IT UNIVERSITY OF COPENHAGEN

Community-based Participatory Design of Technological Alternative for a Development Context :

The Case Study of ICT appropriation for Ethiopian Rural Community

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ABBREVIATION

CI	Community Informatics
ETC	Ethiopian Telecommunication Corporation
EJISDC	Electronic Journal of Information Systems in Developing
ESCPP	Ethiopian Socio-Cultural Participation Practices
FTC	Farmer Training Center
HCI	Human-Computer Interaction
ICT	Information and Communication Technology
ICT4A	Information and Communication Technology for Agriculture
ICT4D	Information and Communication Technology for
IS	Information System
ISDLC	Information System Development Life Cycle
IT	Information Technology
ITD	Journal of Information Technology for Development
ITID	Journal of Information Technologies and International
IICD	International Institute for Communication and Development: The Netherlands
JoCI	Journal of Community Informatics
MCIT	Ministry of Communication and Information Technology
PAD	Participatory Action and Design Research
PD	Participatory Design
PID	Participatory IT Design
SM@SMS	Social media using Short Messaging Service
SMRS	Systematic Mapping of Related Study
SMS	Short Messaging Service
SSM	Soft System Methodology
SST	Soft Systems Theory
STT	Socio-Technical Theory
UCD	User-Centered Design
UI	User Interface
SCPP	Socio-cultural Participation Practice
SST	Soft System Theory
WAEO	Woreda Agriculture Extension Office

ABSTRACT

Background: Significant improvements have been observed in information and communication technology (ICT) in developing countries. This has brought new opportunities to support development goals. As the type of development goals are context-dependent, ICT-based intervention requires a people-centered design approach.

Research problem domain and focus area: ICT for development (ICT4D) intervention in rural communities demand a different approach compared to traditional ICT projects. Participatory design (PD) approach is known for beneficiaries to tackle workplace design challenges. However, the research context of this study is focused on the Ethiopian agriculture scenario. Several analytical dimensions such as the role of local people, technology options, cultural practice, PD techniques, and community empowerment, to mention a few, need to be investigated in a local context. We formulate the research question: *How can community-based ICT intervention be designed in a socially complex rural context with people who have little or no technology experience?*

Approach and methodology: We adapted a pragmatic epistemological paradigm that allows a logical and practical empirical inquiry using multilevel actions and interventions in collaboration with target beneficiaries. P*articipatory action and design research method* was followed. The sequence of interrelated participatory design workshops and meetings was undertaken for understanding local needs and appropriating technological alternatives.

Results: The lessons learned and the knowledge obtained is presented in terms of four themes. The ***first*** theme presents the aspects of Ethiopian sociocultural participation practices. Such practices offer much more elaborate notions about why, how, and under what conditions people do things together. These practices not only facilitate the identification of problems that need to be addressed, but also foster in-depth collaboration attitude. Here, we present a conceptual base to articulate why familiarizing PD concepts and design practices are so important for PD research and approaches.

The ***second*** theme, the participatory problem analysis led us to design two kinds of technological alternatives. Aligning technological alternatives based on community communication practices enable us to bridge the gap between what is known in academic studies from what is useful in context. The results also indicate the need for extending the usability concept and evaluation procedure from individual attributes to a usability attribute related to group (community) users. The ***third*** theme addresses local ownership both in terms of process and design outcomes. Involving communities in the design process is not sufficient

unless they show the willingness to take local responsibility. Here, an integral part of infrastructuring activities is establishing a locally trusted entity towards a common resource and their administration. The ***fourth*** theme presents a conceptual framework that demonstrates commonly overlooked ICT4D issues and links between them. Specifically, it presents an alternative approach to viewing "D in ICT4D" instead of considering it as a simple package of individual rights such as economic information.

Conclusion*:* Our multiple-level investigations and experimentations rooted in community context provide a theoretical and methodological approach. When collaboration for development is the subject of research, people participation will have a sense of intrinsic value that empowers them to take agency in activities that are relevant to their lives. For a community to come together for action around a shared social condition, one of the most important key issues is finding active bonds and local cooperative practices.

ABSTRACT (Danish version)

Baggrund: Der er iagttaget væsentlige forbedringer inden for informations- og kommunikationsteknologi (IKT) i udviklingslandene. Dette har givet nye muligheder for at understøtte udviklingsmål. Da type udviklingsmål er kontekstafhængig, kræver ikt-baseret intervention en people-centered design-tilgang.

Problemfelt og fokusområde: IKT til udvikling (ICT4D) intervention i landdistrikterne kræver en anden tilgang i forhold til traditionelle ikt-projekter. Deltagende design (PD) tilgang er kendt for modtagere til at tackle udfordringer på arbejdspladsen. Forskningsrammen for denne undersøgelse er imidlertid fokuseret på det etiopiske landbrugsscenario. Adskillige analytiske dimensioner som lokalsamfundets rolle, teknologiske muligheder, kulturpraksis, PD-teknikker og samfundsbeføjelse, for at nævne nogle få, skal undersøges i lokal sammenhæng. Vi formulerer spørgsmålet: Hvordan kan samfundsbaseret ikt-intervention udformes i en socialt kompleks landlig sammenhæng med mennesker, der har ringe eller ingen teknologioplevelse?

Tilgang og metode: Vi tilpassede et pragmatisk epistemologisk paradigme, der muliggør en logisk og praktisk empirisk forespørgsel ved brug af multilevel-aktioner og -interventioner i samarbejde med målmodtagere. Deltagelsesaktion og designforskningsmetode blev fulgt. Sekvensen af indbyrdes forbundne deltagende design workshops og møder blev gennemført for at forstå lokale behov og tilegnelse af teknologiske alternativer.

Resultater: Erfaringerne og den opnåede viden er præsenteret i fire temaer. Det første tema præsenterer aspekterne af etiopiske sociokulturelle deltagelsespraksis. Sådanne fremgangsmåder giver meget mere uddybende forestillinger om hvorfor, hvordan og under hvilke forhold mennesker gør tingene sammen. Disse fremgangsmåder lader ikke blot identificere problemer, som skal løses, men også fremme en dybdegående samarbejdsposition. Her præsenterer vi en konceptuel grund til at formulere, hvorfor bekendtgørelsen af PD-koncepter og designpraksis er så vigtig for PD-forskning og tilgange.

Det andet tema, den deltagende problemanalyse, fik os til at designe to slags teknologiske alternativer. Tilpasning af teknologiske alternativer baseret på fællesskabskommunikationspraksis gør det muligt for os at bygge bro over kløften mellem det, der vides i akademiske studier fra det, der er nyttigt i sammenhæng. Resultaterne viser også behovet for at udvide anvendelighedskonceptet og evalueringsproceduren fra individuelle attributter til en brugbarhedsattribut, der er relateret til gruppen (fællesskab) brugere. Det tredje tema omhandler lokalt ejerskab både hvad angår proces- og designresultater. Inddragelse af lokalsamfund i

designprocessen er ikke tilstrækkelig, medmindre de viser villigheden til at tage lokalt ansvar. Her er en integreret del af infrastrukturaktiviteter etableret en lokalt betroet enhed mod en fælles ressource og deres administration. Det fjerde tema præsenterer en konceptuel ramme, der viser almindeligt oversete ICT4D-problemer og forbindelser mellem dem. Specifikt præsenterer den en alternativ tilgang til visning af "D i ICT4D" i stedet for at betragte det som en simpel pakke af individuelle rettigheder som økonomisk information.

Konklusion: Vores undersøgelser på flere niveauer og eksperimenter, der er forankret i fællesskabskontekst, giver en teoretisk og metodologisk tilgang. Når samarbejdsudvikling er genstand for forskning, vil deltagernes deltagelse have en følelse af indre værdi, der giver dem mulighed for at tage agentur i aktiviteter, som er relevante for deres liv. For at et fællesskab kan komme sammen til handling omkring en fælles social tilstand er et af de vigtigste nøglespørgsmål at finde aktive obligationer og lokale samarbejdspraksis.

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Part I: Research problem and Context

1. INTRODUCTION

1.1 Overview

Regarding the rapid proliferation of information communication and technology (ICT) across the world, it is seen as a catalyst for international development agendas in developing countries. Specifically, the capability of ICT to overcome geographic barriers, establish an information-rich global community, and interconnectedness among others have positioned ICT as a prominent agent for development (Gigler, 2015). Governments, donor agencies, and designer-researchers have pushed ICT to the forefront of their development agendas (UN, 2015; Heeks, 2014). Addressing local development in turn demands several background processes such as preparation and establishing collaboration and negotiations, among other things.

When collaboration for development is the *subject of research*, the target beneficiary needs to provide meaningful contributions to the design process. Collaboration and/or participatory approach emphasizes that people have different local needs and perceptions of the design process(Simonsen & Robertson, 2012). It also refers to conception of a shared vision and mutual understanding of different perspectives and expectations of stakeholders (target beneficiaries) to anticipate and shape their own futures. These perspectives or expectations can be articulated only if target beneficiaries are provided with appropriate tools to express their needs. Our interpretation of "development" is founded on who, why, what, and how. That means that "development" requires change, which in turn raises the questions of why *is there a need for change? Who are the target people? What aspects of things should be changed and how?"*

1.2 The practical and research problem area (domain)

ICT for development (ICT4D) is a relatively new research domain to address issues related to ICT and development(Gitau, Plantinga, & Diga, 2010; Heeks, 2006; Walsham, 2013). It is an interdisciplinary field that focuses on investigating links between ICT and target development goals. ICT4D interventions differ from conventional ICT projects in a number of ways. For instance, many contextual issues such as cultural, social, political, and environmental and technical matters are extremely complex, and one-size-fits-all solutions do not work. Simultaneously, addressing the two overlapping areas of concerns, the practical problem area and research problem area, adds more complexity to the ICT4D research field.

Application domain (local) problem: In Ethiopia, agriculture is the largest livelihood provider (more than 80% being farmers), which is characterized by small and marginal farmers owning small and scattered landholdings. Farmers in rural areas have to deal with failed crops and animal illness frequently. A typical scenario is that a farmer decides –maybe after consulting an agricultural development agent – on the selection and a particular crop variety, selection of ranges of agro-inputs, and selection of the right period of farming activities. Nevertheless, the vast majority of gains by farmers are unsatisfactory despite the efforts put into agriculture cost inputs. Farming communities have continued to rely on agriculture information supplied and verified through traditional word-of-mouth. Due to limited communication, solutions to their problems remain out of reach (see Chapter 2).

Improving Ethiopian agriculture service delivery becomes important with incorporating mainstream ICT into development projects, as highlighted in the government vision for 2020 (FDRE, 2016b). For instance, with funding from the Bill & Melinda Gates Foundation(Bernard et al., 2016), the "original idea of Digital-Green project from India (Gandhi et al., 2009) approach" has begun implementation since 2014. The Ethiopia Commodity Exchange (ECX) was established to facilitate the trading between farmers and distributors and/or consumers (ECX, 2017). Similarly, the Ethiopian Livestock Market Information System is another ICT-based intervention that attempts to provide livestock price information on major livestock markets via SMS, email, radio, and Internet (International Livestock Research Institute, 2005). Livestock prices are collected through interviews with traders during the peak of a market day.

The aforementioned technological solutions are limited in scope, type, and actual information and service delivery. These ICT initiatives are characterized as top-down and technology-centric initiatives. Such ICT initiatives often tend to be supplier-led rather than people-oriented, and are not cost-effective. Communities are the closest to grassroots problems; they are the best judges to evaluate technology alternatives and provide innovative solutions to problems in their respective areas. Above all, ICT should not be seen as a panacea for the immediate improvement of community problems, but as one tool among several.

The research problem domain: Contemporary ICT4D research projects are often externally driven and technology-centered rather than community-centered (Dodson et al., 2012; Heeks, 2010b; Maail, 2011). Failure of such large complex ICT4D projects to meet their stakeholder expectations are not failures of technology; rather, these projects fail because they do not recognize the social and organizational complexity of the environment in which the systems are deployed. ICT4D projects differ from conventional information technology

projects in a number of ways. There is a set of environmental and specific constraints related to target users of ICT4D projects that conventional projects rarely can address. People, technological alternatives, and infrastructure should not be studied merely as social and physical phenomena, but rather as part of the ecology of social, physical and technological aspects. Although current ICT4D research investigates social and development aspects directly associated with contemporary technological innovations, there is a lack of a clear theoretical and methodical foundation (Gomez, 2013).

What kinds of design approach to use has been the subject of debate (Blake, 2010; Chetty, Tucker, & Blake, 2003; Doerfinger & Dearden, 2013; Gomez & Day, 2013; Heeks, 2009; Islam & Grönlund, 2012; Merritt, 2012; Parmar, 2009; Sein, Hatakka, Thapa, & Sæbø, 2016; Sutinen & Tedre, 2010; Walsham & Sahay, 2006). Scholars like Reijswoud(2009) argue that the bottom-up , participatory, and holistic approaches are vital, but have not received adequate attention in ICT4D research. In the areas of PD, there is also a growing interest in community-based PD through socio-material-technical arrangements(Bjögvinsson, Ehn, & Hillgren, 2012; DiSalvo, Clement, & Pipek, 2012; Kapuire, Winschiers-Theophilus, & Blake, 2015; Winschiers-Theophilus, Bidwell, & Blake, 2012; Winschiers-Theophilus, Chivuno-Kuria, Kapuire, Bidwell, & Blake, 2010). PD has a number of design principles and techniques that also depend on contextual aspects such as cultural background of the user, user motivation, desire to participate, and availability of resources, among others. User participation and the usefulness of PD methods, however, need to be carefully studied and should be appropriate to a new cultural setting before starting the participatory design process (Winschiers-Theophilus, 2006; Winschiers-Theophilus, Chivuno-Kuria, Kapuire, Bidwell, & Blake, 2010).

In light of the above, we re-examined the PD approach and adapted it to social and cultural context and practices in Ethiopia. For instance, a ladder model does not allow people in the lower stages (e.g., people in the community) any control over decisions and results. See Section 3.2 for a detailed explanation of research gaps in the current technical ICT4D research in general, and Section 3.3, ICT for agriculture (ICT4A) in particular. Here, we emphasize social embeddedness and the importance of local issues for ICT-based intervention. Towards this end, Section 3.4 presents PD aspects and underpinning concepts to address ICT4D issues and design process together with local beneficiaries.

