as “satisfaction, sense of accomplishment, expansion of action possibilities, expansion of control over life conditions” [33].

In most developing countries, studies indicate the state of poor quality of data collected in health information systems [3, 6, 12, 15, 16, 34-36]. To improve the situation, research emphasise on the need for empowering health workers. Braa et al. (2001) and Lippeveld (2001) describe that, health workers can be empowered by improving their skills on understanding and using their data instead of obliging them to collect and report more data. Other studies emphasise on motivating health workers by providing them with adequate

supportive supervision, meaningful feedback and incentives (Franco et al. 2002, Hongoro and Normand 2006, Mathauer and Imhoff 2006, Hamre and Kaasbøll 2008).

Though health facilities and communities are the major sources of data in HIS, there are few studies conducted at the community level with a specific focus on maternal and child health data (Kanjo 2011, Damtew and Aanestad 2012, Kanjo 2012, Damtew and Moges 2013). Health workers at the health facility level will necessarily be empowered by different things/situations as compared to community health workers who are volunteers and regarded as periphery workers without a job description or salary scheme. Research from the community level emphasise that, community health workers can be empowered by involving them in collecting and reporting the data from the community. To do so, Kanjo (2011) and Kanjo (2012), urge policy makers to revise policies that discourage TBAs to report births. Damtew (2010) and Damtew & Aanestad (2012) propose the need for providing health extension workers with appropriate and adequate data collection tools. Even though these studies describe how to empower community health workers, they have not demonstrated how this can be done.

With a specific focus on improving collection and reporting of data from the community level, this study demonstrates the importance of empowering TBAs and village health workers by providing them with appropriate data collection tool and motivating them to record the data. Since health workers view data collection as an excessive demand from higher authority and not as a part of their job [37], it is necessary to understand what can encourage them to record data despite their reservations. In the following sub-sections, we describe motivation and training as major factors that can encourage a change of behavior towards performing actions.

2.2.1. Motivation

Motivation is “an individual's degree of willingness to exert and maintain an effort towards organisational goals” [38]. The concept of motivation has been promoted by behavioral psychologists who regard that, actions of human beings are governed by rewards and punishments and their motives are governed by behaviors to seek pleasure (food, sex, companionship) and avoid pain (social rejection, physical harm, lack of food). Luoma describes this an expectation for personal reward whereby workers will initiate and sustain to work if someone cares about their performance and whether there is a reward in return [39].

In this regard, the concept of motivation brings an understanding that, in a collective activity [26], behaviour is expected to be created towards gaining a reward.

Studies elaborate that motivation mechanisms such as provision of support, supervision, feedback and incentives to health workers can create an atmosphere for behaviour change [40-43]. Health workers in Kenya and Benin indicated that “supervision provides the feeling of being cared for and of appreciation” [42]. Mathauer & Imhoff (2006) indicated that when health workers receive meaningful feedback during supervision, their performance was improved. Ashford et al. (2003) also elaborate that people seek feedback for many reasons, one reason is “to attain a goal and perform well” [44]. In this manner feedback is a reflection from which, one reflects on their performance with regard to goal attainment through making a change.

Incentive as another form of motivation is a reward that associate positive meaning presented after the occurrence of an action with the intention to cause the behavior to occur again. Provision of incentives has been applied as a motivational factor to improve work performance [41-43, 45]. In the study of motivating health workers by giving incentives conducted in Cambodia, results indicated that provision of performance-based incentives led to provision of “better quality health services” and “increased health worker productivity”. According to Dieleman et al. (2003) provision of incentives, being it financial or non-financial, can achieve better performance if it is focused on “showing appreciation and respect”. However, these attributes are highly grounded in the context; they may produce different results in different contexts.

Furthermore, designing incentive mechanisms for health care workers in developing countries can be difficult when it comes to deciding “what to measure and how to measure it” [39]. Luoma proposes using ‘general productivity measures’ such as “hours worked, patients seen per day, cases treated and immunizations delivered” and ‘specific performance measures’ such as “adhering to clinical counseling guidelines, ensuring supply stocks, making supervision rounds and promoting condoms”.

The emphasis of this study is to motivate TBAs and village health workers to record and report the data. Doing so, an incentive mechanism was designed to monitor their performance by measuring the amount of records they kept on births conducted, referral cases made and pregnant women they registered as well as the health facility records on births conducted at the health facility. To be able to do so specific data collection tools were designed to keep

these records. To enhance data recording, training was given to improve skills including using the data collection tools.

2.2.2. Training

From organisational learning studies, the process of changing organizational behavior by improving actions through better knowledge and understanding can be achieved through learning [31, 46-48]. An organisation is considered to learn when organisation members use knowledge acquired through training, workshop, seminars etc. to make better decisions, improve the organizational ability to develop and apply specific tactics that will improve organisational performance.

Research has shown varying reports on the impact of training community health workers in improving women's health during pregnancy, birth and after delivery [49-52]. However there is a consensus that when community health workers are trained, there are significant improvements in linkages between the community and the health facility level. This link is significantly important in improving reporting of maternal and child health data. However previous studies have not looked into the impact on data, this study covers this gap in literature.

This paper conceptualizes training as defined by Nadler (1970) as “activities that are designed to improve job performance by introducing a new behavior or modifying existing behaviors.” Training has been widely used to impart knowledge to learners in different disciplines including HISs [53, 54]. However training is often ineffective if is not properly arranged and conducted. Ngoma (2007) describes that when health workers gained skills on data collection, report aggregation and data utilization, they changed their perceptions toward the data and started to ensure its completeness and accuracy in order to make appropriate decisions out of it.

Though CHAT emphasizes on re-mediation as a way of resolving contradictions, it is also important to understand what actions will enforce change of behavior toward performing actions especially when the components of an activity system are a product of a management activity system. Empowering individuals to be aware of the positive consequences of their performance can enforce a change in behavior.

3. Research Context and Data Collection Methods

In this section we present the empirical setting and data collection methods used.

3.1. Context

The intervention study that is reported in this paper was conducted in Kibaha district of the Coastal region in Tanzania as part of the ongoing efforts in improving reporting of maternal health data from the community level. The community is the lowest level of health care provision in Tanzania which provide preventive health care services. These services are provided by Village Health Workers (VHW) and Traditional Birth Attendants (TBAs). TBAs assist mothers when there are emergency deliveries.

TBAs are supposed to record deliveries they conducted. The records of deliveries were supposed to be collected by district health managers and reported to the districts. They do not have professional medical training, rather, they use experience and knowledge gained through family relations. Most of the TBAs cannot read and write. The VHW also do not have professional medical training and they are supposed to report data on the provided services to the village government, vertical programs and a nearby health facility.

3.2. Data Collection Methods

This study used qualitative data collection methods: interviews, observations, participant observations, meetings, focus groups and document reviews. We chose this approach to gain an in-depth understanding of social meanings and social relations between TBAs, VHWs, Health facility workers (health center nurse and doctor in-charge) and health managers (TBAs' Coordinator and VHWs' Coordinator) in collecting and recording maternal health data. The analysis of the empirical material was informed by the four discursive manifestations of contradictions as discussed by [22].

3.2.1. Interviews

Interviews were conducted to 6 VHWs, 7 TBAs, 2 health facility workers and 3 district health managers. These interviews were conducted between January and March 2010. The objectives of interviewing VHWs and TBAs were to understand the data they collected in the community, how they were collected and recorded, where they were reported and challenges they faced in collecting, recording, transferring and storing the data. The objective of interviewing health facility workers was to get an understanding of how they worked together with VHWs and TBAs and how they supported and supervised them in their daily activities.

The district health managers were interviewed with the objective of understanding how they perceived, valued and supported the contribution of community efforts in reporting maternal health data from the community. Another objective was to assess procedures used in designing data collection registers and report forms, and providing feedback and supervision.

3.2.2. Observations

Observations were conducted with the objective of understanding how the activity of data collecting and recording was taking place in everyday practices of TBAs, VHWs and health facility workers. We observed execution of different tasks, the environment within which VHWs, TBA, and health facility workers operated and the tools that were used to accomplish their activities. We also observed practices in recording information used by VHWs while they were doing household visits and compiling monthly reports. In the health facilities, we observed health facility workers during provision of maternal health services in antenatal, postnatal and children clinic sessions.

3.2.3. Participant Observations

We also used participant observations where we were actively involved in the intervention. We participated in training sessions where training was conducted to VHWs and TBAs by district health managers and health center nurse in-charge. In the TBAs' training session, twenty TBAs attended and the training took five days with six hours every day. VHWs training session included eleven VHWs and they were trained for three days with nine hours every day. In these sessions we were actively contributing our views in the discussions. We were also involved in designing new data collection registers where we contributed on what data should be collected and how it should be presented on the registers. The usage of new data collection registers also involved re-defining rules and roles in the division of labour regarding data collection and recording. The process of re-designing the registers and re-defining rules and roles was done by the health managers in collaboration with the health center nurse in-charge, VHWs and TBAs. We were involved in these activities as consultants to share our experiences.

The objective of collecting data using participant observations was driven by the intervention approach we applied in bringing about a change in work practice. With this approach we were involved both as researchers, as practitioners and as consultants. Even though we were not the main drivers of this intervention, our contributions were taken aboard.

3.2.4. Document Reviews

To further improving the richness of data collected in interviews and observations, this study reviewed several documents. At the district level, documents reviewed were epidemiology reports, country demographic surveys and ministry of health curriculums for training community health workers. In the health center we reviewed data collection registers (5 reproductive and child health registers) and reports (quarterly reports from January to December 2009). In the community, documents reviewed were data collection tools used by TBAs and VHWs and government registers.

These documents were reviewed to get an understanding of the problem domain, guidelines for collecting and reporting maternal health data, what data were collected and reported at the community and health facility levels and different roles and responsibilities of VHWs, TBAs, health facility workers, district health managers, village government and vertical program in accomplishing collection, recording and reporting of maternal health data.

3.2.5. Focus Groups

In focus groups data was collected for the purpose of identifying contradictions and evaluating results of the intervention. The focus groups were created in meetings. These meetings were held at the village where training was conducted. One meeting was on the 22nd January 2011 (one year after the intervention) and the second was on 18th June 2011 (one and half year after the intervention). In both meetings a focus group of nine VHWs and one health center nurse in-charge that was assigned the role of supervising VHWs and TBAs in a new organisation of work were created. The aim of these focus groups was to evaluate the work done by VHWs and TBAs after the intervention and to identify TBAs and VHWs with outstanding performance.

In these groups we introduced discussion topics on the achievements and challenges encountered in collecting and recording maternal health data as experienced by TBAs, VHWs and health center nurse in-charge. In the discussion we were able to collect data on changed behaviours and practices among VHWs and their collaborations with TBAs and health facility workers.

4. Findings

This section presents findings of the study by elaborating how the work practices of TBAs and VHWs were transformed through an intervention.

We started our intervention by studying the execution of tasks in collecting and recording maternal health data as it is was done by VHWs and TBAs (see Ngoma and Igira, 2012). The findings indicated manifestations of contradictions as summarized in Table 1. We further present the reflection of the intervention after training was done, new and improved data collection tools were introduced, and an incentive mechanism was introduced.

Table 1: Manifestations of Contradictions and their Proposed Resolutions

Manifestation	Features	Indicative Findings	Proposed Resolution
Double binds	TBAs and VHWs faced unacceptable alternatives in recording and collecting data	The need for data recording Vs inadequate and/or lack of delivery registers, use of un-standardised registers, not having reading, writing and medical skills, limited stationeries, unreliable transport means and receiving no incentives.	<ul style="list-style-type: none"> - Introduce new and improved tools (standardised registers, stationeries, transport means and incentives) - Ensure adequate supply of the tools - Provide training to improve skills
Dilemmas	TBAs and VHWs faced incompatible evaluation on whether to record and collect data or not	<ul style="list-style-type: none"> - TBAs were torn between helping women and gaining income, and recording deliveries. -VHWs were torn between voluntary workers with no income, and recording and reporting information as a responsibility of a VHW 	<ul style="list-style-type: none"> - Translating the directed goals for performing the actions to a motivating goal by rewarding TBAs and VHWs to record data instead of ordering them to record -Re-defining the rules enforced
Conflicts	Unpleasant working relation between TBAs and health facility workers	TBAs referred women with critical conditions to the health center and when confronted, they stopped referring women and also did not record deliveries	Re-defining the roles and rules to open-up communication among and between TBAs, VHWs, health facility workers, women and village members whereby the use of mobile phones is one thing that can facilitate the communications.
Critical Conflicts	TBAs and VHWs were unmotivated to perform any actions in their activity systems	Inadequate and irregular provision of support, supervision and feedback to VHWs and TBAs by health facility workers and district health managers	Re-defining the roles of health facility workers and district health managers in providing support, supervision and feedback

In the activity of collection and recording of maternal and child health data, Ngoma & Igira (2012) presented the TBAs' and VHWs' activity systems as central activities under analysis. In both activity systems, the tools used, the rules enforced and the division of labour

were produced by the management activity system, the Health Management Information System (HMIS). These are illustrated in Figure 2.

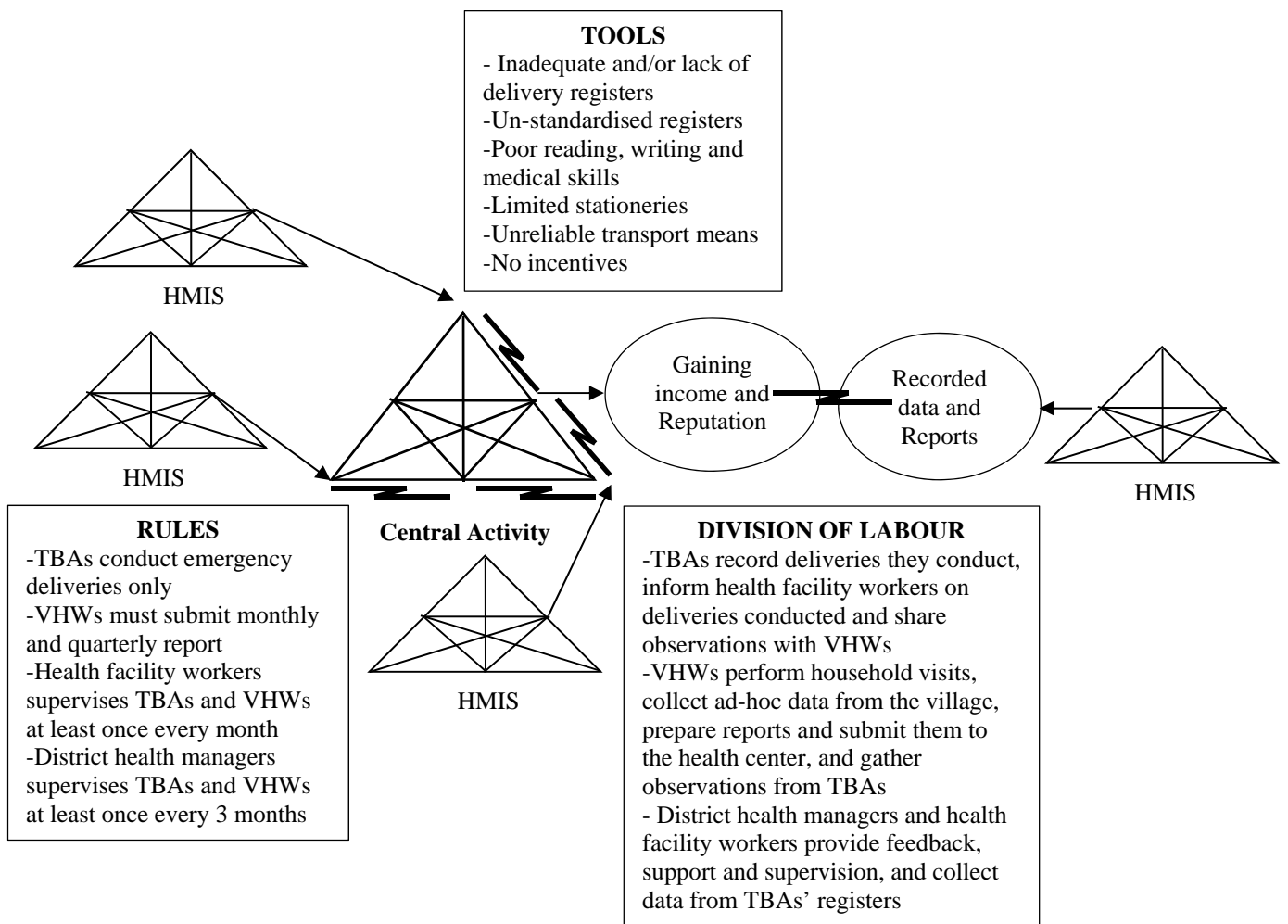


Figure 2: Primary and Secondary level Contradictions

Primary contradictions within the object of the activities were manifested through dilemmas whereby TBAs and VHWs had to choose to record the data or not. In cases where they chose to record the data, findings indicate that they were faced with unacceptable conditions that discouraged them to do so. These were identified as double binds and critical conflicts that were a result of available tools to perform the activity, established rules and regulations, and organization of roles in the division of labour. These led to secondary contradiction indicated by the lightening arrows in Figure 2. Another primary contradiction was identified as a manifestation of conflict between TBAs and the health facility workers within the division of labour.

4.1. Intervention

In this study an intervention was introduced as a solution that will resolve the identified contradictions as presented in Table 1. Training was proposed as a mechanism for improving skills of TBAs and VHWs in data collection and recording. Training was also aimed at raising awareness of the importance and procedures that need to be taken to improve reporting of maternal health data. Another solution proposed was to design new data collection tools that will enable and improve collection of data from TBAs and VHWs. Furthermore an incentive mechanism was devised to encourage recording and referring women and children to the health center.

4.1.1. Training

In 2006, TBAs received training from the TBAs' coordinator from the district for the first time. In that training the emphasis was both on medical practices and recording of births conducted. To support the recording, TBAs were given register to use. In this intervention, TBAs and VHWs were trained with two main objectives. The first objective was to improve VHWs and TBAs' skills and knowledge on data collection, recording and reporting. The second objective was to improve knowledge and skills on professional provision of medical assistance to pregnant women throughout their pregnancy, during delivery and up to forty two days after delivery together with monitoring health status of the babies from when they are born until five years of age.

Traditional Birth Attendants' Training Session

This training was focusing on improving skills on keeping up-to-date records about pregnant women and their delivery outcomes, referring women to deliver at the health center, keeping record of the referrals and recording births of new born babies. The skills given to TBAs did not focus on how to read and write but who to inform when they want to record or report something, when they observe something and how to observe danger signs on pregnant women and report them to the health center or VHWs.

Training method used in this session were discussions, questions/answers and singing and dancing. The classroom arrangement was everyone sitting down around the trainer. Since most TBAs could not read and write, all the training materials were composed into songs. There were 4 training sessions in each day and every session lasted for 1 hour. In each session discussions and questions and answers sessions were done in the first 15. The rest of the time

was spent on singing and dancing. These training sessions were very interesting because of the unique way they were conducted.

Village Health Workers' Training session

The goal of training VHWs was to improve community data management in Kibaha district council by improving VHWs' skills and knowledge on data collection, analysis, utilization and storage. The training focused on keeping an up-to-date record of pregnant women and their follow-up throughout pregnancy, delivery and forty two days after delivery, improving collaboration with TBAs, and improving medical skills of VHWs to enable them to make proper diagnosis and hence recording, and follow-up of women and children. VHWs were also trained on the importance of updating the village register and how to update it every quarter.

Training method used were brain-storming sessions, discussions, group work, questions/answers and role plays. The classroom arrangement was a traditional classroom with a trainer in front lecturing. Training materials used were flip charts, data collection registers and report forms.

4.1.2. Designing Data Collection Tools

During the training sessions, we (researchers, district managers, VHWs and TBAs) discussed on the new format of registers that will accommodate standardised collection of data about pregnant women and birth registration and at the same time follow-up on the performance of TBAs and VHWs. We (researchers) proposed a design of an initial version of the registers where we indicated the necessary data elements to be collected. This design was then discussed in the training sessions together with district health managers, health facility workers, VHWs and TBAs. We collected their comments, amendments were made and the final design was agreed upon and it was put on the registers by VHWs. After the training, TBAs and VHWs were given the new registers.

Registers given to TBAs were two; one was a new book which was based on the current design of delivery registers they were using. This was to record all the deliveries they conducted as they did before. The other register book was of a different design where they were to record the names of all the mothers they refer to health center for delivery and to record all the new born babies. These records were to be verified and signed by the health center nurse in-charge. All the recorded information was to be reported to the health center or

to a VHW. With the new register book, TBAs could keep record on how many mothers they have referred to the health center and the number of births they registered.

VHWs were also given two register books and stationeries to support their daily activities. Of the two registers, one was to be used to record pregnant women in their respective village and their outcome of delivery. This was a new register for them to use. The other register book was an additional notebook for their daily activities.

VHWs and TBAs were trained on how to use the register books and how to collect the data from women and children both on interviewing them and on carrying out observations. In addition to the training, VHWs were also given stationeries such as pens and rulers to support them in data collection and preparation of reports. VHWs were thrilled not only because they gained new skills but also because they received registers and stationeries to use.

4.1.3. Incentive Mechanism

This study also introduced an incentive mechanism to encourage TBAs and VHWs to collect and report complete data from the community. This mechanism was introduced by a district health manager who copied a similar mechanism used in other districts where it has shown improvements on reducing deliveries conducted by TBAs. However the district health managers declared that they have not been able to introduce it in their district due to shortage of funds. In this intervention, the incentive was planned to be given to TBAs if the number of women referred to health center was higher than the ones they assisted for delivery at home. This incentive also was a way of motivating TBAs to record all the referrals and births in their register and to discourage them to conduct deliveries at home.

The training session in itself was taken as an incentive both to the TBAs and VHWs. The new registers together with stationery facilities provided were also considered as incentives. VHWs and TBAs perceived these as means necessary for accomplishing their tasks and also as a way of being recognised and appreciated.

4.2. Results

After the training, introduction of new data collection registers and provision of incentives to TBAs and VHWs, this study evaluated and reflected on the intervention. The evaluation focused on the changed work practices of TBAs and VHWs in collaboration with health facility workers and district health managers based on three criteria; usage of register books to record births, pregnant women and referral cases. The second criterion was on recorded information at the health center on the number of deliveries conducted at the health center as

compared with those conducted by TBAs. The third criterion was recording new information in the village registers. Generally we evaluated the improved collaborative work among TBAs, VHWs, health facility workers and district health managers in recording and collecting maternal health data at the community level.

The evaluation was done two times; immediately after training and one year after the intervention. This section presents the results.

4.2.1. TBAs' Work Practices

Immediately after training, TBAs started to show improvements. For the period of 10 days spent in the field, 3 mothers were referred by TBAs to the health center for delivery. This happened five days after the training. These TBAs were attending the training session and they were taught the importance of bringing women to health center to be assisted for delivery. Instead of assisting the mothers at home, they brought them to the health center. The TBAs also insisted the records to be written in their registers so they can have a good record on referral cases at the end of the year.

After one year, we conducted another evaluation session. During the evaluation, we observed that TBAs started utilising new registers for registering births and recording referrals of deliveries. In several cases, this new behaviour was detected. TBAs started recording the date of birth, name of the baby, gender and place of delivery; Figure 3 presents an example of the registers.

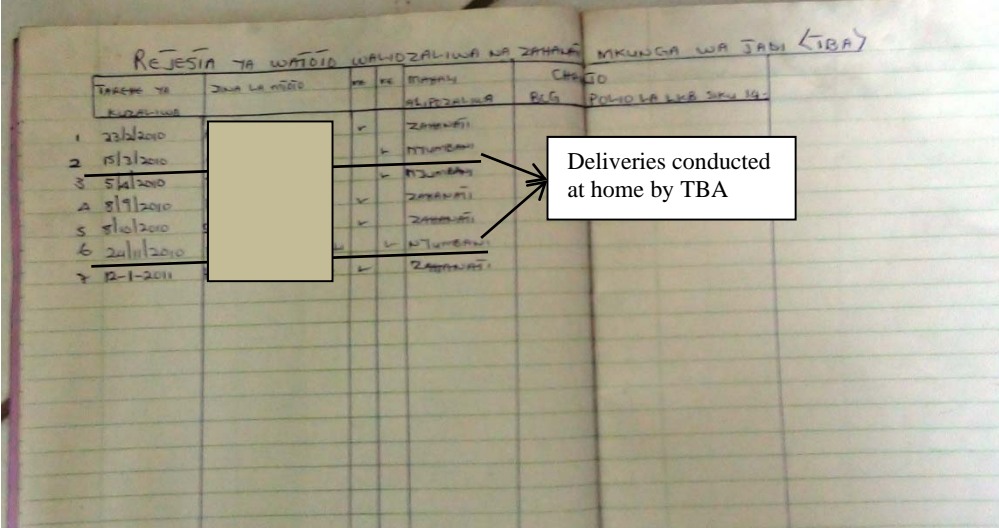


Figure 3: Birth register maintained by traditional birth attendant

As indicated in Figure 3, in a list of 6 births registered in 2010, 2 were conducted at home and the rest at the health center. When asked about how they came up with the records, TBA1 said that;

“The record of these babies is from the women I attended when they were pregnant (as their midwife). These records were written by the health center nurse in-charge when I brought the women to the health center for delivery”

This was an indication that TBAs started to record all the births from the pregnant women they attended and specifically indicating where delivery was conducted. Figure 3 also indicates that TBAs started to record referrals they made for women to deliver at the health center.

A reduction on number of deliveries conducted by TBAs was also observed when comparing what was recorded in TBAs’ delivery registers in the year 2009 (before the intervention) with what was recorded in 2010. Samples of the registers are presented in Figure 4 and 5.

REJESTA YA WAKUUNGA WA JABI			
KIJILI - mwanamama		KATA - kwata	WILAYA - kibauni
Ime kuwa kufungua	Ime ku Mama	Ime ku Baba wa mtoto	Ime ku Mama
2/1/2009			✓
2/10/2009			✓
2/19/2009			✓
2/27/2009			✓
2/28/2009			✓
2010			
2/25/2010			✓

Figure 4: Traditional birth attendant register with records on women who were assisted for delivery in 2009 and 2010

Figure 4: indicates that the number of deliveries conducted and registered by TBA in 2009 were 5 and 1 in 2010.

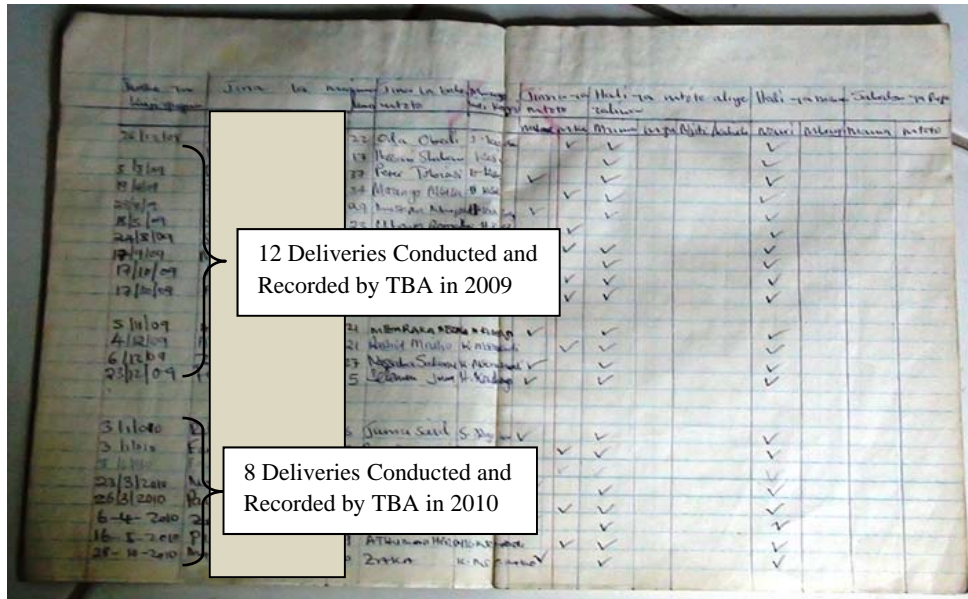


Figure 5: TBAs' register with records on women assisted for delivery in 2009 and 2010

Figure 5 indicates that the number of deliveries conducted and registered by TBA in 2009 were 12 and those in 2010 were 8.

Figures 4 and 5 indicate a reduction of TBAs deliveries. The reduction in TBAs deliveries could however be caused by several factors such as reduction of fertility rate or non-recording of the deliveries. To clear our doubts, we went further to review reports at the health center where training was conducted and where it was not conducted.

From quarterly reports of the health center in the village where training was conducted to TBAs and VHWs, we noted the status of deliveries conducted at health center as compared to those conducted by TBAs. These are summarised in Table 2.