1.3 Research question

My research is situated in the intersection of the PD and ICT4D research fields. The background or the research context of this study is focused on the Ethiopian agriculture

scenario in general and rural community problems in particular. Given the above challenges and gaps in the scientific literature, several analytical dimensions such as the role of local people and collaboration, negotiation, community empowerment, process and design strategies, technology options, cultural practices, and PD techniques were part of the investigation. The central part our community-based PD research focuses on emergent collective action towards the formation of common resources and their administration. To this effect, the research question is formulated as:

How can community-based ICT intervention be designed in socially complex rural context with people who have little or no technology experience?

We adapted a paradigm stance and methodological framework that fits with the community-based PD research. We recognized a real-world problem as composed of complex systems and attempted to understand reality from multiple perspectives. The aforementioned research question demands not only discovery and understanding of the context but also imagining a future world: "dare to emerge new world through design". We followed a pragmatic epistemological stance where knowledge arises not only from "*knowing through observing or participating*" but also "*knowing through making*"(Creswell, 2013). My role was not confined to understanding the problematic situation, but also reflecting on emerging changes by designing ICT intervention together with the community. The social and technological issues were analyzed systemically (jointly) rather than separately. Towards this end, a flexible and reflective research method of participatory action and design research was adapted (*see Chapter 4, Section 4.5 and Chapter 5, Section 5.1*).

1.4 Contributions

This thesis bridges the theoretical and practical gaps to collaboratively design community-based ICT initiatives in a systemic manner. I build upon my research based on relational and contextual aspects of social cultural practice and people's situated action. We understood local participation practices as particular social arrangements for coordinated actions among community members. This in turn was based on systems of shared meanings that surround individuals in social structure through their experiences and their relationships. The study also contributes a comprehensive conceptual framework that provides explanations about how we think (conceptualize) development, the 'D' in ICT4D, and several aspects of the design process and its outcomes. My multiple investigations and experiments rooted in community contexts exemplify a bottom-up approach. Specifically, we argue the following knowledge areas as contributions:

Aspects of Ethiopian sociocultural participatory practices for PD- The concept of sociocultural participation practices such as Edir and Wenfel play a significant role to frame, understand, and analyze participation. Specifically, cooperative practices offer much more elaborate notions about why, how, and under what conditions people do things together. The community social infrastructures are not only used to understand social relations, but also coordinated actions among local members of the community. The concepts of Edir and Wenfel worldview encompass a system of shared meanings that surrounds individuals in social structure through their experiences and their relationships. This in turn incorporates value systems into their genuine participation. Such value systems not only influence the concept and practices of PD, but also the necessity of establishing reciprocity when engaging local people in design activities. In addition to this, in each of the sociocultural participation practices, the presence of a local coordinator and an implicit or explicit social structure is an opportunity for joint action. Thus, prior to a PD in a new cultural environment, the elements of the local culture and the very basic idea of participation (meaning) need to be investigated. Furthermore, we must be able to identify different key local actors and be able to relate to the local sociopolitical structure (Section 7.1 provides a detailed explanation).

Establishing ownership towards shared resources and their administration- Our community-based PD also demonstrates what types of social arrangement might be recognized as legitimate representatives towards the formation of communal resources and administration. Toward this end, we need to look more closely at how we engage local people in the design process and question our approach and methods. Our empowerment and capacity-building strategies demonstrate beyond awareness creation or providing training to the issues of establishing responsibility. For instance, opportunities for local ICT capacity building: arranging "self-help teaching" for community youths were established at the outset of the study, but remain a part of our investigation for the remaining design activities and outcomes. Behind all these activities, the community social structure and culture of participation practices were implicitly or explicitly applied for infrastructuring sociotechnical activities. In doing so, the outcome of the design process was driven by the needs and knowledge of the local community members, as well as constraints emerging from that context. This in turn quickly anchors ICT initiatives to the community's local needs and practices but also transfers ownership to community people. Here, we claim that the collaborations between ICT4D researchers and community people need to address questions that help local people to express and understand their roles, responsibilities, and expectations. For example, the designer-researcher can reflect on how roles, influence, and people's capability are deployed at particular moments in a project

(a detailed discussion is presented in Sections 7.2 and 7.3).

***A conceptual framework about ICT4D issues and links*:** We demonstrate a need for a shift both in focus and perspective on ICT4D intervention with multilevel actions and several intermediate outputs. We analyzed issues related to *contextual*, *technological* and *development perspectives*. These issues are *systemic* issues, which cannot be understood in isolation but need a bottom-up, holistic approach to understand "ground truths" within a context. Toward this end, we demonstrate a unique collaboration that incorporates the interest of the community people and the ICT4D researcher, including local universities. This in turn provides a theoretical and methodological basis for designing and adapting technological alternatives to the local context and needs. As a result, plausible explanations of how ICT4D issues are addressed as well as connections between them are presented as a conceptual framework. This conceptual framework can be thought of as an approach that asks questions such as what are ICT4D issues, the relational structure between issues, and why one issue influences the other(s). The relational structure and the evolution of that structure enable us to investigate the local meaning of development (or aspiration) that is implicated in the design process.

The conceptual framework (approach) also serves as a pathway for ICT intervention from its initial stage of needs assessment up to enhancement of human and social capabilities. We hope that the framework would extend the motivations and priorities of PD values to ICT4D design practices and support in defining and designing for local development. We also develop an initial checklist for a systematizing method and what to take action on. The table describes the issues of ICT initiatives to be considered at various levels both at the design and use time. It also enables us to see how technological solutions might be realized and what kinds of empirical data are to be collected. It is my understanding that our *third* contribution simplifies to adequately ground the concept or theory of development to specify ICT-based intervention and design activity. Here, we argue that the connection between research and community problems is through an ethnographically informed and collaborative design. Such an open innovation process enables us to prioritize community problems and formulate alternative solutions or services (a comprehensive explanation is presented in Section 7.4).

Evolving collaboration and relationship - Beyond my initial plan, I was engaged in different PD activities, which brought several actors to be evolved through time. These inculde: Edir leader, community leader, kebele chairperson, development agent, community youth, and Adama Science and Technology University, community staffs. Establishing community knowledge center (CKC), finding computers and trainers, and organizing trainees enabled to

embrace ICT4D research according to the community need. The arrangement of CKC resources by itself brought another social space for interaction to be formed. For example, some of the community members were coming to the CKC to watch videos stored in the local computer center. Youth also scheduled themselves for shared responsibilities such as cleaning the CKC room every week. The Edir judge, "CKC room key holder," and guard articulated their attachments to common issues that were triggered by their shared responsibilities. Here, we argue the evolving collaboration exemplifies an essential prerequisite for the ICT4D researcher to be guided by PD values. Collaboration between community people and the ICT4D researcher, including local universities, must be in the interests of both sides helping both parties to push ahead with the research-based technological design. This, in turn, provides a theoretical and methodological basis for designing or adapting technical solutions to relevant local contexts and needs.

1.5 Structure of the thesis

The thesis is organized into eight chapters, as shown in Figure 1. Chapter 2 highlights the practical problem in context and our motivation behind this research work. It also provides preliminary pre-study results about the study site.

The Chapter 3 deals with the literature review and related work, discussing the basic concepts of information and communication technology for development, participatory design, and existing ICT4A initiatives across several developing countries. The analysis of such concepts and related works led to identifying research gaps and our research direction. Chapter 4 supports the literature review, but the focus is to identify the appropriate conceptual framework that can guide the research. As a result, different research paradigms, soft systems thinking, and culture were discussed.

Chapter 5 highlights the research strategies chosen for this study. Specifically, participatory action and design research process were deployed. Chapter 6 deals with the actual research process execution and the results obtained both in terms of knowledge and technological designs. The overall process presents the lesson, which was driven by the needs of the local community as well as constraints emerging from the context. It also presents our reflect-in-action on both the design process and outcomes.

Chapter 7 discusses the overall research process and provides insight from this research work. I look back on my community-based PD research journey to reflect upon the results both at the process and outcome level. As a result, several social-technical lessons with respect to sociocultural participation practice, technological alternatives, and local ownership are

discussed. Following this, we present our argument about ICT and development into a conceptual framework. Finally, in chapter 8, we reflect on the implications and insights of this study to both the PD and ICT4D research domains. We end this chapter by highlighting the limitations of the study and making a few recommendations.

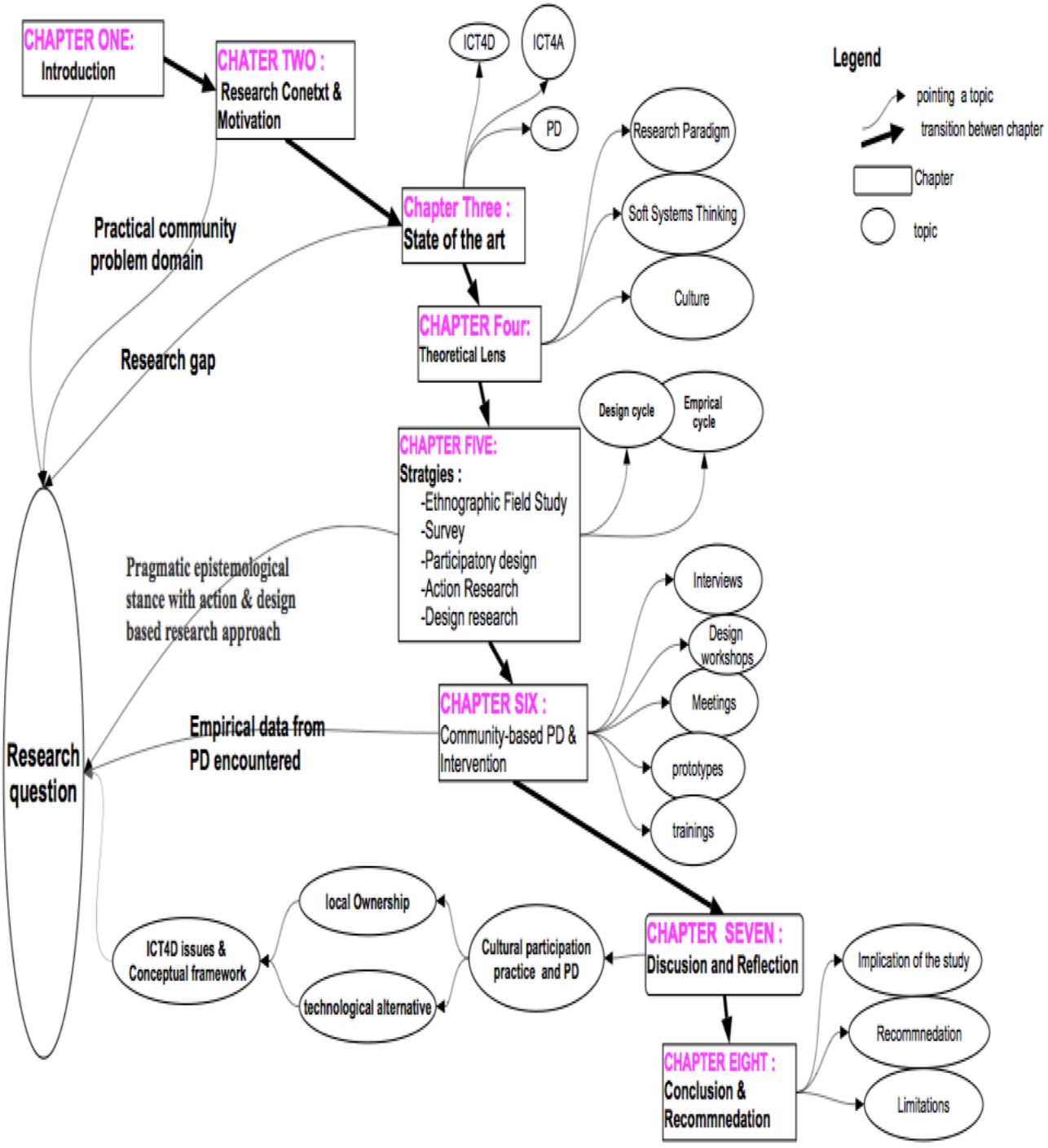

Figure 1: Structure of the Thesis

2. RESEARCH CONTEXT and INITIAL ANALYSIS

Ethiopia is Africa's second most populous country, exceeds 100 million people. About 83 % live in rural areas where an uneven distribution of development has been prevailed. Barriers that are not purely economic but also infrastructural, social, and political systematically affect the marginalized part of society. In light of this, rural communities were taken as the research context for this study. This section provides a background of the research setting, which focuses on the Ethiopian agriculture context as well as the government's ICT for development policy. The background assessment covers several issues from the national level to the rural community. The preliminary survey results also highlight other community problems and opportunities for further investigation.

2.1 Agriculture scenario in Ethiopia

Due to a vast majority of the rural population being engaged in agriculture, agriculture-led development is the priority issue in Ethiopia. Agriculture is the backbone of the Ethiopian economy and is the single largest sector, employing 70% of the country's total workforce. Agriculture accounts for approximately 40% of the country's GDP (EATA, 2016). Despite progress in the productivity of Ethiopian agriculture, the sector is still too small to feed the country's current and projected population. Agricultural services like providing the right information at the right time to the target stakeholders are lacking. In particular, farmers who live in remote rural areas are facing challenges in their daily life.

Rural farming communities have to deal with failed crops and animal diseases due to limited communication facilities. Ethiopian agriculture is characterized by small and marginal farmers owning small and scattered landholdings. A typical scenario is that a farmer decides, maybe after consulting an agricultural development agent, on the selection of a particular crop variety, ranges of agro-inputs, and the right period for farming activities. Currently, the government supports people in rural areas with agricultural advice and education through extension offices.

According to Swanson and Rajalahti's (2010) study, Ethiopia has the largest agricultural extension system in sub-Saharan Africa. A total of 8,500 Farmer Training Centers (FTCs) were established, and 63,000 field extension workers (development agents-DAs) received training (Gates, 2010). The FTCs are positioned to facilitate agricultural knowledge and information exchange between DAs and farmers. The agriculture extension officers are used as educators in disseminating agricultural technological knowledge to farmers. Currently, extension practice

at the FTC uses participatory teaching through farmer field schools and farmer-to-farmer extension. The extension offices, however, often do not function satisfactorily, as the personnel suffer the same adversities as their clientele–lacking a physical and information and communication infrastructure.