Table 2: Health Center where Training was Conducted

Year	Quarter	Number of deliveries conducted at the HC	Number of deliveries conducted by TBAs
2009	1	7	2
	2	13	3
	3	13	3
	4	10	9
	Total	43	17
2010	1	16	0
	2	8	0
	3	10	3
	4	18	4
	Total	52	7

From Table 2, quarterly reports indicated that, in 2009, there was a total of 60 deliveries, 43 of which were conducted at the health center and 17 by TBAs. In the year 2010, which was after the intervention, reports indicated that, there was a total of 59 deliveries, 52 were conducted at the health center and 7 by TBAs. This shows that TBAs have changed their practice of conducting deliveries at home, from 17 deliveries in 2009 to 7 deliveries in 2010. Instead they referred the mothers to the health center, which shows that the health center deliveries increased from 43 in 2009 to 52 in 2010.

Taking a controlled group of a health centre in the village where VHWs and TBAs were not trained, we also compared the number of deliveries conducted at the health centre and by TBAs. Table 3 presents a summary of the findings.

Table3: Health Center where Training was not Conducted

Year	Quarter	Number of deliveries conducted at the HC	Number of deliveries conducted by TBAs
2009	1	3	7
	2	1	8
	3	2	10
	4	11	9
	Total	17	34
2010	1	3	7
	2	3	7
	3	11	9
	4	6	14
	Total	23	37

The results from Table 3 indicate a relatively small increase (from 17 to 23) of health centre deliveries and an increase (from 34 to 37) on TBAs deliveries.

4.2.2. VHWs’ Work Practices

To evaluate transformation of VHWs’ practices in collecting and recording maternal health data, three things were checked; utilisation of new registers, mobilisation of TBAs in recording deliveries and births and referring women to the health centre for delivery, and updating the village register

Findings indicate that, VHWs started to utilise the new registers for recording pregnant women and following-up their health status. The collected data also helped them in preparing their reports. One VHW indicated that:

“The new register for recording pregnant women helps me to have a proper follow-up and be sure of the correctness of data when I prepare reports”

This register became a useful tool for VHWs that helped them in accomplishing the activity. Investigating the efforts of VHWs in mobilising TBAs, findings indicate that the success (changed behaviour) of TBAs was behind what was done by VHWs. VHWs indicated that they now understood that they would get complete information if they worked closely with the TBAs because pregnant women followed TBAs and not VHWs.

Evaluating the updating of the village register, findings indicate that the register was not updated. There was no changed behaviour towards updating the village register. VHWs indicated to have negative impressions towards working with the village government head. This study could not further investigate why this practice was not transformed.

In general, the collaboration between VHWs and TBAs, and health facilities workers and district health managers in collecting and recording maternal health data was also evaluated in this study. Through interviews and observations, health facility workers and district health managers indicated appreciation of work done by TBAs and VHWs after a tremendous increase of deliveries at the health centre. One nurse indicated that:

“Nowadays I meet with VHWs once a month and we discuss on the issues they face and I give them feedback on the work they have done based on the reports (written and verbal) they present to me.... I am getting busier everyday because almost all the pregnant women are brought here (at the health centre) by TBAs for deliveries and the TBAs demand that I should record on their registers so they can have a higher number of referrals at the end of the year”

The nurse also prepared a roster to follow-up on the TBAs referral cases and she said:

“I am going to reward a present to all TBAs because they all did well, even though we agreed that the top three winners will be rewarded, I have seen an exceptional energy in all the TBAs”

Similarly the district health managers indicated to be surprised by the outcomes of the intervention. She was very happy and said that:

“I am going to express this success as an exemplary case to the district team so we can introduce the same incentive mechanism in all problematic (more TBA deliveries) health centres in the district”.

5. Analysis and Discussion

This section presents the analysis and discussion of the findings where we elaborate how the intervention empowered TBAs and VHWs to change their information practices. According to Ngoma & Igira (2012), TBAs and VHWs were collecting and recording maternal health data with two conflicting goals; motivated goal and directed goal. TBAs aimed at gaining some income from mothers and reputation from their society over having recorded information on births for supervision. Similarly VHWs aimed at providing the service to the society and gaining reputation over having records for reporting and following-up.

The complex relationships within and between the elements of activity systems of TBAs, VHWs and HMIS created contradictions that were manifested through dilemma, conflicts, critical conflict and double-bind (Table 1). The manifestations of double-binds and critical conflicts which were a result of the tools used, led to secondary contradictions. And primary contradictions were identified though the manifestations of dilemmas driven by the rules and regulations enforces. Conflicts were driven by the organization of roles in the division of labour. As a result the activity of collecting and recording maternal health data was crippled; and this lead to under-reporting of data.

According to Kuutti (1996), the desire to perform an activity is driven by motives/goals. This study has demonstrated how TBAs and VHWs started to effectively involve themselves in collecting and recording the data after the intervention. Previous findings indicated that VHWs and TBAs performed actions that were motivating than the others. The analysis indicates that the intervention motivated TBAs and VHWs to record data by imposing actions that rewarded them for doing that instead of ordering them. This empowered TBAs, VHWs, health facility workers and district health managers to create a new meaning [32] for collecting and recording maternal health data.

In the next sub-sections we describe how the resolutions of the manifested contradiction through the introduction of new and improved tools, new and re-defined rules, and new and re-defined roles in the division of labour led to re-mediation/transformation of the activity systems.

5.1. New and Improved Tools

In the TBAs' activity system, the intervention targeted at improving the participation of TBAs in recording deliveries they conducted, referring mothers to the health center for delivery and registering new born babies. Most TBAs already had delivery registers for recording

deliveries. Those who did not have the registers were given a new one and all TBAs were given another register to record referrals and new born babies. Findings indicate that TBAs started to record births and delivery referrals which at the same time; they were referring mothers to the health center for delivery. Though the new registers demanded more data recording, still the TBAs were motivated to record the data because at the same time they were recording their performance. This was due to an expectation for personal reward as described by Luoma (2006) and Roth (2007).

Findings also indicate that VHWs' activity system had contradictions (see section 2) that made it impossible to record and collect all the maternal health data at the community. Attempts were made to resolve the contradictions by improving their medical skills, introducing the use of standardised registers to record pregnant women and providing them stationeries to support data collection and recording. Results indicate that the skills gained empowered VHWs to collect complete and accurate information, by including findings from TBAs, and compiling their reports on time.

In both activity systems, the analysis indicates that the presence of new and improved tools resolved the manifestations of double-binds and critical conflicts. As a result a new context in performing the activity of data collection and recording was created whereby new rules and new roles were defined. This indicates transformation of the work practices as a result of changed behaviour driven by learning and motivation. Learning manifests itself when the acquired knowledge through training and other means is applied in the daily activities [46, 48, 54]. Furthermore, this study indicates that provision of incentives catalysed the application of knowledge in performing the activities. Incentives created an additional purpose for collecting and recording maternal and child health data, and referring women to the health center. Transformation of information practices for recording and collecting the data was driven by goals that promised TBAs and VHWs a payoff for performing the activity.

5.2. New and Re-defined Rules

Furthermore, the introduction of new and redefined rules brought about changes in the TBAs and VHWs' activity systems as they enforced performance of roles in the division of labour. The modeled solution in this intervention intended to encourage recording and collecting the data and discourage fear of recording.

The redefined rule was the rule that enforced TBAs to conduct emergency deliveries only in the TBAs' activity system. Instead of conducting deliveries through which they gained

some income, TBAs were insisted to refer the women to the health center and ensure that they keep the records so they can receive an incentive at the end of the year. For the TBAs to be rewarded and to know that someone cared about their performance; this rule was enforced and it led to utilisation of the new register for recording referrals and registering births.

The analysis indicates that, the incentives and training provided to TBAs together with the redefined rules resolved the dilemma on whether to record the data or not and empowered them to collect and record the data. Findings indicate improvements in birth registration and referral cases of pregnant women to the health center.

5.3. New and Re-defined Roles in the Division of Labour

After the introduction of new and improved tools, and new and re-defined rules as an attempt to re-organise the activity systems; new and re-defined forms of division of labour emerged. This re-organisation led to the creation of new responsibilities for TBAs, VHWs, Health facility workers and district health managers. TBAs started to refer women and children to the health center. VHWs were overseeing the work done by TBA. Health facility workers and district health managers provided support, feedback and supervision to the VHWs and TBAs.

Findings indicate that TBAs, VHWs, health facility workers and district health managers started to adhere to their responsibilities. The health facility workers and district health managers used support, supervision and feedback as empowering communication tools rather than as a means of inspection. As a result TBAs and village health workers were motivated to record and collect the data because someone cared [39] about their performance. However VHWs did not update the village register. They failed to collaborate with the village government head so as to execute this role for reasons beyond the scope of this paper.

The re-defining of roles in the division of labour also resolved the identified manifestations of conflicts between TBAs and health facility workers. This opened-up communication between the TBAs and health facility workers which was otherwise unpleasant.

In sum, the manifestations of contradiction in the activity of data collection and recording hindered TBAs and village health workers to perform the activity. They were dis-empowered because they were certain that no one recognized their performance. Though the reception of appropriate data collection tools, training and incentives, they were motivated to change their information behavior by actively starting to collect and record the data. This implies that, empowerment can be a remedy for contradictions.

6. Conclusion

This study has indicated that the manifested contradictions which hindered collection and recording of maternal health data were the driving forces for bringing about change in TBAs and village health workers' information practices. The analysis indicates that, an intervention was attempted to re-organise the activity systems in order to resolve the contradictions. This re-organisation was accomplished by the introduction of new and improved tools, new and redefined rules and roles in the activity systems of TBAs and village health workers.

To answer the research question: How to change community health workers' information practices in order to improve reporting of maternal and child health data from the community level? This study has shown that through understanding and resolving double binds, dilemmas, conflicts and critical conflicts, a change in data collection and recording practices of TBAs and VHWs can be achieved. Reflections on the intervention indicate that, TBAs and village health workers should be empowered to improve their performance and confidence in capturing and communicating these data. Through the provision of standardised data collection tools, appropriate skills through training, motivation and creation of proper means for sharing information among district managers, health facility workers, TBAs and village health workers, the quality of maternal health data can significantly be improved. Findings of this study indicate that, these attributes can lead to creation of a new context where behavior towards recording and reporting of the data can be directed.

Furthermore this study had shown that TBAs and village health workers can be encouraged to record data by providing them with data collection tools that keep record of their performance with a goal of receiving a reward. Their registers should not only be regarded as tool for collecting and reporting data upwards, but also a tool for demonstrating their performances.

Abbreviations

CHAT, Cultural Historical Activity Theory; HIS, Health Information System; HMIS, Health Management Information System; IT, Information –technology; MDGs, Millennium Development Goals; TBA, Traditional Birth Attendant; VHW, Village Health Worker.

Conflicting Interests

We declare that we have no conflicting interests.

Authors' Contributions

In conducting this study, CN and FI collected and analysed the data. Both authors also collaborated in paper writing whereby CN was the main author who developed to concept based on the objectives of her thesis.

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Appendix 4: PAPER IV

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Mutual Learning in Designing a Maternal and Child Health Application: A case of One Health Centre in Tanzania

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Mutual Learning in Designing a Maternal and Child Health Application: A case of One Health Center in Tanzania

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Abstract. Cooperation between users and designers requires mutual learning about the information system to be developed, and research has provided some guidelines and techniques for how to achieve it. Designers working in rural settings in developing countries experience a large knowledge gap between themselves and prospective users. To find out how to achieve mutual learning in this setting, a case study on the introduction of an electronic medical record system in a rural clinic in Tanzania was carried out. Hands-on training with a prototype and further support after implementation helped both nurses learning IT and designers learning about the clinical work. Large parts of the mutual learning therefore took place after system implementation, which is in contrast with recommendations in the literature. Also a simplified version of the “prompted reflections” technique was utilised, and contributed to mutual learning. A surprising outcome of the mutual learning was the nurses’ design on their own initiative of a paper register to ease transfer of data from the paper to the computer-based system. Such improvisations may be particularly useful in resource-poor settings.

Key words: participatory design techniques, mutual learning, prompted reflections, post-implementation learning, electronic medical record system, maternal and child health, and developing countries.

1 Introduction

The cooperation between users and designers in computer systems development has been highly advocated within the Participatory Design (PD)

community. This cooperation requires some insight into each other's activities and a mutual view of what the result will be. Arriving at this joint understanding was termed mutual learning (Bjerknes and Bratteteig 1987). Studies have agreed that mutual learning has been fruitful in building a bridge between users and designers (Bødker and Grønbæk 1991; Greenbaum and Kyng 1991; Trigg et al. 1991; Blomberg et al. 1993; Kensing 1998; Bødker et al. 2004; Lyng and Pedersen 2011; Hansen 2012). But still there are some questions to be asked about the possibilities for achieving mutual learning where wide knowledge gaps exist between the designers and the users.

Mutual learning consists of two perspectives; (1) how users can reach an understanding of design, and (2) how designers can gain users' domain knowledge. Concerning (1), PD literature suggests that users participate in prototype development as a means for learning IT skills related to the system under design (Bødker and Grønbæk 1991; Mörtberg et al. 2010; Brandt et al. 2012). However, in environments where users lack basic IT skills such as how to use a computer, mouse, keyboard and printer, research points out that users must learn IT skills before they can actively engage with designers in prototype development (Nhampossa et al. 2004; Kimaro and Titlestad 2008; Winschiers et al. 2010). The prototyping technique falls short when used in such environments and thus its effectiveness in supporting users' understanding of the system under design may not be optimal.

To facilitate designers learning about users' work (2), PD literature proposes the application of ethnographic techniques such as interviews, document reviews, observations and focus groups (Blomberg et al. 1993; Blomberg et al. 2003; Mörtberg et al. 2010; Blomberg and Karasti 2012). However, studies indicate that understanding work that involves routines and intuitive decision-making based on tacit knowledge such as clinical work (Bjerknes and Bratteteig 1987; Symon et al. 1996; Berg 1999) can be difficult. This is because work in such conditions can be invisible (Suchman 1995; Nardi and Engeström 1999; Star and Strauss 1999) to both researchers and practitioners. Using techniques such as interviews, document reviews, observations and focus groups may not be enough to provide knowledge about users' actual work. According to Stewart and Williams (2005), ethnographic techniques can be more effective when complemented with other techniques that allow users to express their views about requirement specifications and design decisions.