Due to weak linkages and networking among relevant institutions and stakeholders engaged in the agriculture sector, the Ethiopian Ministry of Agriculture is looking to create new platforms for linking stakeholders in the farming context. So far, the primary method for linking different actors including farmers, development agents, and agricultural researchers working at various levels merely depends on traditional communication channels: word-of-mouth. Agricultural extension services to meet farmers' needs have not been effective in communicate with the farmers (EATA, 2016).

2.2 Major stakeholders in the agriculture sector

According to Clarke's (1991) definition of a social arena, it is "a place in which different communities of actors meet to discuss shared concerns". He described how each arena is framed by its structural and process conditions. Actors in a specific arena engaged in the definition of issues require attention, which compete with other arenas for resources. Scholars like Balka and Wagner(2008) demonstrated the implication of social arenas for customizing an information system to the target users. Here, the arena concept is used as a means to study the interaction between different collective entities. Arena analysis not only involves identifying the participants in the important social arenas, their distinctive perspectives, and the nature of their interactions, but also how agendas are set and power is exercised across social arenas. The arena concept was used to get a deeper analysis of stakeholders and their interactions. This in turn was used to clarify key aspects of the areas of concern, such as what needs to be addressed and to draw the boundaries of the solution.

Analysis of major stakeholders and their interaction are presented at three levels: country (Arena A), rural development (Arena B), and rural community (Arena C). Figure 2 shows the interdependency between various interested parties in the agricultural sector. The out circle shows the stakeholders that execute national-level agendas and policy. Similarly, the two inner circles show interested parties and their interactions in rural development and rural farming communities, respectively. As the size of the circle indicates, stakeholders in the outer circle have a greater role and influence on the lower levels. For example, the stakeholder that works at the middle circle (Arena B) has its role and impact on the stakeholder found in the deep inner circle (Arena C). Actor interdependency also be observed between stakeholders in the same

circle. The substantial parts of the arena and stakeholder analysis have been published as a position paper (Zewge, Dittrich, & Bekele, 2014).

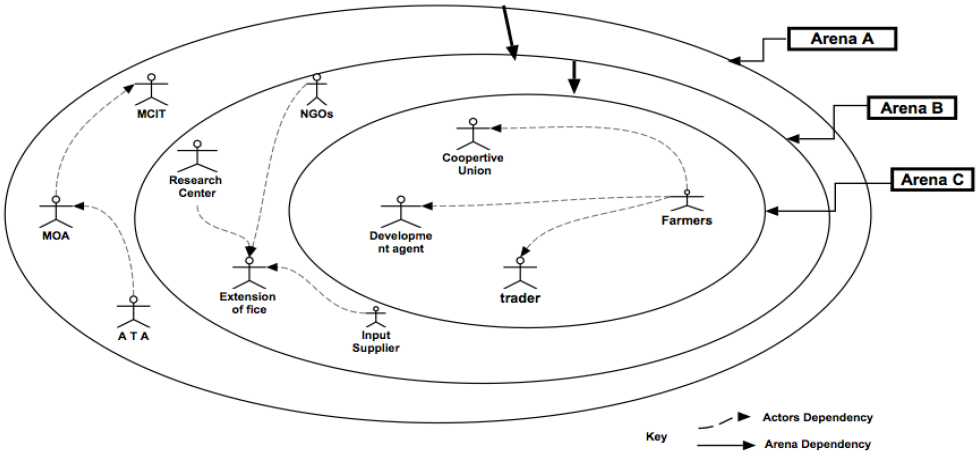

Figure 2: Stakeholders and their interdependency, agriculture sector.

Arena A: National or country policy

Agriculture is one of the most important sectors of national governments, as farming provides the basis for livelihood and development of the whole society. This section gives specific attention in regards to transforming the agriculture service. The existence of a cohesive and well-functioning institutional framework is essential for effective policy implementation and the attainment of national objectives. Figure 2 shows the interdependency between various interested parties in the agriculture sector. There are three major stakeholders who work in the national arena. The Ministry of Agriculture (MOA) is a government body responsible for facilitating and designing policy for materializing the benefits of new technology and best practice across the country. It seeks partnerships with private sector parties such as traders, brokers, and non-governmental organizations. Such attempts aim to maximize and improve agriculture production, food safety standards, and marketing (Gebremedhin, Hoekstra, & Tegegne, 2006; UNDP-Ethiopia, 2012). It also needs strengthening the capacity of institutions and people involved at the various regional and lower branches of the administration.

The Ethiopian Agriculture Transformation Agency (EATA) was established in 2010 to promote agricultural services and to deliver on a priority national agenda (EATA, 2016). Similarly, the Ministry of Communication and Information Technology (MCIT) was established in 2010 to facilitate the role of ICT in national development. This gave the MCIT a comprehensive mandate to promote and development of ICT. The detailed government development policy will be discussed in the next Section.

Arena B: Rural development

Currently the agriculture sector in a developing country is hierarchically structured and administrated top-down with legally regulated means and communication procedures. The Ethiopian MOA addresses rural development at a Woreda-level administration chain. The terms Woreda refers to an English term "district" which is a third-level administrative division of Ethiopia. The policy guidelines defined in Arena-A are dependent on the implementation of coordination of several lower-level administrative agencies that are expected to implement different programs and projects.

Governmental stakeholders in this arena are responsible for generating agriculture-related knowledge, leading to the preparation of best cultivation techniques and farming materials. The Ethiopian Agriculture Research Institutes (EARI) is responsible for creating the agricultural technologies and best practices for the farmers and other officers. Others such as Oromia agriculture research centers are mainly responsible for communicating their findings to the agricultural community. The Woreda extension offices coordinate various experts to address a range of developmental issues, including farming and livelihood problems. The extension offices cooperate with research and government and NGOs development actors. Agricultural extension officers implement government policies. They monitor farm practices periodically with the aim of applying remedies if anomalies occur. They look for ways to ensure that useful information is repackaged and disseminated. Farm input suppliers are other stakeholders who facilitate distribution of agricultural inputs such as fertilizer and pesticides.

Arana C: Farming community

The farming community is a subdivision of the Woreda administration for implementing a development agenda and land management. It is the smallest unit of local government in Ethiopia, which is usually named kebele, or farmer association. Stakeholders in this Arena include actors who have direct and close contact with the rural farming community. For instance, farmers are the primary stakeholders of the agriculture domain engaging in the actual farm activities. At the moment, farmers obtain information from word of mouth, from other farmers, neighbors, local schools, price boards at markets, NGOs, and religious or community leaders. They need a way to put their problems and farm advisory requests and questions quickly. Development agents (DAs) are local representatives of the extension offices who support farmers with knowledge on crops, soil treatment, farming practices, and pest and disease handling. Traders and brokers are other stakeholders who want to get enough information to purchase the desired quality of product. All in all, the diverse stakeholder groups defined in each arena contribute to agricultural innovation processes with defined roles and

responsibilities. More importantly, each of these groups seeks information from various sources and somehow changes social practices.

2.3 Government "ICT for development" policy

The Ethiopian government has approved the national ICT and development policy as a framework (FDRE, 2016a). The ICT policy covers fundamental components of development goals to pave the way for a transition to a knowledge-based economy. Specifically, the vision is articulated as "*transform Ethiopia from a country associated with poverty to a middle-income economy and society with participatory democracy and good governance based on the mutual aspirations of its peoples.*" The policy considers ICT as a tool for socio-economic development.

The policy outlines several objectives. One of the core objectives is to deploy ICT infrastructure throughout the country and make it universally accessible. At the same time, the policy is aimed to facilitate public administration and service delivery, including the introduction of electronic government (FDRE, 2016a). Specifically, the objectives of the policy include:

- ✓ Develop infrastructure—telecommunications and physical infrastructure backbone.
- ✓ Promote ICT use and education development sectors such as agriculture and healthcare system.
- ✓ Facilitate public administration and service delivery by introducing electronic government.
- ✓ Establish legal and regulatory framework for smooth development of ICT sector.
- ✓ Promote research in ICT and development

To implement the policy, the government has crafted various plans and strategies. The growth and transformation plans (GTPs) are one of the elements of the legal background supporting national ICT objective across several sectors. The GTP-II covering for the time frame (2015-2020) is one of the national guiding instruments for implementing the policy. In the GTP-II, the role of ICT is recognized as a vital economic infrastructure element to enhance socioeconomic activities in different sectors. It also indicates the need for coordination with agencies and ministries as well as regional government organizations. The plan also articulated the need for continuous benchmarking and collaboration with international development partners and private sector to achieve the country's development programs. To this end, the Ministry of Agriculture developed an ICT strategic plan to achieve the policy goals.

Given the importance of agriculture to the Ethiopian economy and rural livelihoods, one

of the goals of GTP-II is focused on the modernization of the agriculture sector and the enhancement of rural livelihoods through the application of ICT. The agriculture and rural development that are pro-growth and pro-poor strategies are targeted during the GTP-II period. To this end, expansion of agricultural extension services through teaching and advising is believed to make a significant contribution to improving crop and livestock productivity. Provision of appropriate infrastructural services and establishment of technological transformation to improve productivity and production are central to the GTP-II. In general, the GTP-II position "ICT for agriculture" describes two strategic issues to address. The first is to ensure that all populated rural areas are provided with adequate ICT connectivity; second, to improve agricultural productivity through the application of ICT(FDRE, 2016b).

2.4 ICT infrastructure accessibility and use

The Ministry of Communication and Information Technology (MCIT) is responsible for the goals of the GTP-II that focus on ICT infrastructure. The broad objectives of the MCIT focus on development of physical infrastructure, promotion of universal access, and harnessing ICT for electronic government, among others. The ICT infrastructure is the foundational backbone for increasing penetration of and access to affordable ICT services. In 1999, the Global System for Mobile Communications (GSM) was launched for the first time in the country.

Table 1 presents indicators of the recent status of the ICT infrastructure and its implication for designing technological alternatives. In the last few years, an improvement in cellular infrastructure has been made. For example, in 2005 there were only 0.56 million mobile subscribers, and this number reached 6.5 million in 2010. The number of mobile subscribers in 2017 has risen by 7.6 times (49.6 million) compared to the year 2010. At the aggregate level, access to mobile-cellular telephone subscriptions per 100 inhabitants is an indicator of the status of subscriptions to the public telephone network using cellular technology. Ethiopia's status is by far lower compared to achievement at the regional level (Africa). The data shows that this figure is 50.51 in Ethiopia, 74.6 for Africa as a whole, and 118 for Europe. The Ethiopian Telecommunication Corporation (ETC) has also deployed 3G technologies since January 2009. As of July 2017, 85% of the Ethiopian geographic area is covered by 2G mobile service, and about 51% is covered by 3G (GSMA, 2017). This puts Ethiopia in a relatively a better status compared to the average coverage at the African level (59.3%). On the other hand, the smartphone ownership rate is less than two-in-ten in the three east African countries, where Ethiopia's status is 4%. According to the Group Special Mobile

Association forecast (GSMA, 2017), ownership of smartphone devices and affordable access to mobile broadband will become more widely available in the developing world in the future. The forecast also shows that Ethiopia will be one of the most populated markets in the sub-Sahara Africa region for new subscribers expected in 2020.

Table 1: Key indicators of ICT infrastructure

Key Indicators	**Country/region**		
	Ethiopia	**Africa**	**Europe**
Mobile-cellular subscriptions per 100 inhabitants	50.51	74.60	118.00
2G geographic coverage	85	59.3	99
Mobile-broadband subscriptions per 100 inhabitants	5.28	22.90	80.10
Percentage of households with Internet access	15.37	16.30	80.50

Source, ITU report (ITU, 2017)

In Ethiopia, Internet service was introduced in 1997, but it is still found at a very low use or subscription rate. In ten years' time, 2005-2015, Internet service subscribers increased from 20,000 to 10 million. In 2017, this number reached 13.9 million, which is about 13.9% of the total population. A*ctive mobile-broadband subscriptions per 100 inhabitants* refers to access to the open Internet using a handset or modem/dongle and tablets. The data show that Ethiopian status (5.28) is below by more than four times compared to Africa as a whole (22.90). When it is compared to the European level (80.10), it is fifteen times less. Another indicator used to refer to access to Internet is *percentage of household with Internet access* using a fixed or mobile-based subscription. Ethiopia is one of the least connected countries in the world, with percentage of households with Internet access at only 15.37 percent. The Ethiopia case is more than five times lower than the average European status (80.5%).

In addition to the low coverage of Internet access, connection speed is very slow. As Ethiopia is a landlocked country, it has no direct access to submarine cable landing stations. All connections to the international Internet are completely centralized by the Ethiopian Telecommunications Corporation. International Internet bandwidth (KBit/s) per Internet user, or the infrastructure strength to download or upload Internet-based data is very weak. The recent ITU report shows that the status of Ethiopia (2.2KBit/s) is by far low compared to Africa on the whole (51KB/s).

Beyond "universal access", providing ICT infrastructure access to rural people, affordability is also another issue. The Ethiopian charges for telecommunication services are even higher than in Denmark. As can be seen in Table 2, the current price of a monthly Internet package of 10GB costs 19.69 USD in Denmark, but the same data package costs 43.73 (more than double) in Ethiopia. Similarly, a 200GB internet package costs 49.47 in Denmark, but a 100GB Internet package costs about 339 USD (about seven times more) per month in Ethiopia (EthioTelecom, 2017). It is my personal view that due to high Internet package cost at the individual level, people use Internet cafes, which are relatively cheap. My experience was that a typical user at an Internet cafe pays between 0.25 to 0.35 USD for an hour of access. A monthly SMS package is relatively the cheapest. For example, sending a single message costs 0.02 USD, and sending 600 bulk SMS messages costs 1.8 USD per month. "Alliance for affordability Internet: A4AI" study recommends for Internet affordability to be *"1GB of data for no more than 2% of income*". Their study of Ethiopia shows that the price of a 1GB mobile prepaid cost is 19.6% of average monthly income (Alliance for Affordable Internet(A4AI), 2017).

Table 2: Broadband Internet Package

Ethiopia		**Denmark**	
Data size Gigabyte	**Service charge in USD**	**Data size Gigabyte**	**Service charge in USD**
10GB	43.73	10GB	19.69
30 GB	109.32	40GB	32.92
100 GB	338.89	200 GB	49.47

Source: http://www.ethiotelecom.et and https://yousee.dk

Governments have also recognized ICT as a major tool to meet the United Nations' Millennium Development Goals (MDGs). The government has been conducting multi-sectoral ICT initiatives and projects. For example, Very Small Aperture Terminal (VSAT) technology is used for the delivery of services to various government networks. The broadband rolls out Internet-based services through the use of broadband terrestrial and VSAT infrastructure. The network connects districts and secondary schools all over the country. The two government-based ICT initiatives that use VSAT infrastructure are ***Woreda-Net*** and ***School-Net***.