PD literature provides such techniques. These include prompted reflections, storytelling, future workshop, design games, thinking-aloud and mapping (Greenbaum and Kyng 1991; Bratteteig 1997; Kensing 1998; Karasti 2001; Bødker et al. 2004; Mörtberg et al. 2010). Multiple variations of the techniques have been introduced by combining, extending and adapting them in different ways. Among these techniques, the prompted reflections technique has been advocated for its effectiveness in situations

where users have a vague idea about what they need from the designed system and when designers have little knowledge about the users' work (Kensing 1998; Bødker et al. 2004). In such situations, the technique can support designers and users to develop a mutual vision of a new system. Prompted reflections as described by Kensing (1998) "is composed of four main activities: (1) preparation, (2) workshops, (3) analysis and (4) discussion of results" (p. 10).

Much has been learned about the techniques, however previous research has not considered the enormous knowledge gaps between designers and users that exist in developing countries. The application of techniques will necessarily differ in this context (Puri et al. 2004; Winschiers et al. 2010). Still there is a big challenge in understanding how and when the identified techniques should be applied to support mutual learning in system development. PD literature has also focused mainly on supporting mutual learning in the early stages (during system analysis and design) of system development. However IS management studies (Santhanam et al. 2007; Wagner and Piccoli 2007; Kaasbøll et al. 2010) indicate that when the users start to use the system, designers gain more understanding about the users' work and users gain more IT knowledge. The periods during and after system implementation can be other unexplored venues where mutual learning should be supported.

The case reported in this paper is from an environment where very wide knowledge gaps existed between designers and users. The users were health personnel in a rural clinic in Tanzania who had never worked with computers, while the designers were academic computer scientists without experience in clinical work. To bridge the gaps, mutual learning was necessary to develop a future vision of the system design. This paper will answer the question: which techniques will support mutual learning where wide knowledge gaps exist and in which sequence should they be applied?

To build on previous literature, this case study provides a description of the application of several techniques in a particular order. These include interviews, document reviews, observations, focus groups, hands-on training, system experimentation as well as free-hand drawings and discussions as described in the prompted reflections technique (Kensing 1998). To describe what was learned by users and designers during system design, implementation and after implementation, this study has focused on IT competence on using the system (know-how), understanding how users' work is represented in the system (know-what) and knowledge on tasks and work practices (know-why) as described by Kaasbøll et al. (2010).

The organization of the rest of the paper is as follows: Literature review is presented in section 2. In section 3, I present the research setting and in Section 4, I present techniques employed for data collection and analysis. The findings are presented in section 5 and analysis and discussion in section 6. Concluding remarks are presented in section 7.

2 Literature Review

This section gives an overview of PD's description of how mutual learning can be achieved in system development. I also describe how PD techniques have been applied in developing countries in order to attain mutual learning. Finally I review the literature on tools and procedures used in clinical work as a way to establish the specific emphasis on mutual learning in this study.

2.1 Mutual Learning

Mutual learning is an approach whereby involved parties cooperatively learn from each other. This learning can be fostered when the participants acknowledge each other as experts in their work and eventually learn from each other. In system development, as mentioned earlier, PD literature proposes several techniques that can be used by designers to support mutual learning. This study has focused on prototyping to support users in gaining IT skills, ethnographic techniques to support designers in learning about users' work, and prompted reflections technique to support creation of a mutual vision of a new system.

i. Prototyping: Prototypes have been used not only to help users gain IT skills based on the application area of the system designed but also to help designers evaluate the system design (Bødker and Grønbæk 1991; Carmel et al. 1993; Mörtberg et al. 2010). When users collaborate with designers in designing the prototypes, a work-like environment is established whereby they can start a mutual dialogue and negotiate about the future system. To create a meaningful dialog, Bødker et al. (2004) encourages designers to design and test prototypes with users by using "their own data to perform their own tasks in their own environment" (p. 182).

On evaluating system design, Bødker and Grønbæk (1991) describe the importance of users' input during prototyping. They describe a case of dental assistants where system analysts developed prototypes that showed a picture of a patient's mouth. When the dental assistants were introduced to the prototype they discovered that the picture showed an upside-down representation of teeth, different from the way they viewed the patient's mouth. Insights gained from the dental assistants guided the system analysts to change the system design.

Regarding users with no basic knowledge of how to operate a computer, studies have shown an urgent need for teaching users the skills before they can participate in prototype development (Nhampossa et al. 2004; Kimaro and Titlestad 2008; Winschiers et al. 2010). Researchers have derived different pedagogical approaches to conduct such training. Kimaro et al. (2008) present a case whereby a learning-by-doing approach was used to train users. In that case the designers developed a system prototype without

the users, introduced it to the users and then worked with the users in further customisation of the system. Training on basic computer skills was conducted in parallel with the system customisation process. Users were first given a basic computer lesson in which they were introduced to the future system and then practiced their skills and started to customise it. Working in a similar context, this study has adapted the same approach wherein hands-on training and system experimentation techniques were used.

ii. Ethnographic Techniques: Ethnographic techniques such as interviews, observations, focus groups and document analysis have been widely used to probe users' work in a particular work setting. The techniques are useful for designers to learn about users' first-hand experience by questioning them about their work and by observing them while they perform their work (Blomberg et al. 1993; Blomberg et al. 2003; Bødker et al. 2004; Mörtberg et al. 2010; Blomberg and Karasti 2012). According to Mörtberg et al. (2010), the techniques can help designers "create rich pictures of the practices, people and artefacts" (p. 113).

Interviews and focus group are useful for understanding tacit knowledge about users' practices. Document analysis provides a documented account of the work. Observations allow seeing what was not said in interviews and discussions. In conducting observations, Bødker et al. (2004) elaborate that the observer can take a participant (participate in observed work) or a passive (fly on the wall) role. Using interviews and observation techniques however can be challenging in a work setting that is not familiar to the designer (Bjerknes and Bratteteig 1987). It can be difficult to conduct appropriate observations and ask proper questions about work that one does not understand. To understand users' work in such conditions, studies (Kensing et al. 1998b; Stewart and Williams 2005) recommend that designers combine ethnographic techniques with other techniques in defining system requirements.

iii. Prompted Reflections: This technique aims to build a mutual understanding of a work domain between the designers and users. According to Bødker et al. (2004), the technique can be useful when designers are unfamiliar with users' "materials, tools, work processes, and products involved in the work" (p. 284). The technique is also useful when an understanding of users' work has not been achieved through interviews, document analysis and observations conducted.

The technique was developed as part of the MUST method for PD (Kensing et al. 1998a). As described by Kensing (1998), prompted reflections technique consists of four activities (preparation, workshops, analysis and discussion of results). Preparations involve selecting a topic of the work area that was difficult to understand and selecting participants capable of making free-hand drawings to describe that area. In workshops,

participants explain their drawings to each other. The main goal is “to take advantage of the participants’ reflections prompted by their drawings” (p. 11). Analysis involves analysing the data collected during workshops in order for designers to “prompt their reflections about the work domain and potential interventions” (p. 12). Discussion of results involves discussing the analysis report with the workshop participants. This will allow participants to challenge the designers’ interpretations and to gain new insights. Despite the formality of the sequence of activities for using the prompted reflections technique, Kensing (1998) encourages researchers to adapt and use the technique in their own styles.

Furthermore, Kensing (1998) demonstrated a successful application of the prompted reflections technique in designing IT support for an engineers’ R&D lab. He explains that the engineers’ work setting was difficult to grasp and little about it was understood through interviews and observations. Also the engineers provided different explanations on how they performed their work. The application of the prompted reflections technique established a meaningful dialogue among the engineers. In this dialogue, the engineers started discussions about how they conducted their work and everyone became aware of what the others were doing. This dialogue was also beneficial to the designers in understanding the engineers’ work.

The next section presents other examples from developing countries wherein designers used different approaches to understanding users’ work domains and eventually create opportunities for mutual learning.

2.2 PD in Developing Countries

The main principles of PD, including participation of users in system design, promotion of workplace democracy, mutual learning and empowerment, have been highly challenged in the developing countries context when PD was applied in system development. These challenges include the necessity of developing users’ capacity in order to enable them to participate (Braa et al. 2004; Nhampossa et al. 2004; Byrne and Sahay 2007; Kimaro and Titlestad 2008; Winschiers et al. 2010). Another challenge is a need to include a range of stakeholders to participate with the purpose of catering to issues such as shortage of human resources, power relations, strong hierarchies and politics (Puri et al. 2004; Elovaara et al. 2006; Byrne and Sahay 2007). Defining what participation means in different contexts and cultures is a further challenge (Winschiers et al. 2010).

Despite the challenges, studies report significant potential for using PD in system development in this context by adapting it using a variety of approaches with high emphasis on mutual learning (Korpela et al. 1998; Braa and Hedberg 2002; Puri et al. 2004; Elovaara et al. 2006; Kimaro and Titlestad 2008; Winschiers et al. 2010; Jensen et al. 2012; Rodil et al. 2012). These studies demonstrate the application of PD techniques in ways that are different from the tradition.

In a research network for designing, implementing and scaling the District Health Information Software (DHIS) in developing countries, the Health Information Systems Programme (HISP) has embraced mutual learning in different countries by using different techniques. Braa and Sahay (2012) describe the absence of IT skills and presence of complex social relations, cultural aspects and political systems in these countries. Such conditions determine how PD was adapted in designing and implementing DHIS. In these adaptations, mutual learning was supported through a 'participatory customisation' approach as Kimaro and Titlestad (2008) named it. With this approach, techniques such as hands-on training and system experimentation were used to support users in gaining IT skills and at the same time working with designers in customising DHIS. Designers learned from users through observations conducted during the customisation process. Even though these techniques sound simple and straight forward, their application differed between and within countries.

For example in Tanzania mainland, Kimaro and Titlestad (2008) describe that in order to find health workers to attend training and customisation of DHIS, a number of bureaucratic processes needed to be followed. It was also necessary to invite a large number of stakeholders who were not potential users of the system. With these techniques however, they faced a challenge of not being able to get the right people to participate in the training. This led to loss of resources and a need for re-training.

Working with health workers in Zanzibar, in addition to hands-on training and system experimentation, Elovaara et al. (2006) describe that ethnographic techniques, such as interviews, observations and discussions, enabled them to understand the conditions and work practices within the hospital and to define requirements for customisation of DHIS. Ethnographic techniques also enabled them to involve health workers in customising DHIS while they continued with their daily activities. Using these techniques however, the designers were challenged on agreeing about whose views mattered when users raised different views. The designers were also in constant negotiation with users on their availability for interviews and discussions due to tight working schedules and shortage of health workers at the hospital.

Without specifically showing techniques used, Puri et al. (2004), describe how DHIS development was carried out depending on how it was introduced in South Africa, India and Mozambique. In South Africa the involvement of community heads in meetings and discussions was essential. In India, due to strong political hierarchies, the involvement of top political leaders was necessary. And in Mozambique, the involvement of university staff encouraged other stakeholders to participate in DHIS customisation and implementation.

Other studies (Winschiers 2006; Winschiers et al. 2010) demonstrate the importance of conducting further research to develop an understanding on the application of PD techniques in the developing countries' context. Designing with rural communities in Namibia, these studies indicate that the application of techniques such as future workshops, brainstorming and story telling with a western cultural approach did not work with the Namibian

users. This was due to cultural concerns such as “where a story ‘comes from’ or who is permitted to voice it” (Winschiers et al. 2010, p. 3) and a view of the future system based on “existing items” rather than a “vision” (Winschiers 2006, p. 74).

In general, research on application of PD techniques in developing countries is crucial in gaining more understanding on how to use the techniques in contexts and cultures different from the western. This understanding will also enlighten how mutual learning can be supported in this context and preconditions that have to be fulfilled before mutual learning can take place.

2.3 Tools and Procedures in Clinical Work

Focusing on clinical work as an application area in this case study, previous research (Bjerknes and Bratteteig 1987) indicates that when designing computerised systems to support such work mutual learning is highly important. This is because first-hand experience on clinical work can only be gained from the practitioners who have gone through years of training and have tremendous practical experience. Suchman (1995) describes that first-hand experience can be gained not only by understanding what people do but also the “specifics of how people work” (p. 61).

Clinical work involves complex relationships between people, procedures and tools used (Symon et al. 1996; Berg 1999). For example Symon et al. (1996) describe that the application of formal procedures has been observed to promote problems such as “inability to cope with the dynamics of an ever changing situation” (p. 2). This inability forces the practitioners to use informal procedures (detours / work-arounds) to satisfy a need at hand with the available personnel, equipment and/or medication. Since informal procedures are not documented, mutual learning is important in gaining the first-hand experience of clinical work. In such learning, special considerations of the tools used and procedures applied must be taken into account.

There is a need for understanding not only about the techniques that will support such learning but also about when the designers can learn about the tools and procedures used. This understanding can provide guidelines for supporting successful collaboration between designers and users. By looking beyond the possibilities for achieving mutual learning during system analysis and design, PD literature can also learn from Information Systems (IS) management studies (Santhanam et al. 2007; Wagner and Piccoli 2007; Kaasbøll et al. 2010) which describe that users and designers can learn from each other when the system is implemented in a live environment. Santhanam et al. (2007, p. 187) indicate that the post-implementation period can be the most appropriate time to encourage users to expose “misalignment between system design and actual practices” and encourage designers to gain

knowledge on modifying the system functionalities to support users' lived practices.

3 Research Setting

This study was conducted in a Reproductive and Child Health (RCH) clinic in a rural health center in Tanzania. The research was done under the project "Improving access and quality in maternal health care in sub-Saharan Africa." The project was part of on-going research in the HISP global network. Being a member of the local design and implementation team of HISP Tanzania, the study was conducted in collaboration with programmers and researchers who are referred to as we (designers/researchers) in this paper. The undertakings of the fieldwork were done by the team but I am presenting the findings as a single author in this paper. The study involved customising and implementing a module of DHIS2 called DHIS Tracker at the clinic to support provision of maternal and child health services. The following sub-sections describe the setting of maternal and child health in Tanzania followed by the elaboration of the DHIS2.

3.1 Maternal and Child Health Services

Maternal and child health service in Tanzania includes antenatal care (ANC), delivery, postnatal care (PNC), child health management and prevention of mother to child transmission (PMTCT). Provision of these services goes hand in hand with paper-based data collection and reporting. Handling of a client incorporates exchange of verbal and written information in formal (using standardised data collection tools) and informal (using improvised data collection tools) manner among different entities. These entities include: RCH clinic, other clinics (care and treatment center and outpatient department), laboratory, and entities outside the health center (mother and the community members). The laboratory and clinics can belong to one health center or different health centers.