Woreda-Net is one of the public network infrastructure elements established purely to make the government operations transparent, to make the government accountable, to increase citizen participation in government, etc. More than 630 Woredas are connected. The objective

is to provide ICT services such as video conferencing, file directory service, messaging, and VoIP and Internet at the federal, regional, and local level of government throughout the country (Belachew, 2010). The videoconference service is one of the major services widely used in meetings and training using point-to-point or multi-point connections.

School-Net provides schools with educational programs, which integrate ICT into Ethiopia's educational system. It supports the teaching and learning process by offering similar content in all schools. In this network, more than 756 schools are connected. Video-based education service, a digital library and Internet are provided in the schools that are connected to this network (Belachew, 2010).

At the general level, the ICT Development Index (IDI) data show that Ethiopia remains one of the least connected countries in the world. The IDI is a composite index that combines 11 indicators into one benchmark measure (ITU, 2017). The IDI evaluation, which is computed out of ten, Ethiopian's status falls to 1.65. When we compare the evaluation at the continent (regional) level such as Africa or Europe, Africa stands at 2.64 and Europe 7.5. This in turn places Ethiopia at the bottom level, at 170th out of 176 countries. Similarly, within the African region, Ethiopia is 32nd of 38 countries.

As a final remark, although there has been progress in ICT infrastructure and mobile communication service, the telecommunications industry is still under the monopoly of the government. The government is the only provider of telecommunications services, including fixed and mobile telephones. Limited or inadequate infrastructure is one of the major challenges—low connectivity, limited bandwidth, low Internet use. The digital divide in Ethiopia is wide, and it becomes much wider if we look at rural and urban areas independently.

2.5 Preliminary survey

To get preliminary information about a rural context, one Woreda, "Hitosa Woreda," from the eastern Oromiya region was selected. The administrative center is located in a local town named Iteya.

Figure 3. According to the Central Statistical Authority's census report (CSA, 2007), the two largest ethnic groups reported were the Oromo (84%) and the Amhara (14%). Similarly, the majority of the inhabitants (81%) were Afan-Oromo language speakers, followed by 17.76% speaking Amharic languages. The pre-study survey was performed in the rural farming community that later cooperated in the participatory design; see the methodology chapter for more details. The pre-study investigates the possession level of various ICTs, identifies and

prioritizes farmers' information needs, and seeks an understanding of the difficulties in collecting, transmitting, and storing local content. A total of 110 farmers were interviewed through a structured questionnaire. In parallel with this, a total of 12 and 15 agricultural development agents and agricultural extension officers, respectively, were interviewed.

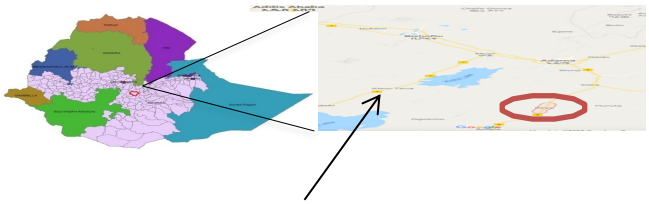

Figure 3: Study site, rural farmer association (Kebele)

2.5.1 Basic indicators obtained from the results

Demographic characteristics – The respondents' educational level is very low. 46% of the respondents didn't receive any formal education, and of the remaining 54 % who received any formal education, 31% only completed grade 1- 6. Even though the percentage depicted for educational level and lack of electricity in their homes is high, these problems didn't stop them from using mobile phones as a means of communication. Some of the respondents said that there is no electricity in their home, but they have an opportunity to recharge their mobile battery every week when they go to the nearby town to do the marketing. To narrow the knowledge gaps and increase agriculture production technology, currently extension education is being given by development agents (DAs). One of the ways that DAs were doing this was by training a group of model farmers in the hope that such farmers would come in contact with other farmers.

Infrastructure including electricity transportation **-** This part assesses the status of availability and access to electricity, transportation, and telecom connectivity. The unreliability of electric power may be frustrating for further ICT development in these areas, since 62% of respondents lived without electricity. Transportation and logistics costs present other significant constraints for smallholders. From the analyses of this study, about 86% of respondents used animals like donkeys to deliver farm products to the marketplace. In one particular case, the products came from the longest distance to the market within four hours' walk.

ICT use among farmers- Concerning ICT infrastructure, farmers used various channels to communicate and disseminate agricultural information and knowledge. The results indicated that 87% were owners of a mobile phone, and 68% of the respondents own both a radio and a

mobile phone. However, for the users of mobile phones, about 50% of the respondents said that mobile phones and their associated cost are too high, and 27 % of the respondents reported that they have serious technical problems in using full mobile phone services. However, only 13 % of the interviewees had no access to an ICT device (TV, radio, mobile phone, computer). It is at least theoretically possible to reach the poorest farmers by these media, provided that the information is useful and usable. This indicates that the widespread use of mobile phones and establishing an ICT-based information system has promising potentials for facilitating smallholders' decision-making and knowledge sharing.

Despite cell phones having access to many value-added services, in rural Ethiopia it is used mainly for phone calls. Some people are facing difficulty in using numbers and ask someone else to dial up, then use the phone themselves to talk. At the study time, only 48 % of those who have a mobile phone have sent and received SMS in the last six months. Only 8% of the respondents reported that they sent and received on average 1-5 messages per week. SMS is yet unfamiliar to most Ethiopian farmers. Age is significantly correlated with the use of SMS; younger people use it more frequently.

Most of the respondents (above 35%) expend 25-50 Ethiopian Birr per month for sharing agriculture-related information or social issues via calling. This is a bit high compared to the perception that say farmers are too poor to recharge mobile phone airtime, let alone buy a phone. Such expenses indicate that farmers are in a position to pay for information services as long as the information is helpful to them. Hence, information services need to be designed for farmers through accessible and usable media.

Information needs-This part investigates extension and advisory, market, information services, etc. to ensure they are available and accessible for use by farmers. The major crops that respondents are growing include wheat, barley, and beans. The respondents reported that the agriculture market, farm input (like seed and fertilizer), and best practice information are their first, second, and third choices of relevant information. The marketing channel in the area heavily relies on traders as intermediaries. The results showed that 13 % and 70% of respondents sold their harvest at local villages and nearby marketplaces, respectively. Respondents mentioned that in most cases they want to access market information, farming practices, and techniques.

Farmers' perceptions of information services- The understanding of the advantages of modern information technology, such as mobile phones, computers, and networks is growing among information service workers at the grassroots level and even farmers. It is a common

view of all farmers that government-provided information service in rural areas is important. Nowadays, farmers know information services' major requirements. Almost all of the respondents in the study area said, "We can pay for information service as long as that information is mandatory or supportive for our productivity and prosperity." They now start to look for information instead of passively receiving it.

2.5.2 Barriers to ICT use for agriculture in the study site

As with any other developing country, Ethiopia's economy is mainly supported by the agrarian sector. Hence, a green revolution is needed not only to produce more food in the region, but also to enable participation of small and poor farmers in markets, generate more rural livelihoods, and improve quality of life and the environment. The role of ICT uses for knowledge-sharing and rapid development becomes imperative considering the linkages between information availability and access and practical use where it matters most. Thus, we need to address the key challenges facing agricultural research, technology generation, knowledge dissemination, and delivery systems so that millions of unreached resource-poor smallholder farmers can benefit from environmentally sustainable productivity and improvement in systems that can increase farmers' incomes. The following primary constraints were noted:

Farmers' Educational Level - People engaged in agricultural production are those who are aged with a low-level education. Farmers have poor awareness of what is available and how to access information and technological services. The education level of respondents is low, as many respondents (39%) didn't receive any formal education. About 33% of the respondents attended primary school. Among all respondents who attended formal education, only 50% read and write an Amharic language or Afan-Oromo language, but not both. However, all of them participated in farmers' associations training, and they were active during the interview. This indicates that in addition to illiteracy, language multiplicity is another concern. 44% of the respondents are within the age range of 25-34 years. This age group is assumed to be younger and can easily learn and adopt a new technology. In addition to this, adopting information technology could be facilitated through younger people, as they are directly or indirectly attached to the remaining aged people.

Low efficiency of information services- the responses from the rural community show that it was relatively easier for them to get information compared with their experience in the past. However, when the farmers are not organized with a collective understanding of the market, their production is not focused on something that might be a competitive advantage.

With so many smallholders all doing their own thing, information service workers could be overwhelmed in handling a large number of simple and repeated questions. Thus, the investment in agricultural information service would be quite high, and the impact of information use would be minimal.

Lack of human resources for introducing information services- There is a shortage of development agents in agricultural information services. For example, the ratio of development agents to the total number of registered farmers in the study site is about 1:700. As a result, one development agent is assigned to give agricultural advice to 700 farmers, which is a bit difficult since the farmers are living in scattered settlements. There is no ICT technology like the computer onsite to support the DA's work. In the case of the regional agricultural office, only 3- 4 computers are available per Woreda. Information and advisory services are supposed to reach farmers within a specified time interval, but due to lack of budget and logistical support at the regional agricultural offices, mobilizing people from the local agricultural branch office to the rural farmer's village poses another challenge.

Above all, most of the farmers said that due to many reasons, DAs are not usually living within the Kebele, or there is a high turnover. As a result, farmers are not satisfied with the service given by DAs. On the other hand, DAs prefer to live in a place where there is good infrastructure like electricity and ICT facilities. Hence, information service workers in rural areas not only need to be familiar with agricultural technology but also need to master computer applications of the network and be good at collecting, processing, and publishing agricultural information.

***Lack of digital content and information availability*-**Probably the largest burden and cost in information platforms for agriculture is managing current content. There are two main types of content: relatively "static" content that does not change, such as information about agricultural processes and techniques, and content that is dynamic, such as weather and market price information. Much static agricultural content is not readily available in digital form. Trusted and reliable sources for content such as tips and advice for planting and disease management must be obtained and then rendered in the mobile application platform such that searches return the expected results and the content is easily retrieved. Sometimes the content is already available but resides in disparate repositories from which the data must be extracted, consolidated, edited, and reduplicated, and may need to be translated into multiple local languages.

Affordable media for information sharing- Compared with the traditional information dissemination media, the cost of obtaining information from any digital source is far too high. The use of digital information using mobile phones (beyond voice call) and computers to solve problems from a distance is limited to none. Information provided through television, radio, and hard copy is the service category from point to area without accurate targeting and meeting the information needs of rural populations. According to the needs of local communities, the FTC information service needs to collect agricultural information from various sources and disseminate it to producers. Disseminating such information would accelerate the transformation of modern knowledge, speed up the extension of practical agricultural technologies, and to some extent help to resolve the problem of disconnection between agricultural technological extension and the actual needs of farmers. This in turn improves the effectiveness of agricultural extension services.

2.6 Summary

This section provides a background of the research context, the Ethiopian agriculture context in general and community context in particular. Agriculture is the backbone of the Ethiopian economy and is the single largest sector, employing 70% of the country's total workforce. So far the primary method for linking different actors including farmers, development agents, and agricultural researchers working at various levels merely depends on traditional communication channels: word-of-mouth. In fact, the broad objectives of the MCIT focus on development of physical infrastructure, promotion of universal access, and harnessing ICT for electronic government, among others. During the last ten years, access to ICT networks has expanded significantly.

The background assessment shows that several constraints are preventing Ethiopian rural communities from benefiting from ICT. For example, local problems such as a lack of locally relevant applications and services and awareness of sharing of information create a less inclusive information society and need to be addressed. Specifically, to lift up the extension service with an ICT-based information system at a grassroots level, we need to focus on a people-centric design process. To this end, we are motivated to support a bottom-up information and knowledge sharing. Specifically, farmers should be part of the data collection and sharing process through affordable and appropriate ICT. In doing so remote rural farmers can access relevant information and exchange opinions, experiences, and good practices among themselves and with other related actors.

PART II: Review of theoretical underpinning and related work

3. STATE OF THE ART

This chapter reviews the literature and related work to illustrate the landscape in which our study is situated. The review is broadly focused on ICT for development (ICT4D), which refers, here, to a research application of ICT toward social, economic, and political development in developing countries. The overall discussion covers several areas of interest, which are structured into four main sections. Section 3.1 discusses some of the concepts and perspectives of development. Section 3.2 considers broader ICT4D research and existing issues, followed by Section 3.3, which presents a detailed investigation of research on ICT for agricultural (ICT4A). The ICT4A research analysis was conducted on selected journals and conference proceedings. Finally, Section 3.4 examines the Scandinavian participatory approach and possible directions to extend people involvement in design in general ICT4A initiate in particular.

3.1 Conceptualizing development perspectives

Several worldviews, explanations, and arguments have been defined to tackle development issues in the 21st century (World Bank, 2000). Development theories try to clarify the complexity of development problem and how reality is constituted toward action programs. Within the discourse on development, two key concepts are the most prevalent: development and developing countries. At the same time, contradictory development theories have been posited that have ideologically polarized the discussion (Hettne, 1990).

In this section, we discuss some of the development perspectives in three categories focusing on their key concepts: *neoliberalism*, *capability development*, and *international development goals*. Figure 4 presents a timeline that shows when different development perspectives emerged and how they are related to each other. A colored rectangle with an arrow on the right is used to indicate a basic construct (i.e., *concepts*) that underpins a particular development perspective. A rectangle with a broken line shows a particular development perspective, including the following: economic growth (EG), a capability approach (CA), human development (HD), a sustainable livelihood approach (SLA), millennium development goals (MDGs), and sustainable development goals (SDGs). The arrows indicate the relationships between foundational concepts and/or development perspectives over the timeline. The discussion is structured based on a timeline followed by situation-specific matters. ICT is part of the discussion in all perspectives.

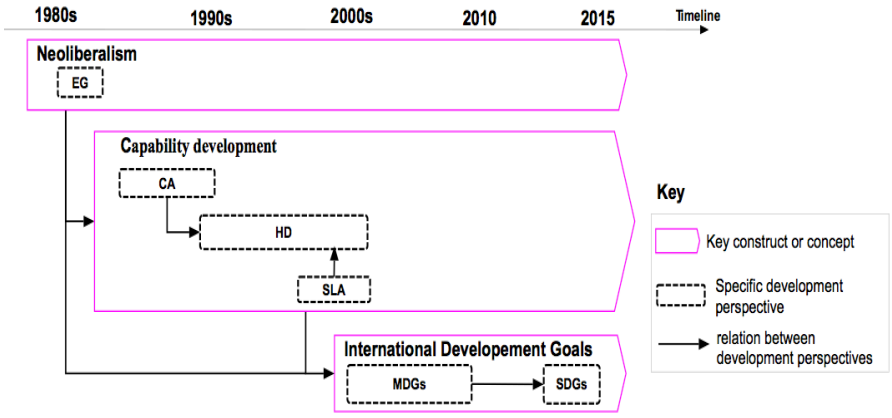

Figure 4: Relationships between development perspectives over a timeline

3.1.1 Neoliberalism: market-led development

Neoliberalism as a concept refers to an economic system in which a free market extends to every part of an individual's personal world (Hettne, 1990, p. 94). The idea of development is rooted in the assumption that there are certain institutional constraints influencing market efficiency. Neoliberalism advocates that development can be achieved through motivated entrepreneurs and self-regulated markets. Scholars such as Pieterse (2009) have stated that allowing market forces to operate through structural reforms and privatization is required to strengthen market transparency. It is assumed that market capitalism can offer individuals more opportunities for entrepreneurship. Since the 1980s, neoliberalist ideologies and policies have been characterized by measuring development by EG (Hettne, 1990).

In a practical sense, efforts toward EG focus on establishing efficient markets in societies that have low production capacity, inefficient allocation of existing productive resources, and inadequate trade mechanisms (World Bank, 2000). Specifically, after 1990, the concept of globalization has been used to establish a world economy system through progressive integration of worldwide marketing. This, in turn, requires national governments to reach out to international partners as the best way to manage changes affecting trade, financial flows, and the global environment (World Bank, 2000). This development perspective is based on the concept that changes in one region can rapidly reach and bring significant consequences to distant regions of the globe. Thus, it is assumed that developing countries can reach the level of development of advanced countries by imitating the latter (Hettne, 2009). This perspective assumes that linear Western modernization can be copied in developing counties by eliminating trade barriers and improving investments to transform the countries' socio-economic systems into free markets. Similarly, at the local, community level, development is seen as establishing

a platform for commercializing product and transparent commodity exchange. Here, income is considered to be an important indicator of progress and is usually measured in gross domestic product(Hettne, 2009).

Hettne (2009) argues that from this perspective, Western technology is believed to be culture-neutral and is seen as an instrument for accelerating EG. Culture is not only considered irrelevant to development but is also seen an obstacle. Different cultures are thought to adapt themselves to economic processes as well as to technological development. Furthermore, it is explicitly or implicitly assumed that there is a direct relationship between technology and EG, social development, and enhanced democratic participation (Avgerou, 2008). For example communication technology, which has become faster and cheaper, is considered the most influential driving force behind globalization (Hettne, 2009). ICT is assumed to provide developing countries with the necessary mechanisms to "leapfrog" stages of their development by embracing a new knowledge-based economy (Avgerou, 2003). Physical access to ICT is assumed to allow people to benefit from its use.

3.1.2 Capability development

The theoretical perspective within the capability development category sees development as a multidimensional and multidisciplinary process of enlarging people's choices and freedoms (Hamel, 2010). Proponents of capability development seek a bottom-up development approach for local people to be empowered and build an entrepreneurial spirit. The process of empowerment focuses on helping primary stakeholders to be able and willing to take part in their local problem analysis. Here, development is seen as an empowering process for people to handle challenges and influence the direction of their own lives. The empowerment process focuses on primary stakeholders for joint decision-making about what should be achieved and how. Toward this end, the three capability development perspectives and their relations, CA, HD, and SLA, are discussed.

***The CA*:** In this approach, development is viewed as a process of expansion in freedom of choice in personal, economic, social, and political spheres that supports the lives people value (Sen, 1999). The two major constituents of CA are capabilities and functionings. Capability refers to a set of possibilities for realizing things that people value. Functioning refers to achievements that have been realized or expectations that have been fulfilled using available possibilities. That means the capability of a person is a derived notion that reflects various combinations a person's freedom to choose between different ways of living. Here, the focus of development is to improve people's capabilities to lead lives they value.

An essential analytical tool in the CA is that it provides a distinction between means, ends, and achievement of well-being. Figure 5 presents the relationship between key concepts of the CA. Goods and services are means to achieve a life that people value. The extent to which people can generate capabilities from goods and services influences sets of conversion factors, which include personal, social, and environmental characteristics in a given context (Robeyns, 2005). For example, personal characteristics such as literacy and gender influence the degree of capability with which a person can generate opportunities from goods and services. Social factors are a number of characteristics of social settings, such as social norms, social institutions, and power structures. Environment related issues, such as infrastructure and public goods are also indicated as factor to translate goods into individual functionings. The diamond symbol in the figure below represents a combination of possible opportunities or choices. All in all, a person's freedom to achieve something is defined by his or her capabilities—that is, the potential functionings that he or she is able to enact. Finally, the *actual achievement* of a functioning is a result of a personal choice selected from the available capabilities. Again, the individual decision-making mechanism itself is subjected to personal, social, and environmental conversion factors.

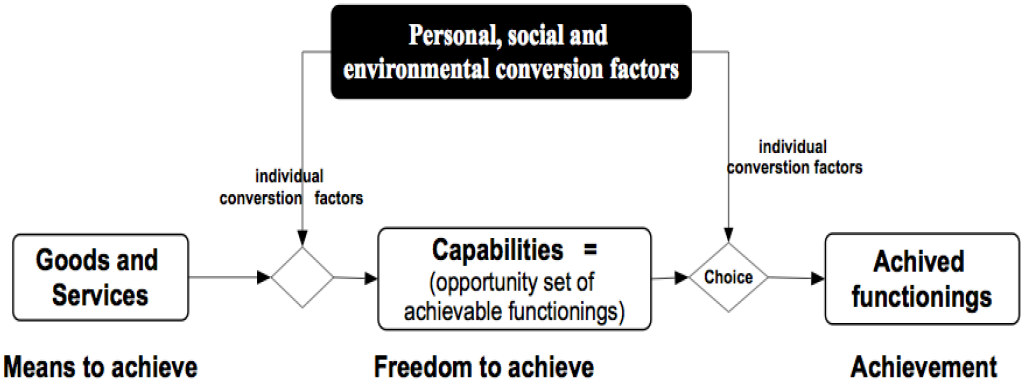

Figure 5: Core concepts of the capability approach, adapted from Robeyns (2005)

When viewing ICT as a means to achieve development, there has been a concern within the development community as to how we can understand the linkages between the CA and the impact that technologies can have on peoples' lives. The CA positions ICT as a means to improve the capabilities of individuals to function in their societies (Oxoby, 2009). However, specific conversion factors need to be addressed to allow people freedom of choice and to help them realize their achievements. Sen (199) argues that the availability of only one resource, such as ICT, does not necessarily imply an improvement in social well-being because of variations in terms of personal, social, and environmental factors that can affect the outcome.

For example, establishing a telecenter service in a rural village does not make a difference if it cannot provide relevant content to the local people (Thapa & Sæbø, 2014).

***HD*:** This framework can be viewed as a translation of the CA into measurable indicators and associated policy. It perceives development as building human capabilities through active participation in the processes that shape their lives (Hamel, 2010; UNDP, 2016). Specifically, the target beneficiaries of HD in the spirit of CA need to include two things: a) they should be able to decide what they value and b) they should have the capabilities to set their own development agendas and develop ways to get there. HD was developed as an alternative measure to the economic assessment of a nation for determining national progress. HD positions ICT as a tool that could have positive impacts on the lives of individuals by addressing not only income but also other HD dimensions, such as education, empowerment, health, and participation (UNDP, 2016).

A human development index (HDI) can be used to define criteria for assessing development (Haq, 1995). An HDI is a summary measure of the average achievement in the three dimensions of HD: standard of living, health, and education. The first dimension, "standard of living," is measured by gross national income (GNI) per capita. The second dimension, "health: long and healthy life," is assessed by life expectancy at birth. The third dimension, "education: being knowledgeable," is measured by two indices: (a) expected years of schooling for children of school entrance age represents the number of years of schooling that a child of this age can expect to receive, and (b) mean years of schooling for adults aged 25 years refers to the average number of years of education received by adults aged 25 years and older. Finally, the scores (indices) from each dimension are aggregated into a composite index (HDI). The values of the HDI range from 0 to 1. Here, an HDI value close to 1 indicates that the development status of that country is in a good position. In contrast, an HDI value close to the minimum (0) is interpreted as a low development status for that country. An obvious disadvantage of the HDI is that it generalizes the Aspects of developement at the national level (country), which lacks to capture differences between geographical regions within a country (e.g., rural and urban areas). In addition to this, the HDI simplifies and captures only part of what HD entails, but it does not reflect inequalities, poverty, level of empowerment, etc.

The SLA: This approach is a way of thinking about objectives, scopes, and priorities based on livelihood resources and strategies for different groups (Ashley & Carney, 1999; DFID, 1999). The SLA framework moves one step further from linear or direct cause-and-effect thinking. Instead, it values collective capabilities, which underscores that ICT is not a

means to an end in itself but is a complex web of mutual causality. SLAs have been used to guide participatory planning processes and prioritize UNDP programs (Ashley & Carney, 1999). First and foremost, the SLA is concerned with gaining an understanding of people's strengths toward positive livelihood outcomes. The Authors states that the approach is founded on a belief that people require a range of assets to achieve positive livelihood outcomes. Thus, the SLA breaks poverty down into basic issues that can be tackled via locally available resources and opportunities (individual or community).

The SLA is organized into a set of checklists and principles (DFID, 1999, p. 7). At the core of this perspective, there are five intangible and tangible types of assets: physical, natural, financial, human, and social assets. These types of assets and their relationships are visually presented as an *asset pentagon*. Improving access to the five core categories of assets is assumed to bring development to local individuals. Here, development focuses on an assessment of people's assets and objectives toward two kinds of change: a) "transforming structures and processes to address the vulnerability context" and b) improving livelihood outcomes (e.g., improved well-being and reduced vulnerability) and one or all five of the livelihood assets (Ashley & Carney, 1999,p.47).

In the SLA, ICT is assumed to support the capabilities of local people to realize economic, social, political, and cultural opportunities. ICT is perceived as a commodity that can help people perceive their own capabilities. Information, knowledge, and communication are important in each person's ability to formulate strategies appropriate for a sustainable livelihood (Heeks & Molla, 2008). Thus, ICT is assumed to facilitate different modes of communication, acquisition of information, and sharing of knowledge. The SLA provides logical thinking about complex issues through a people-centered analysis. This is achieved by examining how people's activities enhance their livelihoods through the use of assets and through the empowerment obtained via information and ICT. Among the strengths of the SLA based design is its broader focus on social structures and processes, in contrast to the isolated design of ICT.

3.1.3 International development goals

Since 2000, development thinking has shifted from a structural adjustment of an economy to wider dimensions of development. Here, the definition of the development concept covers issues beyond a lack of economic access to fundamental human needs, are identified in the HD perspective. The international development perspective includes other issues such as empowering women, caring for the environment (global warming), social and political

arrangements to mention a few. The international development goals start by setting a common strategy of the development needs of the world. Global targets to be achieved by the global community imply that every country (state) has a set of obligations to the world community. Furthermore, states that have achieved those goals have an obligation to help those who have not. In response to the, development perspective is embodied into MDGs and SDGs with measurable targets and defined indicators.

***MDGs*:** These goals were used as a key instrument in shaping international development agendas from the early 2000s up to 2014. HD is a relevant and founding principle in framing the United Nations' (UN's) MDGs. A core objective of the MDGs is to determine how developing countries address structural impediments and deprivation in several domains (UNDP, 2003). The MDGs are divided into eight categories, as shown below. The MDGs are a particular quantitative articulation of core HD dimensions (goals), so they set broader targets than does HD. For instance, the *having a decent standard of life* dimension of HD is related to MDG-1; the *being knowledgeable* dimension of HD translates into MDG-2; and the *long life expectation* dimension of HD is equivalent to MDG-4, -5, and -6. MDG-8 focuses on the formation of a global partnership for development to address difficulty while each developing country accomplishes development goals. For each of the first seven MGDs, target and measurable indicators were defined. But for MDG-8, lists of stepping-stones toward the first seven goals were provided.

- MDG-1: *Eradicate extreme poverty and hunger*
- MDG-2: *Achieve universal primary education*
- MDG-3: *Promote gender equality and empower women*
- MDG-4: *Reduce child mortality*
- MDG-5: *Improve maternal health*
- MDG-6: *Combat HIV/AIDS, malaria, and other diseases*
- MDG-7: *Ensure environmental sustainability*
- MDG-8: *Develop a global partnership for development*

***SDGs*:** These goals began to supplant MDGs at the end of 2015 (World Bank, 2016). The UN General Assembly formally adopted an agenda that will guide global action until 2030. It consists of 17 development goals and 169 associated targets. For each of the 17 goals, global practices, and crosscutting problem areas, indicators are placed to analyze essential trends and challenges.

The MDGs refer to ICT (the infrastructure aspect) in Goal 8, Target 18, which states the

following: “In co-operation with the private sector make available the benefits of new technologies, specifically information and communications” (UN, 2001). ICT-related indicators for Target 18 focus on telephone lines per 1,000 people and personal computers [PCs] per 1,000 people. Specifically, in 2003, the UN ICT Task Force (UNICT, 2003) established a framework for mapping each MDG to the relevance of ICT. For example, deploying appropriate ICT based on people’s needs was considered a powerful economic, social, and political tool to address MDG-1, “eradication of extreme poverty and hunger.” For example, ICT intervention is assumed to be an opportunity for farmers to reduce transaction costs and improve competitiveness across borders(UNICT, 2003,p.8)

ICT is also considered to be a key element in achieving the 17 SDGs. It focuses on “ [increasing] access to ICT and [striving] to provide universal and affordable access to the Internet in least developed countries by 2020” (World Bank, 2016). Specifically, Goal-9 and its targets emphasize the role of technological progress and bridging the digital divide to find lasting solutions to both economic and environmental challenges.