This study focused on the exchange of information between an RCH clinic (that provided ANC, delivery, PNC and childcare services within one health center), mothers, and the community within which the mother and baby belong. In this clinic, the maternal and child health services were provided by nurses who were all women. The provision of these services incorporated data recording where formal and informal data collection tools were used. Also adherence to procedures and organisation of roles among nurses was highly important in service delivery. These procedures and roles ranged from formally defined by the Ministry of Health and Social Welfare (MoHSW) to locally defined by the nurses.

Data collection tools used at the clinic included registers which stayed there and cards which were in the mothers' possession. The registers and the cards recorded similar but not the same information. The registers recorded administrative data that was useful for further reporting and administrative activities. The cards recorded personal details for the sake of providing continuous care and follow-up when a woman/child returned or attended a different health center or clinic.

To report maternal and child health services, quarterly and yearly reports were produced. Most of the information was acquired from the registers and some of the information from the cards. Since the cards were not stored at the health center, necessary information from the cards that was needed for reporting was recorded in nurses' improvised registers.

3.2 DHIS2

DHIS2 is a generic software which can be customised to fit local requirements. The customisation of the DHIS2 involves designing data structures and interfaces to support the local setting. This customisation is done by setting parameters in the existing software and by adding new code. The addition of new code is limited to some functionalities whereby local innovations can be added but the structure of the software cannot be modified. Throughout this paper the process of DHIS2 customisation is mentioned as a design process because it involved designing of data structures and user interfaces.

The software was initially designed to support data management and analysis at the district levels. At this level only aggregated data are dealt with. An urgent need to improve accuracy and completeness of the data necessitated the support of collection and reporting of individual data at the health facility levels. To enable this, a module called DHIS tracker was developed. Within the HISP network, DHIS tracker had been customised to support several use cases such as tracking of women through pregnancy, delivery and postnatal care, anonymous inpatient admissions and deaths, collection of vital events such as neonatal and maternal death, and supporting provision of family planning education (HISP).

In this case study DHIS tracker was customised to support provision of maternal and child health services and store records for easy access and sharing. Based on the longitudinal nature of providing maternal and child health services, the application was designed to operate in stages over a period of time through which pregnant women and children were followed-up. The customised application was named maternal and child health application.

4 Data Collection and Analysis

In this section I present techniques used for collecting and analysing empirical material. Data gathering techniques used were focus groups, interviews, observations and document reviews. To analyse the data, I applied the categories of IT competence areas as described by Kaasbøll et al. (2010). These are discussed in the following sub-sections.

4.1 Data Collection

Data collection was carried out throughout the research project. Table 1 presents summary of the data collection techniques applied in each development activity by following a timeline. The same timeline will be used in section 5 of this paper to describe the development activities in detail.

	<i>Period</i>	<i>Data Collection Technique</i>	<i>Development Activity</i>
System Design and Implementation Period	January 2010	Focus groups, Interviews (1 st iteration), Observations, Document reviews	Gathering domain knowledge
	November 2010		Designing a Prototype
	Early March 2011	Document reviews and Observations	Training and experimenting on the prototype
	Mid March 2011		Designing Version 1 (V1) of the system
Post-implementation Period	Late March 2011	Observations	Refinement of V1
	November 2011	Observations and Interviews (2 nd iteration)	Designing SMS Messages

Table 1: The Timeline

i. Focus Groups: Focus groups were formed during a workshop session that was conducted in January 2010. A wide range of health workers participated in the workshop. These were nurses and doctors from five health facilities including the health center in question, district health managers in-charge of RCH services and community health services, HMIS focal persons, and the regional medical officer-in-charge. The participants from other health facilities and districts were involved in order to obtain a broad understanding on collection, reporting and management of maternal and child health data at the regional, district and health facility levels. The workshop participants were selected by the district health management, following our written request for key people involved in provision and management of maternal and child health care. The participants' details are presented in Table 2.

	<i>Place</i>	<i>Nurse</i>	<i>Doctor In-charge</i>	<i>District Health Managers</i>	<i>HMIS Focal Person</i>	<i>Medical Officer In-charge</i>
Health Facility	Health center 1	2 (Nurse A & Nurse B)	1			
	Health center 2	1				
	Health center 3	1	1			
	Health center 4	1				
	District hospital	2				
District	District 1			2	2	
	District 2			2	1	
Region						1

Table 2: The Timeline

Each focus group had 3 to 4 participants. In each group there was a mix of a nurse, doctor and district health manager/HMIS focal person. Discussion topics were prepared based on aspects of service provision, data collection and reporting, handling referral cases and provision of support, supervision and feedback from health managers to health facility workers. Findings from these discussions were incorporated in designing the system prototype.

ii. Interviews: Interviews were conducted in two iterations. The first iteration was conducted between January and March 2010. This was before designing the prototype and after the workshop session presented in the previous section. The second iteration was conducted in January 2012 after the implementation of the system. In the first iteration, thirteen community health workers, four nurses, one doctor and two HMIS focal persons were interviewed. The nurses, doctor and HMIS focal persons were the same participants involved in the focus group discussions as presented in Table 2. In the case of nurses, 2 more nurses were interviewed and did not participate in the focus group discussions. The summary of the interview participants is presented in Table 3.

<i>Place</i>	<i>Nurse</i>	<i>Doctor In-charge</i>	<i>HMIS Focal Person</i>	<i>Community Health Workers</i>
Health center 1	4 (Nurse A, Nurse B, Nurse C & Nurse D)	1		
District 1			2	
Community				13

Table 3: Interview Participants in the 1st Iteration

The main focus of conducting the interviews was to understand the interplay between formal (defined by the MoHSW) and informal (locally defined) routines in providing maternal and child health services. Data collected in these interviews were used in designing the prototype.

The objective of interviewing community health workers was to understand how they collected, recorded and reported maternal and child health data at the community level. Nurses and the doctor were interviewed with the objective of understanding their work practices in recording data on different clinic visits and management of these visits, what data collection tools were used, and procedures employed in retrieving information for follow-up and provision of care. HMIS focal persons were interviewed with an objective of assessing procedures they used in designing registers and report forms, and providing feedback and supervision to the health facility workers and community health workers regarding data management.

During the second iteration, four nurses, one doctor and two HMIS focal persons were interviewed. The respondents were the same as in the first iteration. The objective of these interviews was to investigate what was learned by the nurses from the pilot implementation from their own perspective, and from the perspectives of the doctor in-charge of the health center and HMIS focal persons from the district.

iii. Observations: In conducting observations, I assumed the roles of both a passive and a participant observer (Bødker et al. 2004). As a passive observer, I observed the nurses while they were performing their daily activities. I observed how they recorded data in registers, how they interviewed women during antenatal, postnatal and children clinic sessions and how they handled referral cases. The aim was to understand the interplay between the registers used for recording data and the procedures followed to accomplish their activities. These observations were carried out after the interview sessions between January and March 2010. From early March to November 2011, I continued to conduct further observations by focusing on the use of the maternal and child health application and reflections made.

As a participant observer, I conducted observations in workshop and training sessions. My roles in the workshop and training sessions were to prepare, invite participants and conduct the sessions. These activities were done in collaboration with the programmers and researchers from the HISP Tanzanian team. The workshop conducted is the one described previously. The health workers trained were nurses, doctors and HMIS focal persons. This training was conducted in early March 2011 after designing the prototype. It was a hands-on training that aimed to teach health workers how to use computers and the system prototype. The training also aimed to

evaluate the prototype so as to design a stable version of the system. In particular, training on how to use computers focused on giving them an understanding about computer components and how to use them. These included computer monitor, CPU, mouse, keyboard and printers. After the health workers had mastered computer skills, we introduced them to the prototype where they continued to exercise their IT skills.

Prospective system users were nurses, but other health workers such as doctors and HMIS focal persons were also included in the training because of the projects' standard procedure of engaging all stakeholders so as to encourage system ownership and awareness within the health center, district and regional administration. However, only the nurses were included in the later stages of this study. This was because all the maternal and child health services were conducted by the nurses at the health center.

Additionally, I conducted observations as a participant while the nurses were using the maternal and child health application during training and at the clinic. My role was to support and supervise the nurses while they were experimenting with the system. During this time, I observed their reactions based on the system design when they confronted it and when they proposed new and changed requirements.

iv. Document Reviews: Documents reviewed include data collection registers, clinic cards and report forms. The reviewing process started in January 2010 and only formal registers were acquired at this stage. At that time the MoHSW was updating its registers, and the old ones were still used at the clinic. The new registers started to be used in January 2012. The prototype design was based on the old registers, but it was later revised to reflect the new registers in V1 of the system. Clinic cards reviewed include RCH and child health cards. Monthly and quarterly reports generated at the clinic and other reports created by the nurses for local utilization of their data were also reviewed.

During the implementation, from late March 2011, the designers discovered the improvised registers used by the nurses. These registers were reviewed and incorporated in refining the system requirements because they were part and parcel of the nurses' practices.

4.2 Data Analysis

To analyse findings in this case, identifying knowledge gained by nurses and designers from the design to the post-implementation periods was the main focus. This analysis was guided by the categories of IT competence areas as described by Kaasbøll et al. (2010), 'know-how' - IT knowledge on how to

use the system, ‘know-what’ - knowledge on representation of users’ work in the system, and ‘know-why’ - knowledge on tasks and work practices.

According to Kaasbøll et al. (2010) users and IT professionals develop these competences when a computerised system is introduced in their work. The IT knowledge on how to use the system in this case has also been described to include knowledge on how to use a computer.

5 Findings

This section presents the results obtained from this case study by following the sequence of research activities as presented in Table 1.

5.1 Designing the Prototype

The customisation of DHIS tracker started in November 2010. At this stage, the designers had very little understanding about the work domain. We first designed a system prototype with the goal of upgrading it to a fully functional system after gaining users’ insights. The local requirements that were used to customise the generic software were based on the MoHSW standardised procedures in providing maternal and child health services. These requirements were gathered through the ethnographic techniques of focus group discussions, interviews, observations and document reviews as described earlier.

The designed prototype allowed nurses to register and make complete service delivery and follow-up on all clinic visits for ANC, delivery, PNC and child health management. Further design to aggregate data to produce monthly, quarterly and annual reports, and to support sending Short Message Service (SMS) to clients was planned for later stages of the system development

At this stage, designing the interface for data entry was challenging because of the different layouts that existed in cards and registers. Figures 1, 2 and 3 present the distinctions.

JINA LA MAMA	UMRI:	KIMO (CM):	
JINA LA MUME / MWENZI	ELIME:	KAZI:	
	UMBI:	ELIME:	
KUJITAMAA/Kimajaji:	KAZI:		
WELAYA:	JINA LA MWENYIKITI		
HABARI KUHUSU UZAZI ULIOANGOLEA			
MIMBA YA NGAPI	AMEZAA/MARA NGAPI	WATOTO WALIO HAI	
Mwaka mimba ilipoharibika	Uteri wa mimba	Mwaka mimba ilipoharibika	Um
1.	2.	3.	4.
2.	3.	4.	
TARIEHI YA KUANZA, HEDHI YA MARA YA MWISHO (UNMP)			
TARIEHI ANAYOTAZAMA KUBUNGUUA (EDD)			
CHUNGUZA VIDOKAZO VIFUATAVYO KWA MAMA AFIKAPO KWA MARA ¹			
A WEKA ALAMA (✓) PANAFUHUSIKA, MPELEKE KITUO CHA AFYA AI UCHUNGUZI/USHAURI ZAIDI ENDAPO MAMA ANA:			
LURI/CHINI YA MIKAO YA			
MIKAO 10 AU ZAIDI TOKEA MIMBA YA MWISHO			
KUZAKIWA KUPASABUWA			
KUZAA MTOTO/MFUKIFU CHA MTOTO/MCHANGA (WA 1)			
KUHARIBIKA KWA MIMBA ZA AU ZAIDI			
USOKUKWA MIMOYO (✓) <input type="checkbox"/> KIBUKARI <input type="checkbox"/> KIFUKA KIKUJI <input type="checkbox"/>			
B WEKA ALAMA (✓) PANAFUHUSIKA, MSHAURI AENDE KITUO CHA			

Figure 1: Cards on Page 1 (registration)

MAHUEHURIO	HUEHURIO LA KWANZA (idadi ya siku 24)	HUEHURIO LA PILI (idadi ya siku 7)	HUEHURIO LA TATU (idadi ya siku 28)	HUEHURIO LA NINE (idadi ya siku 42)
Tarehe (Kilo)				
Uzungu wa wotundu wa damu (Hb)				
au unguu wa vigejaji				
Joto la mwili (°C)				
Lishe ya Moto: Maziwa ya mama pekee (ESP), Maziwa mbadala (RP)				
Hawazi kumoyya				
Angalia kushachacha kwa mtoto				
Je, ni kidogo kuliko kawaida?				
Macho - Yanatoa uchafti				
Mimoa - Una utandio mwenye				
Masiiko - Yana uchafti				

Figure 2: Cards on Page 2 (recording visits) - The arrow shows direction for recording data on a visit

HUJUHURIO LA KWANZA AU HUJUHURIO LOLOTE													MAJUHURIO YA MABUDDIO	
1	2	3	4	5	6	7	8	9a	9b	10	11	12	13	14
Namba	Tarehe	Namba ya Usajili	Jina kamili	Umri	Mahali Anapishi	Mume/Mwenza	Jina la MNIJI Serikali za Mitaa Kitovogaji	Aanahija Kadi ya TT?	Tarehe ya Chanjo ya TT	Lini wa Mili ba Kwa Witu	Habari ya Mimba Zilizopita	Vidokezo vya hatari	Vigimo vya Kaswende	Wika kwanza ya () Inapo kama matatio. Andika herifi ndigo wama atakura na matatio kwenye hudhuro buika. Wika uliana ya A, O, P, H, U, D, M - Inapo wama anakaja na matatio raiwovidochera kupo chini

Figure 3: Registers (registration and visits) - The arrow shows direction for recording data on a visit

Note that, on the cards, as indicated in Figure 1, the first page was used for recording information one time only during client registration, and the fields were grouped based on categories such as personal information, pregnancy history, danger signs etc. On Page 2 as presented in Figure 2, records for each visit were recorded in one column; see the direction of the arrow. On the registers (Figure 3), both personal information and records of visits were recorded in one row for each visit.

The designers decided to design the interface to mimic the presentation of the cards. This design was chosen because of its clarity in presenting continuation of care from all the visits where the nurse could observe what was done or omitted in previous visits. Figure 4 presents a screenshot of the designed data entry form on the computer.

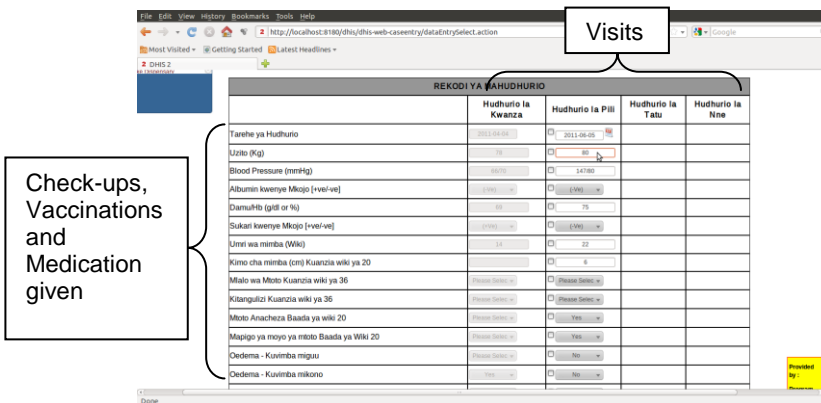


Figure 4: Data Entry Form

The designed data entry forms incorporated all the data elements on the cards and on the registers.

Since the ethnographic techniques did not provide sufficient basis in defining requirements, the prototype was planned to initiate a dialogue with the users in order for the designers to understand the users’ work. Hence the goal was to upgrade the prototype to a fully functional system after gaining concrete insights from the users.

5.2 Training and Experimenting with the Prototype

In early March after designing the prototype, the designers taught health workers how to use computers and how to operate the prototype as described earlier. It was necessary to give them basic IT skills before they were able to work with the prototype. Working with the system prototype, the main focus of the training was on how to register clients, enter data about their check-ups, medication and vaccinations given in different visits, and interpretations of different colour displays, icons and pop-up messages. In this training, hands-on exercises to enter data in the prototype using real data were given.

During hands-on training sessions, the prompted reflections technique was also used by the designers to learn how the nurses performed their daily activities. The application of prompted reflections in this study did not follow the formal sequence of activities (preparation, workshops, analysis and discussion of results) as that described by Kensing (1998). In this study, we followed three of the four activities: preparation, workshops and analysis. We went back and forth between preparation and workshop activities. Analysis was done at the end of the training session.

In preparation, we used two approaches; first instead of the designers selecting topics for discussion, the nurses were given time to experiment with the system. When they encountered misrepresentations of their practices in the system, they were asked to make free-hand drawings to elaborate accurate representations of their work. In the second approach, the nurses were also asked to make free-hand drawings to describe complex practices that were out of the ordinary to the designers. In the workshop activity, the free-hand drawings were discussed. What was agreed upon in these discussions was analysed and the results were used as a basis for designing the V1 of the system.

This technique was chosen for two main reasons, the first being to give nurses an opportunity to reflect on their work based on how it was represented or misrepresented in the system. These reflections gave the designers an opportunity to gain firsthand experience on how the nurses actually carried out their work. The second reason was to provide a common point of reference to be used throughout the design process based on the mutual understanding developed. The major reflection made during training was on the presentation of check-ups to be made, and medication to be dispensed in the system.

While the nurses were experimenting with the system prototype, they realised that the system had restricted check-ups and medication to specific visits while in real practice this was not the case. Nurse A described that

“For example, we are supposed to do HIV and syphilis tests on all first visits, however due to the availability of our lab technician and lab equipments, we may not be able to do so. When a check-up was not made in the current visit, it will be made in the next visit if possible. Similarly we are supposed to provide iron, folic and malaria medication to the women on different stages of their pregnancy and this depends on the availability of the medication. These things should not be restricted on a specific visit.”

Similarly Nurse D noted something useful on provision of vaccinations. She said,

“We have our own timetable for dispensing vaccinations and we arrange the timetable based on the activities in the clinic and the availability of nurses to provide the services. Following the timetable, we inform mothers when to bring their babies. This may be one week or so past or before the required time in some cases. However we try to stick to the standard of four weeks intervals between the main vaccines for children.”

The nurses’ timetable was determining which dates particular vaccination will be provided regardless of the fixed time intervals between vaccinations scheduled in the protocol. However, the vaccination intervals were fixed in the system and this could not support the current practice. Furthermore due to the context where not all babies were born at the health center (Ngoma and Igira 2012), these babies were brought to the clinic at different ages from new borns to over one year old. In any case they were supposed to be given necessary vaccinations. Nurse A explained that

“All the babies receive the necessary (BCG, OPV0-3, PENTA1-3 and measles) vaccinations within the period of nine months. However there are cases where a baby is brought to the health center for the first time when they are one year or more. In such cases we give them all the vaccinations on the same day.”

At this point there was a misunderstanding between the designers and the nurses on how they dispensed vaccinations. We asked one Nurse A to elaborate the intervals in a timeline. This is what she drew for explaining:

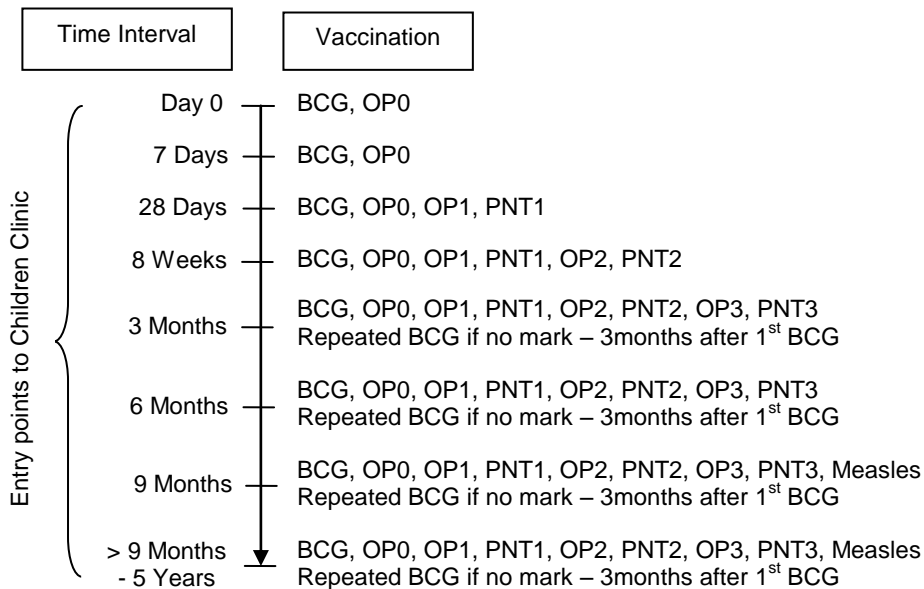


Figure 5: Description on Vaccination Timeline (Redrawn by the author based on Nurse A’s drawing)

Figure 5 gave us (designers) more understanding of the practice. Compared to the design where vaccinations, check-ups and medication were set at

particular intervals in specific visits, the system could not support these practices.

5.3 Designing V1 of the System

After the training we (designers and nurses) came up with a common vision on what should or should not be included in the system. In designing V1 of the system, we changed the design by making these attributes (vaccinations, check-ups and medication) as flexible as possible so that any vaccination, check-up or medication could be recorded at any visit. To provide further description, Figures 6 and 7 present some screenshots of the prototype vs new design (V1) respectively.

Figure 6: Data Entry Form on the Prototype

Figure 7: Data Entry Form on V1

As presented in Figure 6, note that in the prototype, data entry boxes were present on specific vaccinations; meaning that these were the only allowed vaccinations to be recorded in that particular visit. In the new design (Figure 7), data entry boxes are present in all vaccinations in each visit to allow any vaccination to be recorded in any visit. The layout of the data entry form also indicates what was recorded/not recorded in the previous visits to allow the nurses to make a follow-up on what to do next based on what was done previously.

5.4 Refinement of V1

V1 of the maternal and child health application was introduced to the clinic in late March 2011. In this implementation, the application was used in parallel with the paper-based system, in that the nurses started to enter data into the system. However due to the busy schedules of the nurses and the nature of the pilot (the health center administration did not allow the system to be used at the point of service delivery), the nurses entered data after working hours.

During this implementation, we (designers) continued to work with the nurses at the clinic on different intervals. The first week after the training, we worked every day for five days, taking two hours each day. The following

weeks we supported the nurses once a week, and throughout these interactions, in collaboration with the nurses, we refined the system to fit their practices.

Using prompted reflections at this stage, the nurses continued to further reflect on how the system design fit with their everyday practices. The following sub-sections present reflections made by focusing on two main areas: system and domain definition of the stages, and the possibility of using a computer for data entry at the point of service delivery.

i. System Vs Domain Definition: From late March 2011, when the nurses were entering data into the system, we discovered that most of the data entered on ANC service was on the first pregnancy stage, <16 weeks. When I asked the nurses to explain why there were many entries on the first stage as compared to other stages, Nurse C mentioned that

“More women attend their first visits than any other visit, that’s why they are many.”

But this explanation was not very satisfactory. When we continued to observe how they chose a stage to enter data, we realised that all the women who attended their first visit at the clinic were recorded in this stage. This indicated that the nurses did not understand the meaning of ‘stage’ as defined by the designers versus a ‘visit’ which they were referring to as a stage. The system meant to enter data on a stage of pregnancy regardless of a visit. When we explained what the system meant regarding stages and visits, they were surprised, Nurse B said,

“We never thought about that, we normally record ANC on visits not on stages. When a woman attends the ANC for the first time when she is 40 weeks pregnant, we will record that as a first visit and not as a fourth stage, even though it means so. However in children and PNC we record on the stages and not on the visits.”

At this point, there was a need to create a common understanding of the terms, ‘visit’ and ‘stage’. The nurses were asked to describe how they related to the visits and stages in a drawing, and explain how they used the terms in their daily practice. Nurse B came up with a drawing similar to Figure 8.

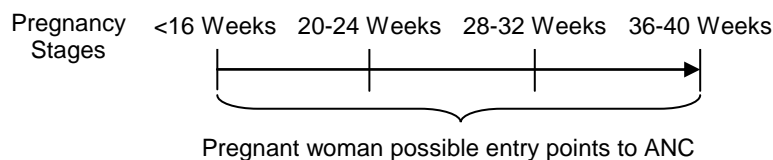


Figure 8: Description on Stages

From Figure 8, Nurse B continued to explain and drew Figure 9:

“...this is how we record from the first entry point that can be at any stage.”

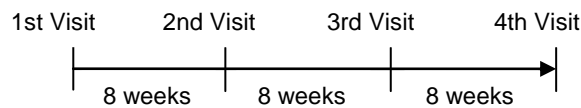


Figure 9: Description on Visits

“However under special cases there can be more than four visits and the intervals between visits will be four weeks or less depending on the situation.”

These explanations were eye openers to designers. The nurses’ understanding was completely different from the system design. So we (designers) changed the system to allow for this practice where data was recorded on visits and not stages in ANC. Figures 10 and 11 present an example of screenshots on what was designed previously in V1 vs. the refined design.

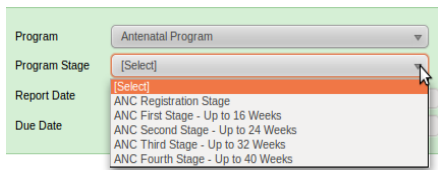


Figure 10: Previous Design

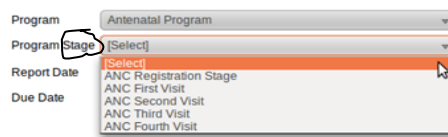


Figure 11: New Design

As indicated in Figure 10, previously the nurses were supposed to select a particular stage of pregnancy, however they only selected the first stage (ANC First Stage – Up to 16 Weeks) for all client records for the first visit. Figure 11 depicts a new design where the nurses were selecting visits (example ANC First Visit) as they were doing in their daily practices. The word Stage (circled in Figure 11) continued to appear on the form because it was part of the data structure that could not be modified through customisation; only the content within the combo box could be changed.

ii. Data Entry at the Point of Service Delivery: The data entry forms on the computer were used for recording information obtained from both registers and cards as stated previously. However the nurses were concerned about obtaining the data from the cards. Nurse D noted that

“We do not record most of the information about the check-ups in our registers, they stay in the mother’s ANC card. We only record in our registers (referring to improvised registers) what we use for reporting. How are we going to get this information so we can enter it into the computer?”

It was true that there was no simple way for the nurses to capture these data. Since we did not get the permission for the nurses to use the computer at the

point of service delivery, the nurses were entering data after working hours, sometimes one or two weeks later. We could not provide a quick fix for that but only tell them to enter into the computer whatever information was available. To our surprise the next time we visited, they had filled in all the information from mother's cards. When asked how that was possible, Nurse C said,

“We have created a register that records all the information that is missing from our daily register (showing me the improvised register). We have realised that we need to record this information for further following-up of the mother by seeing what check-ups were made last time and what were not made instead of relying on our own practices where we could forget sometimes. So now we are using this register to enter data into the computer.”

This new register was an innovation made from what they were doing previously. From that register they added other columns that were necessary for data to be entered in the computer. The presence of the computer application was perceived as a way of simplifying their work and making it more efficient. The application first created a motivation for entering data which the nurses found useful for retrieving previous information, following-up on their clients.

5.5 Designing SMS messages

At this stage, the SMS messages to be sent to health center's clients were not incorporated in the design. The purpose of these messages was to send reminders about the next clinic visit and to provide information on health education to registered women and key person(s) around women and children. For assurance of creating appropriate messages, the nurses' input was necessary because they knew how and when they communicated with their clients. The nurses were asked to create a list of messages they normally exchanged. These messages were to remind women and key persons around them about their next appointment and to give them health education. Also the messages were supposed to be short (not more than 160 characters) and precise. The nurses came up with a list of 43 SMS messages. For example:

“Nenda kituo cha huduma mara moja iwapo utaona dalili zifuatazo: Maumivu makali ya tumbo, Kulegea na kuchoka, Kupumua kwa shida, Kuona maruweruwe”

This translates:

“Go to a health center immediately if you experience any of the following symptoms: Severe tummy ache, Tired and restless, Difficulty breathing, Dizziness”

The SMS messages designed by the nurses were incorporated in the system.

When the nurses were using the system at the clinic, they continued to come up with prompted reflections. These reflections were made while we were together experimenting with the system and while the nurses were working on their own in our absence. What they discovered in our absence was elaborated when we visited them. With these reflections, we continued to refine the system design.