3.1.4 Positing development perspectives in this study

Here, the development perspectives and their relationships are summarized in relation to their position in this study. As shown in Figure 4, neoliberalism sees development only from one dimension: Economic growth. The CA not only extends to the neoliberalism debate but also considers multidimensional assessments. The HD adopts (well-being) concepts from the CA to form three dimensions of development: health, education, and standards of living. The SLA categorizes development issues into five intangible and tangible types of assets: physical, natural, financial, human, and social. Again, the SLA is used to inform the HD for participatory planning processes and to prioritize the action of programs. The MDGs and SDGs are based on key concepts from the aforementioned development perspectives. In relation to functionings and capability concepts from the CA, most SDGs indicators represent their goals and are directly focused on functionings. Here, we argue that expanding basic functionings demands expansion of people’s capabilities. People must participate as agents to value the functionings that SDGs aim to deliver.

With respect to ICT, there is an overall belief and claim from the aforementioned development perspectives that marginalized people will eventually gain from adopting ICT. Both governments and donor agencies have aggressively pushed ICT to the forefront of their development agendas. For example, the International Telecommunication Union (ITU), the UN Development Program (UNDP), and the World Bank all stress ICT intervention as a means

of assisting developing countries (WSIS, 2014). Similarly, the UN ICT Task Force was established to provide policy advice to governments and international organizations as to what ICT can realistically do (UNICT, 2003). The discourse of international development agencies on the role of ICT values has influenced the legitimacy of professional interventions in terms of specific objectives (Avgerou, 2004). To articulate actual development outcomes and how these outcomes can be evidenced, the ICT4D research domain came to be, together with several other research communities.

The two-development perspective, MDGs, and CA, used to position this study. Development requires change, which raises the following questions: Why is there a need for change? What aspects of things should be changed? And who are the target beneficiaries? I took one of the key issues within the MDGs or SDGs: *eradicate extreme poverty and hunger*. Here, poverty is not only considered an economic and social deprivation but also a lack of access to information (UNDP-Ethiopia, 2012). ICT is seen as a tool to establish access to information, as a means to promote local knowledge sharing and empowerment (see Chapter 2). I focus on the informational power of ICT, where benefit comes when social ownership of ICT and outputs are locally appropriate. I underscore development from a "capability approach" as the basis for this study. One important reason here is that it emphasizes capability of ICT to improve the daily livelihoods of communities than the other approaches, which emphasize the significance of technology itself for development. Thus, my intended aim is to investigate conversion factors (environmental, social, and personal) within a context together with target beneficiaries. Investigating local opportunities and capabilities with achievable functionings need to be investigated together with local people. The interpretation of development depends on contexts such as application domain and target beneficiaries, which are subject to debate in the academic community. The details are further developed, in Section 3.3.3 and 3.4.

3.2 ICT4D research and contemporary issues

In ICT and development literature, several terminologies and acronyms (e.g., ICTD, ICT4D, technical ICT4D, CHI4D, and ICT for developing countries) are used. The studies also cover a wide range of topics and contexts. For instance, Walsham (2017) states that ICT4D is a relatively new label in the academic field, which is concerned with the use of ICT for international development in general and extending the benefits of ICT to underserved societies in particular. Again, understanding and establishing a relevant ICT4D research discipline has been highlighted to indicate the implications of intended research outputs.

The ICT4D domain is an interdisciplinary field that encompasses computer science (CS), telecoms and networks, information systems (ISs), media studies, development studies (DS), sociology, and political science, among others (Gitau et al., 2010; Heeks, 2006; Walsham, 2013). Scholar such as Heeks (2008) has defined the ICT4D knowledge areas based on three core disciplines: ISs, DS, and CS. ISs offer models for understanding human, political, and contextual issues. DS provides guidance to understand and match digital technologies with development paradigms and processes. CS knowledge areas offer technical ICT4D research that places a strong emphasis on designing ICT interventions to support development agendas. Scholars such as Ho et al. (2009) have proposed human computer interaction for development (HCI4D) research to improve the lives and freedoms of individuals.

Using a literature survey, Walsham and Sahay (2006) categorized ICTD literature into three primary areas. **(a)** *Understanding the link between ICT and development*: The primary objective of research in this category revolved around understanding the causal relationship between ICT and development. This area of research attempts to prescribe how to maximize developmental benefits derived by ICT use and adoption. (**b**) *Understanding the cross-cultural implications of ICT*: Research in this category focuses on tailoring western-inscribed technologies to fit the cultural, political, and social aspects of developing countries. These investigations also look at the national, organizational, and individual implications of ICT. **(c)** *How ICT leads to development for marginalized groups,* which is focusing on investigating capability of technology to support marginalized populations. The authors also identify a need for an increase in the number of action research (AR)-based studies.

More recently, Gomez et al. (2012) conducted comprehensive literature surveys to identify trends in ICT4D literature. The authors analyzed the contents of journals and conference papers from 2000 to 2010. A total of 948 papers were classified into 7 research areas:

1. *Best Practices*: lessons learned or success factors
2. *Field Experience*: description, evaluation or analysis of an experience (project)
3. *Policy Recommendations*
4. *Theory*: formulation of a theory or a conceptual framework
5. *Design*: description, creation, evaluation, or testing of software or hardware
6. *Testing Theory*: validation of existing typologies, theories, or frameworks
7. *Method*: novel methods or approaches to collect or analyze data

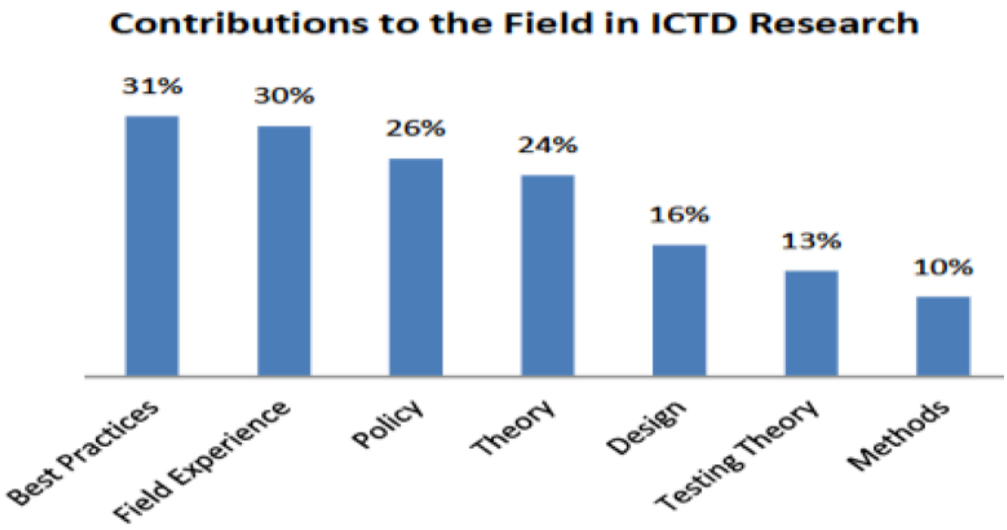

Figure 6: Research contributions to the field of ICT4D (Gomez et al., 2012)

As shown in Figure 6 the three most often reported research contributions focused on *Best Practices*, *Field Experience*, and *Policy Recommendations*. With respect to theory-related research contributions, about 24% focused on the formation of a theory, while the remaining 13% focused on testing an existing theory. In a separate study, Andersson and Hatakka (2013) argued that a large percentage of ICTD discourse was limited to theory that was related to the technology acceptance model (TAM), which lacks an understanding of the relationship between ICT and development. Research contributions toward technical ICT design showed very low percentages. For instance, 16% of the research contributions focused on design and evaluation software, while only 10% focused on innovative methods to collect or analyze data. Given the complexity of the ICTD research context, the authors proposed that research contributions using a bottom-up design approach are required. In addition, the analysis from Gomez et al.'s (2012) study also showed that most research focused country as a *unit of analysis*. For example, 40% of the research used a country as a unit of analysis, followed by 29% that looked at organizations (including universities and businesses).

Technical ICT4D research emphasizes the design of technical interventions to promote development (Sutinen & Tedre, 2010). In doing so, it takes technology into the field, where real conditions differ greatly from those in laboratory experimentations. Technical ICT4D research often focuses on *designing* functional technology that can support intended beneficiaries (ibid.). Here, *technology* signifies software applications and physical infrastructure to access information electronically. Pitula and Dysart-Gale (2010), among others, have classified technical ICT4D research areas into three main categories: **a)** developing infrastructure to provide connectivity and devices appropriate to a given context,

b) building ICT capacity, which includes the skills and competencies necessary to maintain and use the technology, and **c)** designing digital content and services.

Researchers reporting interventions to address socio-economic development also report issues that are open to debate. For instance, Walton and Heeks (2011) pointed to a lack of adequate infrastructure, a lack of beneficiary participation, poor technical feasibility, and the absence of a sustainability strategy as the factors for ICT-based intervention. Technology designed for the industrialized world is often a poor fit for developing countries' communities. Several researchers have articulated that the majority of ICT4D projects continue to be externally driven and technology-focused rather than community-centered (Dodson et al., 2012; Tongia & Subrahmanian, 2006). Heeks (2008) states that appropriating technologies for, approaches to, and views of the underserved people in developing countries are required.

Recently, based on a study of a government-owned ICT initiative in Ghana, Abbott and Kashefi (2016) found that misinterpretation of "soft" constructs, such as politics, culture, emotions, people, and context, was a barrier to using the community information center. In addition, several authors have reported that ICT initiatives are not widely adopted because of a poor requirement-gathering process that does not fully accommodate the intended user, lacks attention to user needs, and primarily focuses on technology (Gichamba, Waiganjo, Orwa, Wario, & Ngari, 2016; Knoche, Rao, & Huang, 2011).

Participatory development approaches play an increasingly important role in overcoming the shortcomings of the top-down development approach and can be a vehicle for encouraging community empowerment (Chambers, 2002; Green, 2010). Some of the commonly known methods are participatory action and learning (PAL) and participatory rural appraisal (PRA). Methods from participatory development support ICT4D design method to enable community participation in developing alternative technologies (Joseph, 2010). Scholars such as Dearden and Rizvi (2008) also argue for the importance of complementing participatory ICT design with participatory development methods.

In this Chapter it is argued that establishing a clear, relevant domain of a context can help us to differentiate problems that exist in one domain from those that exist in another. From this standpoint, let us clarify gaps in the research and issues in agriculture domain, which is labeled as (ICT4A). We examine ICT4A to consolidate our understanding of this concept and to obtain a clear picture of the research practices of different countries. The process of analysis and investigation is discussed in detail in the following section.

3.3 ICT4A research and initiatives

This section presents an analysis of ICT4A studies that focus on different developing countries. The collection and analysis of the studies were performed in two categories. The first category, described in Section 3.3.1, is a compressive overview of research in ICT4A through a systematic mapping study, the main objective of which is to systematically search and analyze studies in selected ICT4D journals and conference. The second category includes articles and reports from other sources to complement the results of the first category. In Subsection 3.3.2, the procedures and analyses of studies from the second category are examined. Finally, in Subsection 3.3.3, a summary of core ICT4A research issues is presented.

3.3.1 Systematic mapping study

The main object of analyzing studies in both categories is to provide an overview of, identify gaps within, and position this research in contemporary ICT4A literature. In response to this, I used four journals and the proceedings of one international conference. The review protocol was formulated based on guidelines of the systematic review/mapping study presented in Kitchenham and Charters (2007). A full analysis of a systematic mapping study is published in an international journal (Zewge & Dittrich, 2017). The procedure and results from the systematic mapping study are presented in detail below.

3.3.1.1 Inclusion and exclusion criteria and review process

ICT4D research covers a wide range of interdisciplinary approaches (see Section 3.2). This makes it difficult to analyze the vast number of digital sources available. Thus, I approached the systematic mapping study by selecting a few journals and conference proceedings. In order to select relevant studies for this investigation, the following inclusion and criteria were applied.

***Outlet (venue)*:** There are more than 79 journals[1] that publish articles related to ICT for socio-economic advancement. Journal impact measurements, such as those created within the Institute for Scientific Information (ISI), reflect the importance (rank) of a particular journal in a given research field. However, ICT4D journals are not yet indexed in the ISI. This creates a problem finding a sound basis when selecting one journal in the field over another. Three journals ranked by Heeks (2010) were chosen, including *Information Technology for Development* (ITD), the *Electronic Journal of Information Systems in Developing Countries* (EJISDC), and *Information Technology and International Development* (ITID). The

[1] https://www.ictworks.org/complete-list-ict4d-journals/#.W40Km5MzZQI

assumption was that relevant projects would be presented in these outlets. Although a quantitative measure of ranking journals is useful and informative, I feel that each individual researcher has his or her subjective views on each journal. As mentioned in Chapter 2, our ICT4A research is based on a rural community as a unit of analysis. Although the *Journal of Community Informatics* (JoCI) was not considered in Heeks's ranking, it was used to supplement my analysis. Here, I aimed to select a journal, which mainly focuses on the public or society as a unit of analysis, which is also the focus of this study (rural community).

The data in Table 3, columns 3 and 4, depict the average citation scores for each journal or conference. For example, in 2008, the average number of Google Scholar citations per paper from the ITD journal was 2.85. As shown in column 4, the overall citation score of this journal was 1.58. This led ITD to be ranked first. ITID and the EJISDC followed ITD at the second and third ranks, respectively. The asterisk (*) next to JoCI indicates a lack of citation score data for comparison. With respect to conference proceedings, an ICTD conference was chosen. According to Heeks's(2010) comparison, the publication of a paper at certain ICT4D conferences was, on average, more impactful than it was in the ranked ICT4D journals (see row 6, columns 3 and 4).

Table 3: Selected journals and international conferences with citation scores

Outlet	**Type**	**Average Google Scholar Citations per Paper**	**Citation Score**
Information Technology for Development (2008)	Journal	2.85	1.58
Information Technologies and International Development (ITID) (2008)	Journal	2.79	1.55
Electronic Journal of Information Systems in Developing Countries (2008)	Journal	1.45	0.81
Journal of Community Informatics	Journal	*	*
ICTD (2007)	Conference	6.27	2.73

Source: (Heeks, 2010)

***Publication year*:** After identification of the above journals and conferences, the publication year was taken as a second inclusion/exclusion criterion. We considered papers published between 2006 and 2014 (although publications exist from before and after this timeframe). As I started my started in 2014, this time frame, 2006-2014, was chosen to include relatively most recent publications.