6 Analysis and Discussion

Findings of this study have shown how nurses and designers learned from each other throughout the design and implementation of the maternal and child health application. This learning bridged the knowledge gaps between them and facilitated the creation of a mutual vision of the designed application. This section presents the analysis and discussion of the findings by focusing on what was actually learned by nurses and designers through the application of different techniques. The knowledge gained is described in three categories: IT knowledge on how to use the system (know-how), knowledge on tasks and work practices (know-why) and knowledge on representation of users' work in the system (know-what).

The summary in Table 4 indicates that a combination of different techniques applied during system design and implementation and post-implementation periods enabled the nurses to gain 'know-how' and 'know-what' while the designers gained 'know-what' knowledge. This was through the application of hands-on training (during the training) and system experimentation (in all periods) techniques. It is evident that the designers became clear on how to meaningfully represent the nurses' work in the system design after the nurses gained IT skills and understood how their work was represented in the system.

Contrary to the PD tradition that advocates for prototyping as a technique for supporting users in gaining IT skills (Bødker and Grønbæk 1991, Mörtberg et al. 2010), in this study, the nurses could not participate in designing the prototype due to lack of basic IT skills. Nurses gained IT skills through hands-on training and by experimenting with the system. Similar to the findings presented by Nhampossa et al. (2004) this study has also shown that before the users can be involved in designing prototypes, they must first acquire IT knowledge. Additionally, findings have also shown that before the users can engage in a mutual dialogue with designers, they must have an understanding on how their work is represented in the system.

Timing		Technique	What was Learned			
				Know-how	Know-why	Know-what
System Design and Implementation Period	Before designing the prototype (before November 2010)	- Focus groups - Interviews - Observations - Document reviews	Designers	-	-Provision of services based on the MoHSW standard procedures and tools	-
	During training (early March 2011)	Hands-on training and System Experimentation	Nurses	-Recording medication, vaccination and check-ups -Modifying visit dates	-	-Flow of activities in the system -Interpreting colours, icons, pop-up messages
			Designers	-	-	-Representation of medication, vaccinations and check-ups in the system
		Prompted reflections	Nurses	-	-	-Flexibility on recording medication, vaccinations and check-ups
			Designers	-	-Provision of services based on nurses' timetable vs. MoHSW standards	-
		Observations	Designers	-	-Application of local practices	-
Post-Implementation Period	When the nurses started to use V1 of the system (from late March 2011)	System Experimentation	Nurses	-More knowledge on recording medication, vaccination and check-ups -Registering clients on appropriate visit		-Improvise an intermediary form between computer and paper
			Designers	-	-	-More knowledge on representation of medication, vaccinations and check-ups in the system
		Prompted Reflections	Nurses	-	-	-System definition of Visits vs. Stages
			Designers	-	-Domain definition of Visits vs. Stages	-
		- Interviews - Observations	Designers	-	-Utilisation of improvised registers -Challenges of using a computer at the point of service delivery -Informal exchange of information between nurses and mothers and community members	-
	When designing SMS (from November 2011)	System Experimentation	Nurses	-Create SMS to be sent to clients	-	-
			Designers	-	-	-Appropriate messages to be sent to clients

Table 1: When and what was learned by nurses and designers through different technique

Referring to Table 4, the analysis also shows that through prompted reflections technique in all periods, the nurses gained ‘know-what’ while the designer gained knowledge on nurses’ tasks and work practices – ‘know-why’. To the contrary, the application of ethnographic techniques such as interviews, document reviews, observations and focus groups enabled the designers to gain knowledge on how work was supposed to be done instead of how it was actually done. This may be a result of designers’ inadequate knowledge about the clinical work and time limitations that hindered the health workers from having enough time to build trust and be able to share their knowledge and experiences with the designers.

The prompted reflections technique in this case allowed mutual learning to take place during the design and implementation and post-implementation periods, contrary to the case presented by Kensing (1998) wherein mutual learning was experienced before the system was designed. In this case, the actual use of the system during and after implementation prompted the nurses’ reflections on how their work was misrepresented or not represented in the system. And free-hand drawings and discussions conducted prompted the designers’ reflections on how they represented the nurses’ work in the system. A mutual understanding created by the nurses and designers became the basis for designing V1 of the system and further refining the system requirements.

7 Conclusion

This study has elaborated how PD was adapted in designing a maternal and child health application with the nurses. In this case PD created a learning platform through which the nurses gained IT knowledge, the designers learned the nurses’ work, and together the nurses and designers developed a mutual understanding on how the domain should be represented in the system design. In this section, I present the conclusion by answering the posed research question: which techniques will support mutual learning where wide knowledge gaps exist and in which sequence should they be applied?

Regarding which techniques, this study has shown that the application of ethnographic, hands-on training, system experimentation and prompted reflections assisted designers and users in learning from each other. As indicated in the analysis, the designers first used ethnographic techniques to acquire domain knowledge. However, the designers only grasped the basic understanding about tasks and work practices of the nurses. Hands-on training and system experimentation techniques were used to support nurses in gaining IT competence on how to use computers and the maternal and child health application. Also the hands-on training and system experimentation techniques supported the nurses in understanding how their

work was represented in the system, and allowed the designers to reflect on the system design concerning bad design, missed and new requirements, and a need for more training.

Prompted reflections and system experimentation techniques were used simultaneously during training and after the system implementation. The prompted reflections technique enhanced mutual learning between the nurses and the designers whereby together they gained more understanding of how the nurses' work was represented in the system. The techniques also enabled the designers to gain more knowledge about the tasks and work practices of the nurses by complementing what was learned through the ethnographic techniques used.

Different studies (Jirotko et al. 1992; Suchman 1995; Symon et al. 1996; Berg 1999) have emphasised the necessity for understanding work in a particular setting before designing computer systems to be used in that setting. The wide knowledge gaps as demonstrated in this study posed a challenge to designers in that the nurses' practices were not properly understood during the early stages of system development. What was actually done by the nurses, especially informal procedures and improvised registers used, surfaced during and after the system implementation.

Bratteteig (1997) and Mörtberg et al. (2010) indicate that it is difficult to achieve mutual learning in most cases because the involved parties may not be ready to give up their ideas, power or perspectives. This study has shown how mutual learning was supported during and after the system implementation through the prompted reflections technique despite the wide knowledge gaps between users and designers. Results indicate that to bridge the gaps, the technique should be used after two things have happened. First the users have received hands-on training and have started to experiment with the system in a real-life environment. Second, the designers have become aware, to some degree, of the users' tasks and practices. This implies that to support mutual learning, not only are the techniques important, but also their timing is important.

These findings indicate that mutual learning can occur during and after system implementation. This supports findings presented in IS management research (Santhanam et al. 2007; Wagner and Piccoli 2007; Kaasbøll et al. 2010) that emphasise the fact that users and designers learn more when the users start to use the system in their work environment. This study contributes to the PD literature that in contexts where wide knowledge gaps exist between users and designers, mutual learning should be supported during and after system implementation.

While the PD literature has described mutual learning as a means for including users in IT systems design, this case showed that users on their own initiative designed a paper tool for transfer of data from previous paper records to the IT system. In a resource-poor setting, such designs may be necessary to couple paper and computer based systems.

In this case we have also revealed that the use of prompted reflections technique to stimulate mutual learning cannot only be used before the implementation but also during and after implementation stages contrary to the work of Kensing (1998). Another contribution of this paper is a demonstration of a simpler and less formalized application of prompted reflections technique than that described in (Kensing 1998) that can be useful as a technique for mutual learning. In this case, three (preparation, workshops and analysis) of the four activities in prompted reflections were conducted.

The application of different techniques as demonstrated in this paper can be useful for research in a similar context. Further research is needed to look into the cultural issues associated with their application. This paper also has not completely answered the overall question of ‘which techniques will work and in what sequence’. This is because the effectiveness of many techniques has not been addressed. Also the sequence of techniques used in this case was not optimal for designers to learn about the nurses’ work earlier in the process. Further research is needed to demonstrate whether other techniques will work in a setting such as this and what sequence can be optimal.

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Appendix 5: PAPER V

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Challenges in Implementing a Computerized Name-based Information Tracking System: Practical Experiences from Maternal Health Care

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Abstract: This paper presents challenges encountered in implementing a computerized name-based system for tracking information of pregnant women and children in rural clinics. Results indicate that the implementation of a computerized name-based system faces potential challenges that include; understanding the complexity of local healthcare practices within the community as well as correlating standardised and improvised data collection tools used in health facilities. Other challenges are; application of localised and standardised procedures in healthcare provision, replacing the paper-based system and lastly gradual learning curve during the implementation. These are initial findings drawn from a qualitative research study conducted in the Coastal region of Tanzania. This study intends to improve data reporting and utilisation of health facility services for pregnant women, children and other key community members.

Key Words: Maternal healthcare system, computerised systems, name-based systems, health information systems, implementation, developing countries

1. Introduction

The implementation of computerized Information Systems (IS) in organizations adds potential in information storing, processing, retrieving, and presenting it more efficiently and effectively [1, 2]. However, the implementation of these systems at the lowest levels of Health Information System (HIS) has to realize practical potentials of communication and

information needs. In their study, Ngoma et al. [3] describe that at the community level, incomplete information on maternal health is reported to the health facility levels not because it is not available, but because of weak information links between the community and other organizational hierarchies. Creating an integrated information infrastructure that combine the use of paper-based tools, computers and mobile phones indicate prospects in strengthen these links.

In developing countries, implementation of computerized systems in most cases and specifically in the health domain has been challenging [4-8]. The remarkable challenge faced by implementers and designers of the systems is the complexities of healthcare processes and healthcare cultures. Heeks [4] indicates that, understanding magnitude of the gap between future expectations and the current realities of the system can lead to a successful implementation of health information systems. According to Braa et al. [8], creating flexible standards can help unpacking the complexities.

Name-based systems add another challenge as compared to systems that collect aggregated data. Confidentiality is important and data security is an essential element. The work practices as well are intertwined in the processes of collecting, aggregating and reporting the data [9-11]. It is evidenced that, a deeper understanding of the context where the system will be used, contribute to a better design. Therefore, this study is adding knowledge on practical challenges encountered in implementing a computerized system for maternal healthcare at the lowest levels of HIS in Tanzania. This knowledge can be useful for designers and implementers of similar systems in related context of use.

The organisation of this paper is as follows; objective of the study follows in section 2, research setting is presented in section 3 and the methodology employed in data collection is presented in section 4. Thereafter, the case description is presented in section 5 and lessons learnt in section 6. Conclusion and recommendations are presented in section 7.

2. Objective

This paper aims at presenting lessons learnt from a case of implementing a computerized maternal health system in a rural context. These lessons were learnt from designing and implementation of the system which is intended to improve reporting of mother and child health data from the community level to the health facility level in rural settings. The system is also perceived to improve clinic attendance of pregnant women and children. These will eventually contribute to the improvement of maternal health and reduction of child mortality rate in the country.

3. Research Setting

This research is conducted in Kibaha and Bagamoyo districts in the Coastal region of Tanzania under the Ministry of Health and Social Welfare (MoHSW). In the health management information system, data is collected from communities and health facilities (dispensaries, health centers and hospitals). In the health facilities, health professionals collect patient data while providing healthcare services. Provision of health services in the community is dominant in rural and semi-urban communities in the country. In the community, data is collected by community health workers who are non-medical professionals. Community health workers in this context are village health workers and traditional birth attendants.

Village health workers with the supervision of health facility nurse in-charge provide preventive health services in the community. These include; family planning (educate community and distribute pills and condoms), registration of pregnant women and monitoring their condition until they give birth, registration of new born babies, follow-up

on the growth status and childhood diseases for children under five years of age, mobilization and monitoring immunization status of pregnant women and children, reporting maternal and child deaths to the health facility, and reporting disease outbreaks.

Traditional birth attendants provide delivery services in the community. In addition to provision of delivery services, traditional birth attendants register babies at birth. They also mobilize mothers to take their babies to health facilities for immunization. Trained traditional birth attendants are supervised by a traditional birth attendant coordinator at the district level.

4. Data Collection

This is a qualitative research study where data was collected through interviews, observations, attending trainings and meetings, document reviews and software testing. The qualitative method was chosen because it gives a strong grounding on understanding people from their own perspectives [12]. We needed to understand the context so we can develop a system that will support the current work practices.

Interviews were conducted between January 2010 and March 2011 with six village health workers, seven traditional birth attendants, ten health facility workers and three district health managers. These interviews went hand in hand with observations. The objective of interviewing village health workers and traditional birth attendants was to understand how they collected and recorded maternal health data and where it was reported. Health facility workers were interviewed with the objective of understanding their work practices in recording data on different clinic visits and management of these visits, what data collection tools they used, and procedures employed in retrieving information for follow-up and provision of care. These practices were studied before and after the implementation of the system. The objective of interviewing district health managers was to assess procedures they used in designing register books and report forms, and providing feedback and supervision to the health facility and community health workers. Another objective was to investigate what they learnt from this pilot study and how they will apply this knowledge.

We also attended training and participants and conducted training as trainers where we were involved in different discussions that gave us an understanding of the context and the design of the system. We participated in training sessions where district health managers provided training to village health workers and traditional birth attendants. In these sessions we were contributing our views. We also conducted training with health facility workers on using the name-based maternal health system. The aim of this training session was to familiarize health facility workers with the system and to evaluate the design of interfaces and flow of activities in the system. From this training we gained knowledge on redesigning the interface and reorganising the flow of activities in the system.

This study was also involved in several meetings with village health workers, traditional birth attendants, district officials and health facility workers. In these meetings we engaged in several discussions with the aim of understanding the context and what and how to translate it into the design of the system.

Documents reviewed include data collection registers, clinic cards and report forms. Registers ranged from old to new registers, whereby the initial design of the system was based on the old registers which were later revised and started to be piloted in January 2011. We also reviewed locally improvised registers that were not standardized but were created by health facility workers to be used locally in their health facility. Pregnant women and children clinic cards were also reviewed. These cards contained personal information that the clients (women and children) moved with them and no other similar record was kept in the health facility. We also reviewed monthly and quarterly reports generated at the health

facility to be sent upwards to the district level and other reports created by health facility workers for local utilization of data.

Data was also collected during system testing in the pilot site. In this site, a computerized system had never before been implemented to be used by health facility workers. This was the first time for some health facility workers to use a computer and for all health facility workers it was their first time to use a computer in daily activities as part of the procedure. While health facility workers were experimenting with the system, all the strengths, shortcomings and overlooked requirements were noted.