***Application domain*:** We took the agriculture sector as the domain of ICT project context. After we collected all publications published within 2006–2014, only articles that focused on

ICT with reference to agriculture, rural communities, or farming were studied. Furthermore, only studies focusing on developing countries were considered.

***Discipline (subfield)*:** As ICT4D research spans many disciplines, we only considered research studies related to the three core subfields (Gitau et al., 2010; Heeks, 2008). These included DS, CS (e.g., human commuter interaction for development), and ISs.

Table 4 presents a summary of the collected articles from the four journals and the conference. Except for the ITD journal, all other outlets became active after 2000. The focus and scope of each outlet show a significant connection with the MDGs. A total of 1,013 articles were published within nine years (2006–2014).

Table 4: Overall publications by selected journals and conferences

Acronym	Journal/Conference Name	Started	Number of Publications	Number of Selected Papers
TID	*Journal of Information Technologies and International Development*	2003	213	12
EJISDC	*Electronic Journal of Information Systems in Developing Countries*	2000	290	12
ITD	*Information Technology for Development*	1986	12	7
JoCI	*Journal of Community Informatics*2	2004	202	8
ICTD	Information Communication Technology and Development	2006	182	9
Total			**899**	**48**

The screening and reviewing process comprised five steps (see Figure 7). The activities in Step-I began by defining a data extraction form, which includes fifteen variables such as the article title, author(s), venue, year, main research contribution, research method, theoretical underpinning, and discipline (see Appendix E: Data Extraction). Based on the venue and publication year, a total of 1,013 articles were collected. In Step-II, all the collected papers were organized using open source software: Mendeley. This software program enables researchers to categorize, tag, and create references easily. Articles that did not take agriculture as an application domain were excluded. In other words, only articles that fulfilled the following *text-search operation* were considered. This resulted in 241 papers for further analysis.

(Agriculture AND farmer AND ICT) OR (agriculture AND farmer AND information technology) OR (farmer AND ICT) OR (rural community AND ICT)

[N]A[2]: Journal not ranked by Heeks (2010b)

In Figure 7, the arrows that point from top to bottom indicate an output of the previous step that led to further analysis in the next step. In Step-III, titles and abstracts were used as exclusion criteria. After reading 241 study's abstract and/or introduction and/or conclusion, 75 papers were marked for further analysis. In Step-IV, after reading the full text of each article, only 48 papers fulfilled all the inclusion criteria. All selected articles were exported to Microsoft Excel file format for data extraction and analysis. In order to export papers from Mendeley to Microsoft format, another tool, *JabRef*, was used. Finally, in Step-V, the analysis of qualitative and quantitative results was synthesized.

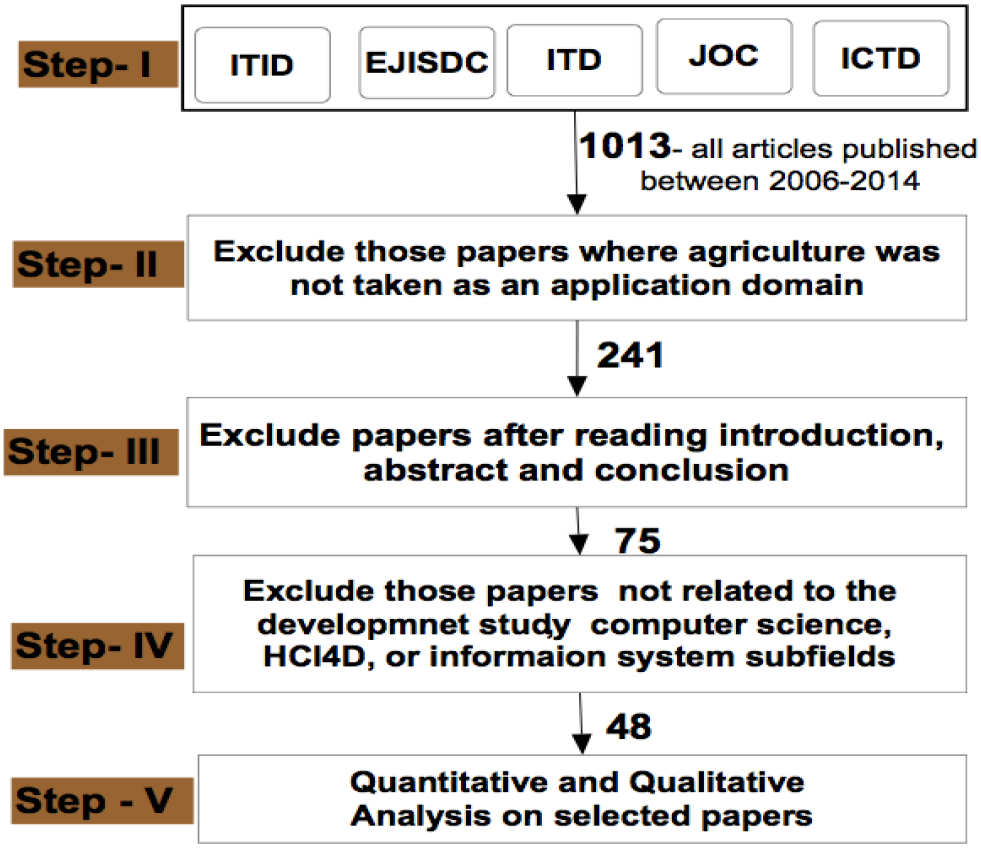

Figure 7: Selection process detailing the inclusion and exclusion criteria

3.3.1.2 Limitations of the systematic mapping study

Although we attempted to include necessary and relevant papers, we admit the existence of a publication bias in our inclusion and exclusion criteria. Four journals (ITID, ITD, JoCI, and EJISDC) and one conference proceeding (ICTD) are not the only outlets for ICTD research. Even though we are aware that several outlets exist (Heeks, 2010), considering all of them would have been beyond the scope of our objective. As shown in Table 4, about 1,013 papers were initially identified, which took a long time to process in order to reach the final analysis.

While analyzing studies from the selected outlets mentioned above, I realized that closely

related studies were available in other outlets. To complement the systematic mapping study, I started collecting articles that dealt with participatory and socio-technical research related to ICT4D or ICT4A through a snowballing technique. Using this technique, I found a few studies that were relevant for this study. Ranking journals does not mean that they contain all the relevant studies, and both journal ranking and paper selection depend on the researcher's views. I also found interesting reports that were published by an international development organization such as the World Bank(Baumüller, 2012; Qiang, Siou, Andrew Dymond, & Esselaar, 2011). However, these reports were not available in the selected outlets. A further limitation was not including agriculture- and/or rural development-related journals in the systemic mapping study. To address this limitation, I selected studies from agriculture- and/or rural development journals that are summarized in Section 3.3.2.

3.3.1.3 Publication trends over the years

This subsection presents a preliminary analysis of publication trends in the five publication outlets. The data show that very few ICT4A publications were produced over the considered time span. From a total of 48 reviewed papers, 50% of the contribution was from EJISDC and ITID (with 25% each). As can be seen in Table 5, none of the outlets show consistent increments in ICT4A studies over time. Even in 2014, the total number of ICT4A publications was low (only two papers) compared to previous years. Although the ICTD conference became active in 2006, it has contributed a number of articles (21%), comparable to both ITID and EJISDC. A list of all the reviewed articles is attached in Appendix A: List of included papers. The JoCI was not ranked by Heeks (2010), but we obtained eight articles from it, which is a high number compared to that of the ITD journal (six articles).

Table 5: Distribution of publications by data source and year (2006–2014)

Journals/conference	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Total**	**%**
ITID	-	1	1	3	1	1	3	2	-	12	**25%**
EJISDC	-	-		1	1	1	3	5	1	12	**25%**
ITD	-	1	1	1	1	-	1	1	-	6	**12%**
JoCI	-	1	-	1	4	-	1		1	8	**17%**
ICTD	3	2	-	-	-	-	4	1	-	10	**21%**
Total	**3**	**5**	**2**	**6**	**7**	**2**	**12**	**9**	**2**	**48**	**100%**

3.3.1.4 ICT4A initiatives by country, information type, and technology

***Distribution of ICT4A initiatives by country*:** I classified the articles based on the geographical location where the research was undertaken. The national distribution of the research was as follows: four countries from Asia (India, Bangladesh, Cambodia, and Sri Lanka), eight from Africa (Tanzania, Ghana, South Africa, Uganda, Lesotho, Nigeria, Mali, and Malawi), and two from South America (Peru and Colombia; see Figure 8). When we looked at the proportions of papers across countries, more than half of the publications (54%) were from India. In Figure 6, only data from publications found in the aforementioned outlets (four journals and one conference proceeding) are shown.

Figure 8: ICT4A studies, **only** from four journals and one conference proceeding

Since agriculture is the main economic backbone for many developing countries, the number of ICT4A research reports in the aforementioned outlets is surprisingly limited. In East Africa, it has been reported that Kenya has a good reputation in ICT penetration across the country (GSMA, 2017); however, not a single paper in our data sources reported on research in Kenya (see Figure 8). This is can also be related to Gomez et al.'s (2012) study, who reviewed 948 ICT4D papers and found that only 6% of the publications were related to ICT4A. ICT4A research might also be conducted in a certain context but not reported as a research paper. These findings led us to investigate other articles (see Section 3.3.2).

***Distribution of ICT4A initiatives by purpose*:** Over the past decade, a number of ICT4A studies have been conducted to support farmers. The information provided includes market prices, technical advice, and suppliers and buyers in local markets. The majority of these services focus on market prices, weather, and transport costs, most likely because this information is easy to collect and disseminate. Projects that provide information on agricultural

practices and inputs are relatively rare, likely because such information is difficult to convey. The use of ICTs for agricultural and extension information services is growing in developing countries to provide agriculture marketing information. However, this is not supported by agricultural advice on improved farming practices and farmer education; agricultural marketing information alone may not necessarily lead to the desired impact or outcome for smallholder farmers.

An example here is the e-Choupl[3] initiative that was designed to tackle the challenges posed by the unique features of Indian agriculture. The e-Choupal supports the community with Internet kiosks managed by farmers to enable the rural community to readily access information on the weather and market prices. These kiosks also serve as hubs for disseminating knowledge on scientific farming and risk management practices(Gollakota, Pick, & Sathyapriya, 2012).

***Distribution of ICT4A initiatives by technology*:** Communication media is an important consideration if users, especially low-literacy users, have the advantage of using ICT services. Mobile phones, personal computer (PCs), telecenters, and the Internet are used in rural communities. In this research, 31% of the studies investigated general ICT (PCs, Internet, and mobile phones), but not all technologies are suitable for all categories of actors in agricultural communities. With the growth of mobile phone coverage over the past decade, 35% of the studies collected focused on this technology. These mobile phone studies went beyond investigating the impact of voice calls to include interactive voice response (IVR) and short message service (SMS). Avaaj Otalo (a voice forum) in India (Patel, Chittamuru, Jain, Dave, & Parikh, 2010) was designed to let local farmers ask questions and/or browse others' responses on agricultural topics. Some of the voice-based (IVR) information delivery services included telephone-based information delivery services using call centers or hotline extension support.

SMS-based extension services essentially use message-based platforms to collect or disseminate information. For instance, the Warana Unwired project in India replaced a PC-based system for managing information in a sugarcane cooperative with an SMS-based mobile phone system (Veeraraghavan, Yasodhar, & Toyama, 2009). The authors state that unlike kiosk

[3] https://www.itcportal.com/businesses/agri-business/e-choupal.aspx

(telecenter)-based agriculture information service, SMS-based data can be used to provide information for the farmers' individual needs.

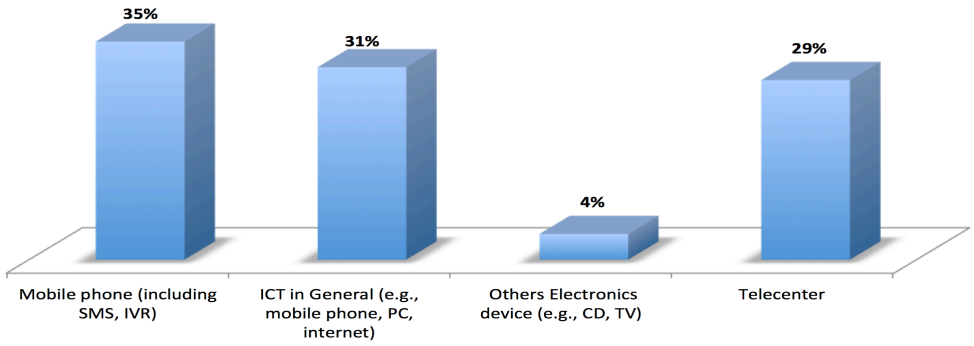

Figure 9: Means of communication technologies studied

As enablers of digital inclusion in resource-poor countries, a shared access model (telecenter) has also been used. A rural telecenter (sometimes called an ICT kiosk) is a physical location that provides a computer through which valuable information is available to agricultural users, including farming techniques, market information, and Internet-based government records for the rural community (Gollakota et al., 2012). At the most basic level, a telecenter is a physical facility that offers the community access to computers and the Internet. About 29% of the studies in our review assess telecenter-related issues (see Figure 9). These studies reported a number of problems that telecenters face related to the dissemination of agricultural information. For instance, lack of assistance, awareness, and skills; language barriers; and inadequate service delivery were reported as reasons for the very low usage rate of telecenters (Amariles, Paz, Russell, & Johnson, 2007; Srinivasan, 2007; Tandi, 2010).

Some research projects also used different kinds of low-cost electronic devices to collect and disseminate agricultural practices. A *digital green* project was designed for the production, dissemination, and adoption of best practices and agricultural information to rural Indian farmers using locally generated digital videos, which were played through a shared TV and DVD player (Gandhi et al. 2009). For people to better learn and adopt agricultural best practices, human-mediated recording and screening of videos were used.

3.3.1.5 Research contributions

The criteria for classifying papers in exclusive categories were rather difficult to determine. As presented in Figure 6, Gomez et al., (2012) defined seven categories of research contributions. Bon, Akkermans, and Gordijn (2016) classified ICT4D literature into roughly three categories (see Table 6). Although there is some similarity between the above two studies,

I faced difficulties classifying papers according to either of the two schemes. However, Bon et al.'s (2016) methods of classification are relatively similar to my categories.