Furthermore, through research collaboration with different stakeholders, we have been able to gather information on experiences in developing and implementing similar systems from other local and global stakeholders. These include the HISP network (Malawi, Guinea Bissau, Ghana, Vietnam, India, Kenya, Norway), OpenMRS (Malawi), DTree (Tanzania) and ITIDO (Tanzania). We also utilised research results from Masters students [13] engaged in different aspects of the project.

5. Case Description

This study is part of the global network for HIS research and development, Health Information System Programme (HISP). HISP started in South Africa in 1994 and thereafter it was extended to other developing countries such as Ethiopia, Vietnam, India, Botswana, Tanzania, Malawi, Nigeria and counting. In all the countries, the primary goal of HISP is to design, implement, and sustain HIS to support local management of health care delivery and information flows [14]. In Tanzania, HISP started in 2002, since then it has undertaken a number of activities such as standardization of data sets, redesigning of data formats and standards, adaptation of a District Health Information Software Version 2 (DHIS2) software standard, and institutionalization of these standards at different levels of the health system. DHIS2 is free and open software which is generic and once adapted; it is tailored to fit local requirements. For further details please visit: www.dhis2.org.

In Tanzania, DHIS2 operates from the district level, upward to the regions and to the ministry level. At the district level, aggregated data reported in paper based reports from health facilities are entered into the system where they are analysed and further aggregated. From the districts, data is sent electronically to regions and further to the Ministry. So far DHIS2 is operational in all districts of Coast, Lindi, and Mtwara regions in Tanzania.

With the current need of meeting the Millennium Development Goals (MDGs), especially goal number four (Reduce Child Mortality) and five (Improve Maternal Health), an emerging need arose to bridge the gap between the community (informal HIS) and the formal HIS so as to support complete and accurate data collection in remote communities and timely reporting to health facilities and further to the district. One of the obvious initiatives was to extend the use of DHIS2 to the health facility level where data collected in the communities which is name-based data (not aggregated) will be captured. A generic module Name-bases Information Tracking System (NBITS) was developed for this purpose.

NBITS can be used for case-monitoring, reporting and planning. As a case-monitoring tool, NBITS can be used to support timely service delivery and monitoring of individual case/client. This functionality is also extended to be used by a mobile phone client. As a reporting tool, NBITS enables aggregation of individual case data and import it into district based HMIS (DHIS). NBITS can also enable planning of activities (weekly, monthly) for community outreach activities. NBITS has been adapted in several countries for different purposes; in Malawi, India and Vietnam for monitoring and following-up service delivery to pregnant women and children. In Guinea Bissau, NBITS is used for monitoring and following-up service delivery to pregnant women, children and TB patients. In Ghana,

NBITS is used for monitoring and following-up service delivery to pregnant women, children and TB patients and in Kenya for death registration.

The implementation of NBITS was first done in India with an objective of supporting routine health facility reporting by involving community health workers in sending reports from the community using mobile phones. They capture information on pregnant women and immunised children while providing the services and send it to the health facilities.

The implementation in Tanzania is targeting monitoring and following-up service delivery to pregnant women and children. Pregnant women are registered and their information is monitored throughout the ante-natal care visits (ANC), during delivery and 42 days after delivery in post-natal care visits (PNC). Children are registered from when they are born and their health status is monitored until they are 5 years of age with the emphasis on immunization and growth assessment. The system registers and makes a complete service delivery and follow-up on all visits to the health facility. The system also sends Short Message Service (SMS) to women and key person(s) around pregnant women and children to remind them on their next clinic visit and give emphasis on health education given. Furthermore, the system aggregates data in different intervals to produce reports such as monthly, quarterly and annual reports. Further research is continuing to extend the functionality of the system to incorporate the use of mobile phone to collect data from the community level and send it to the database. Figure 1 depicts a pictorial illustration of the flow of activities in the system.

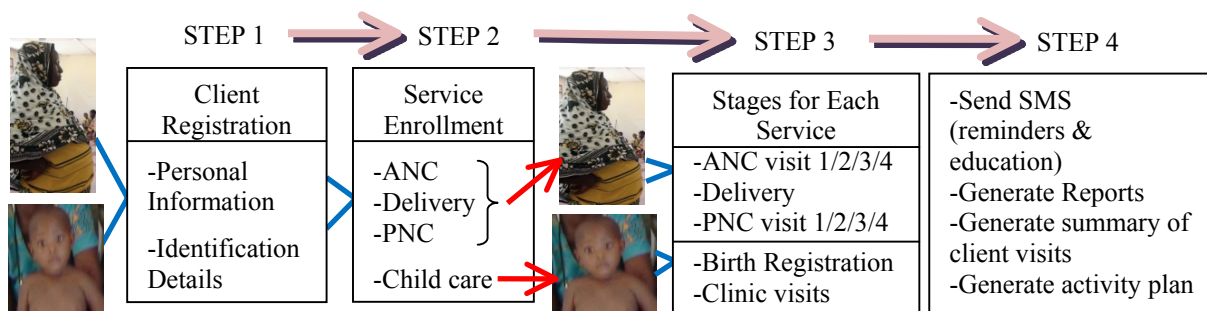


Figure 1: Flow of Activities in the maternal health care system

This is a pilot implementation where the system is installed in one health centre and it is used in parallel with the current paper-based system. In the pilot site data is entered by health facility workers after their working hours and not on direct encounters with their clients. The system can operate at the point of service delivery, however it is not used so because of the current work practice whereby they record on paper-based registers. And with a high number of clients, recording both on paper and on computer can compromise provision of the health services. Data are entered into the computer system from one week to one month after the provision of the service.

In this pilot site we are in a process of collecting more requirements while experimenting with the system in real-life working environment. The system has been operating in this health facility since March 2011. We are planning to extend the pilot to one rural health facility so as to collect and understand the requirements from different settings. Further research is also continuing to explore the potentials of scaling the use of the maternal health system for supporting data collection, and provision of services such in Prevention of Mother to Child Transmission (PMTCT) clinics, Care and Treatment Centers (CTC) clinics and TB clinics. This is perceived to facilitate data flows, sharing and reporting between different clinics attended by pregnant women and children.

6. Lessons Learnt

In the process of requirements determination, customization, training and testing the name-based Information Tracking System for maternal health, the encountered challenges are presented in this section as lessons learnt.

6.1. Complex local practices at the community level

In most developing countries, community based systems collect and report data on individuals. This information can loosely be called patient-based, however un-standardised it is. When it comes to implementing computerized patient-based system, there is a need of understanding what data is collected at the community level and procedures therein.

In this study, it was challenging to get hold of community health workers because they operate in an informal sector and they do not have an office where they can be met. Also the informal ways of conducting their activities became difficult to be captured and translated into the design of an automated computerized or mobile phone system.

However this has been possible through the involvement of district officials who were willing to introduce us to the village government head and health facility in-charge in the village. After they understood our intentions, the village head and health facility in-charge arranged a meeting where the village health workers and traditional birth attendants were invited. From that meeting, we started learning from them on what data they collected regarding mother and child health, and how they processed, reported and utilised it.

6.2. Catering for Standardized and Improvised tools

At the health facility level, data are collected using standardized paper-based system. Due to the dynamic nature of HISs, data requirements keep on changing and in most cases new data collection requirements are not specified in the standardized registers in use. In these cases health facility workers create their own improvised registers that capture new requirements so they can collect the additional data and aggregate it and report it upwards as needed. While trying to understand what data is collected it became important to review both standardized and improvised registers.

In this study, the design of the system included data collected both on standardised and improvised registers. Inspired by health facility workers, we drew a balance by including the data that was needed to be reported upwards and that was needed for local utilisation. Figure 2 presents a sample of screenshot for data entry.

REKODI YA MAHUDHURIO				
	Hudhuria la Kwanza	Hudhuria la Pili	Hudhuria la Tatu	Hudhuria la Nne
Tarehe ya Vipimo	2011-04-04	2011-06-05		
Uzito (Kg)	78	80		
Blood Pressure (mmHg)	80/70	147/80		

Figure 2: Data entry Screenshot

Similarly the design of computerized system to be used in this context needs to be flexible in such a way that, new requirements can be taken on board with a minimum involvement in changing the code structure of the system. These changes need to be done at the local level by health facility workers with minimum effort.

6.3. Balance between Localized and Standardized work practices

Provision of maternal health services in Tanzania follows standardized procedures set by the MoHSW. For example pregnant women attend four ANC visits and four PNC visits. In reality however, the arrangements of the intervals between visits and services to be provided follow localized procedures. For example the procedures for arranging clinic visits and immunization schedules are locally defined depending on the activities of health facility workers.

The local arrangements, which reflected the daily work practices posed a challenge in the system design because the systems needed to capture the lived practices without compromising the standardized procedures. In addressing this challenge, the flexible design of the system was the answer where health facility workers could adjust dates for clinic visits depending on their plans on provision of the health services.

6.4. Replacing the paper-based system

Health facility workers are required by the MoHSW to use paper-based registers for data collection, storing, and data reporting to higher levels. Introducing a computer-based system as a pilot implementation, the two systems needed to operate in parallel. The health facility workers are already overworked with a high number of clients to attend to. The computer system increased their workload, however important it is to test the requirements for the computer system.

To motivate the computerized system to be used, the feature provided by the system such as report aggregation and generation of summary report on client visits have been encouraging them to use the system. To be able to generate ready made aggregated reports which took them days to make one, they found it useful to enter the data for this purpose. The system also provides colourful reports on status of visit of each client, with these reports they can make a thorough follow-up on missed visits. Figure 3 presents an example of a report on summary of visits.

Full Name	ANC Registration Stage	ANC First Visit	ANC Second Visit	ANC Third Visit	ANC Fourth Vis
N	2011-04-03	2011-04-03	2011-04-03	2011-08-01	2011-10-03
i	2011-05-02	2011-05-02	2011-06-27	2011-08-22	2011-10-17
N	2011-06-01	2011-06-01	2011-07-27	2011-09-21	2011-11-16
At	2011-07-01	2011-07-01	2011-08-26	2011-10-21	2011-12-16
C	2011-08-01	2011-08-01	2011-09-26	2011-11-21	2012-01-16
h	2012-04-26	2012-04-26	2012-06-21	2012-08-16	2012-10-11
V	2012-05-27	2012-05-27	2012-07-22	2012-09-16	2012-11-11
J	2011-12-26	2011-12-26	2012-02-20	2012-04-16	2012-06-11
E	2012-06-27	2012-06-27	2012-08-22	2012-10-17	2012-12-12
Log summary	2012-05-27	2012-05-27	2012-07-22	2012-09-16	2012-11-11

Figure 3: Sample report of summary of visits

6.5. *Gradual user learning curve during implementation*

Implementing a computer-based system at a health facility level in a rural setting has never been done in Tanzania with exception of a few cases. Health facility workers at this level have never used a computer let alone integrate it in their daily activities of service provision. Together with the impossible practicalities of using a computer at the point of service provision, the implementation of maternal health system in this study focused on using the system after working hours.

Health facility workers need more time to get used to the idea of using computer and then it will be easier for them to integrate it in their daily practices. This study found out that the learning curve in using the maternal health system in this context is gradual. But the health facility workers are eager to take advantage of what the system can offer and even more features that will simplify their work and support them in providing better services.

7. **Conclusion and Recommendations**

In the HIS, mother and child health data comprises above 60% of all routine data. Managing these data incorporate complex procedures starting from data collection, analysis, and reporting across the organizational hierarchy. In addition, the context of use is complex in nature due to large number of clients both women and children attending the health facilities on daily basis as compared to a small number of available health facility staff. The capacity of health facility staff to manage data process and provide healthcare becomes inefficient.

Designing and implementing computerized systems to operate in this setting and become sustainable over time, this study underscores the importance of profound understanding the context. This understanding can help in creating flexible standards [8] and reducing the gap between system realities and future design expectations [4]. Flexibility is needed to accommodate changing requirements (both planned and unplanned) in data collection, processing and reporting. The knowledge about the current lived experiences of health workers will determine how the expected future practices should be modelled. This study has revealed that informal practices and improvised data collection tools are important components to be incorporated in designing and implementing computerised name-based systems.

Therefore, from our experience of designing and implementing a maternal health name-based information tracking system, this study recommends system designers and implementers to:

- Acquire a deeper understanding of the real life work practices of health workers at community and health facility levels on how they organise and manage data collection, recording and provision of healthcare services while adhering to standardised (formal) and localised (informal) procedures.
- Find a compromise between improvised and standardised data collection tools in designing data entry forms. Findings indicate that, improvised data collection tools reflect on the daily practices better than standardised data collection tools.

Working around the challenge of gradual learning in a complex context of use is still an empirical question. Further research is needed in this area. Furthermore, while the pilot study is operating in parallel with the paper-based system, understanding the full potentials of using a computerized system at the point of service delivery is yet another challenge that this study is trying to address.

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Appendix 6: Research Permit

THE UNITED REPUBLIC OF
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Ministry of Health and Social Welfare
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28th January 2010

Caroline Ngoma
University of Dar es Salaam
Department of Computer Science
P O Box 35062, DAR ES SALAAM

**CLEARANCE CERTIFICATE FOR CONDUCTING
MEDICAL RESEARCH IN TANZANIA**

This is to certify that the research entitled: Technological approaches in the improvement of the quality of maternal health data. (Ngoma C *et al*), has been granted ethics clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health & Social Welfare and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Approval is for one year: 28th January 2010 to 27th January 2011.

Name: Dr Mwelecele N Malecela


Signature

**ACTING CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE**

CC: RMO
DMO

Name: Dr Deo M Mtasiwa


Signature

**CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, SOCIAL
WELFARE**

THE UNITED REPUBLIC OF
TANZANIA



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21st December 2010

Caroline Ngoma
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APPROVAL FOR EXTENSION OF ETHICAL CLEARANCE

This letter is to confirm that your application for extension on the already approved proposal: Technological approaches in the improvement of the quality of maternal health data (Ngoma *C et al*), has been granted ethics clearance to be conducted in Tanzania.

The extension approval is based on the progress report dated 06th December 2010 on the project, Ref NIMR/HQ/R.8a/ Vol. 1X/920. Extension approval is valid until 26th January 2012.

The Principal Investigator must ensure that other conditions of approval remain as per ethical clearance letter. The PI should ensure that progress and final reports are submitted in a timely manner.

Name: Dr Mwelecele Malecela

Signature

**ACTING CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE**

Name: Dr Deo Mtasiwa

Signature

**CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH
AND SOCIAL WELFARE**

**RMO
DMO**