Table 6: Categories of research contribution

Bon et al.'s (2016,p.86) classification	**Redefinition of "classification" in this study**
i) "Desk research studies that consider various policy aspects at a conceptual level"	**i)** "*Aspects of development* "—studies where the main contribution is defining new aspects (concepts) of development
ii) "Ethnographic field studies that analyze effects and impact of ICT on people"	**ii)** "Understanding context"—studies where the main focus is investigating the causes and effects of ICT using qualitative or quantitative surveys (e.g., research outputs that describe or analyze a field experience of an already deployed ICT solution)
iii) "Technical studies that describe local or regional ICT deployments or present technical tools"	**iii)** "*User interface design*"—studies that focus mainly on investigating factors or simplifying user interaction in relation to a technological solution
	iv) "*Design method"*—studies that provide guiding principles or steps for design and evaluation solutions or a description of how to conduct empirical data collection and research that describes best practices of an intervention
	v) "*Conceptual framework"*—research that takes a theoretical stance, offering an organized view of reality and relationships between different concepts through a theoretical model

Here, explicit claims by the author(s) and a discussion of their contributions were extracted. For example, all papers either implicitly or explicitly attempted to address development issues. However, the main difference between them was that some authors considered development studies to be more of a subject, while others considered development studies to be more of an outcome. "Aspects of developement" was defined and discussed as one category of the research contributions. Similarly, if the author(s)' main claims addressed the effects of ICT use through a qualitative or quantitative survey, we classified that research contribution as having an "understanding context". However, we split the third category defined by the technical studies of Bon et al. (2016) into three more categories to obtain a better understanding of technical ICT4A research and processes. Discussions of each of these categories in chronological order are presented below.

3.3.1.5.1 Aspects of development

Most of the JoCI articles (six out of the eight) focused on developmental dimensions. For instance, Rao's (2009) study showed that in order to empower poor people and reduce digital divide, ICT projects should be developed in local languages, prioritizing locals' needs and contents. Similarly, Alam et al. (2010) viewed development to be responsible for "empowering marginalized populations". Johansson (2014) analyzed the influence of a particular ICT initiative in telecenters in Malaysia. This study demonstrated a positive impact on the empowerment of women in terms of economic and social progress, as well as women's decision-making capacity.

Vincent and Cull's (2013) study demonstrated a link between mobile phones and development, exemplified by offering ten mobile phones ("ten seeds") to rural women-led cooperative farmers in Lesotho. The study found that the seeds brought economic growth via improved communication, which in turn aided cooperation in terms of seeking markets, reducing waste, and reducing costs associated with traveling to markets in the capital city. In addition, mobile phones were reported to empower farmers by improving their mathematical literacy (using a calculator) and to facilitate community building in terms of the farmers' social networking capital (ibid). In northern Ghana, Schmidt et al. (2012) examined the effects of a low-cost audio computer ("Talking Book") that enables farmers to create, listen to, and copy recordings. The authors stated that developmental dimensions, including learning, behavioral changes, and crop yields in the villages, were observed.

Walsham (2010) reported that many ICT4A initiatives have taken place in India over the last decade; however, the beneficiaries were not farmers. Walsham further stressed that the large body of literature on the subject does not offer a precise notion of what development means. Additionally, the ways in which ICT can promote development are often left implicit or underemphasized.

3.3.1.5.2 Understanding context

This research is primarily concerned with the descriptions of field experience, assessment and evaluation, and benefits, barriers, and success factors of ICT initiatives. Figure 10 shows that 24 (50%) of the reviewed papers fall into the "understanding context" research category. For instance, Futterman and Shuman (2010) and Iadah et al. (2012) assessed information needs and interests of rural populations in Uganda and Malaysia, respectively. Their studies showed that agriculture-related information was found to be the most necessary information when

compared to health, education, sports, politics, and news information. Dissanayeke (2014) discussed the influence of mobile phone penetration in rural areas to enable farmers to contact input suppliers, buyers, and agriculture extension officers via voice calls. For ICT to be effective, it is important for it to have an adequate infrastructure and affordable tariffs, skills, and information services. All of these should be broadcast at relevant times. Studies have shown that the ICT (radio, mobile phone, television, computer, and Internet) enhances agricultural information services (Wulystan & Andrew, 2013). However, not all ICT used by stakeholders is suitable for providing agricultural information services across all categories of actors.

Muthiah et al. (2013) described their experiences in India in a project that aimed to establish a call center where farmers could post their queries on a mobile phone-based multimedia agriculture advisory service dashboard, then agriculture experts at the center would respond accordingly. However, as the study reports, the usability of the project was minimal due to the unavailability of diversified information. Similarly, Siyao (2012) argued that access to agricultural information in rural settings is difficult because of various obstacles, including poor communication facilities, poor transport systems, poor electricity transmissions, high illiteracy levels, a lack of knowledge on how to access information, and a lack of financial resources. Re-packaging information into an appropriate format, size, and language, as well as regular dissemination, was recommended.

The lack of ICT, or mobile phone ownership for rural people, is a commonly known barrier to the sharing of useful information. Nevertheless, Kameswari et al. (2011) reported that a rural farmer's ownership of ICT (e.g., a mobile phone) and ability to use it does not alter the relationship between the farmer and middlemen, nor does it bring economic benefits to rural India. This is because middlemen are the major creditors for smallholder farmers. Additionally, a middleman is typically a person known to the farmers personally, and is therefore seen as trustworthy. Likewise, Tomitsch et al. (2010) argued that access to mobile phones as a solution for improving economic situations in the context of seaweed farms in Tanzania turned out to be infeasible. Patel et al. (2012) investigated the difference between university scientists and farmer peers to disseminate the same agricultural information (tips) for rural farmers. The results showed that the farmers' follow-ups to agricultural tips were significantly higher when their peers delivered the tips compared to when the tips originated from agricultural scientists. The authors explain this by discussing the stronger social bonds among the community members than the bonds between these members and the external information providers. Thus, ICT should not be considered the sole remedy to all problems in

developing countries; rather, careful investigations and consideration of the local context, as well as political and ethical issues, need to be made.

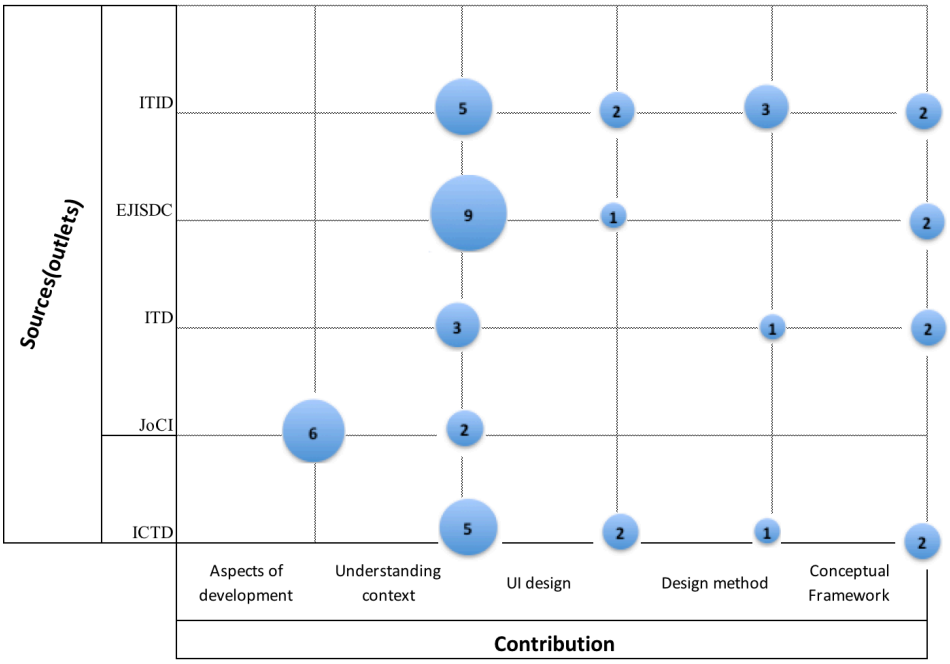

Figure 10: Research contributions by source (based on the author's ***main*** contribution)

In general, the studies grouped in the understanding context category are descriptive research types that generally answered, "What is" questions. They are related to characteristics pertaining to the infrastructure, benefits, barriers, success factors, and causes and effects of ICT access (through mobile phones, telecenters, information). What is missing in the lessons learned such studies are knowledge creation through action and design.

3.3.1.5.3 User interface design

According to a 2016 world demographics profile (IndexMundi, 2016), there were 775 million illiterate adults in the world, most of whom lived in developing countries. This fact proves the necessity of designing an appropriate user interface (UI) in order to make current information technologies useful for these people. To improve IS usability for low-literacy populations (Medhi-Thies et al., 2014) the proposed requirement criteria for UI designs include the ease of learning, the ease of remembrance, the use of graphics (icons) with speech annotations in local languages, and the ease of use. However, as seen in Figure 10, only four of the researched papers (8%) contributed to UI design research.

Emmanuel and Hippolyte (2010) reported on mobile phone app UI design research. The authors designed a culturally sensitive UI for a rural South African community. The authors

considered people's daily practices, such as the use of signs, symbols, and artwork, to adapt the interface according to cultural issues. Addressing a culturally sensitive UI began with the localization of the UI using local language. Based on its usability and the pilot study, the authors reported four users' cultural preferences with respect to the UI. The users preferred an interface that avoided hidden information and images that expressed their collective existence. Second, they favored images that were gender-oriented and colors that were familiar. Third, they preferred a simple menu with an adequate interactive guide for navigating. The authors also recommended limiting the use of graphics due to constraints on the mobile device and the cost of wireless services.

Siyao (2012) offered a unique challenge that affected the sharing of digital farming practices in most rural African communities. Additionally, two studies (Dittoh, Aart, & Boer, 2013; Plauché & Nallasamy, 2008), designed a voice-based interactive system. Schmidt et al. (2012) examined the effects of a low-cost audio computer, the "Talking Book". The Talking Book was designed to enable local experts to bring accessible information to rural people. The Talking Books provided the residents to create and listen to audio recordings and to copy recordings between devices. Based on this pilot evaluation, the authors reported on the usefulness of the Talking Book device and the UI for rural illiterate communities. The authors also stated that the devices intimidated several local people; thus, strong support from their peers and improvements in the UI design could reduce people's fear and improve the device's usability for a wider audience. Plauché and Nallasamy's (2008) study showed how a speech-driven UI overcame illiteracy barriers among village farmers in India.

Medhi and Toyama (2007) suggested that beyond illiteracy, people often face several barriers when using a PC for the first time. The authors reported that there is often a lack of awareness of what a PC can deliver. Furthermore, there is a lack of comprehension about how relevant information can be accessed via a PC. The study aimed to investigate issues related to designing UIs for first-time computer users with little or no formal education. As a strategy, before their use of the computer, a video that provided an explanation of the broader context of the application was presented to each user. This study showed that dramatizing the activity by teaching the users how to use the application through a full-context video improved upon the completion of the task.

3.3.1.5.4 (Design) method

Bratteteig et al. (2012) define "method" as a coherent set of organized principles and general guidelines for systematically carrying out actions. The research contributions in the

current study were classified as methods if the research provided guiding principles or descriptions of activities (steps) to design and evaluate technical solutions. We also considered studies that provided narratives on best practices from successful interventions or described how to conduct empirical data collections. As seen Figure 10, only five of the studies were classified as method contributions.

Doerfinger and Dearden (2013) developed a software development methodology called Distributed Agile Methodology. This methodology covers initial team setups through ICT system design, development, prototyping, and scaling up to other settings. Their approach was refined and implemented in pilot studies in Ghana and Burkina Faso due to its effectiveness in supply chain operations for cashew and shea agriculture product.

Based on the results from two ICT interventions in a South African rural community, Maunder et al. (2007) discussed the limitations of tools and techniques in the user-centered design (UCD) method. The authors pointed out difficulties that arise when interpreting analyses and findings in order to produce requirement specifications. They proposed "UCD for development" (UCD4Dev) methodology. This methodology is underpinned by several tools and techniques, including "Real Access/Real Impact" criteria (Bridges.org, 2005), to investigate contextual issues in the developing world. The authors also recommended the importance of developing motivated groups of users and supportive structures.

Three studies focused on reporting their best practices in ICT interventions (Agarwal et al., 2010; Gandhi et al., 2009; Veeraraghavan et al., 2009). The authors presented lessons learned from design, development, and usage patterns of ICT solutions for rural Indian people. They also demonstrated empirical data collection through field experiments and pilot feedbacks. These studies offered interesting insights into how the local community can be part of the design process in creating and sharing local content and information. Moens et al. (2010) developed a round table (RT) workshop methodology consisting of two parts: the RT workshop itself and its preparation comprised of a total of 15 steps.

3.3.1.5.5 Conceptual framework or approach

The last research contribution category focuses on conceptual framework, which is vied as comprehend ideas of reality (assumptions) and rules that hold them together. This category includes the studies in which the research focused on the formulating or testing of theories. As shown in Figure 10, eight studies (16.5%) were classified as contributing conceptual frameworks. Although each study had a different area of focus, all eight papers developed

several underpinning concepts, and theorized the relationships among these concepts(see Blake & Garzon, 2012; Sambasivan & Smyth, 2010; Parmar, 2009; Reijswoud, 2009; Puri & Sahay, 2007; Tongia & Subrahmanian, 2006).

Two related studies (Blake & Garzon, 2012; Reijswoud, 2009) developed a theoretical framework for appropriating the processes of ICT-based interventions. The core themes of these theories were established according to cultural, environmental, organizational, economic, and political contexts. Reijswoud's (2009) conceptual framework highlighted the need for appropriating ICT at the hardware, software and ICT change management levels. Similarly, Blake and Garzon (2012) proposed a conceptual framework to support the process of implementing ICT in a socio-economic development project. The authors used the "capability approach" to plan, implement, and evaluate the projects along with the guiding principles. This study was an elaborative investigation of Reijswoud's framework.

Parmar (2009) argued that offering rural users relevant and personalized information is a possible solution for the problem of information poverty. The author was motivated by the limitations of giving computers to residents and installing Internet connections in rural areas. Their study suggests a framework for integrating knowledge from multiple disciplines and stakeholders to inform the design and development of a sustainable IS. Considering that ICT4D issues are ill-structured and have "wicked problems", Tongia and Subrahmanian (2006) elaborated upon the dimensions of design by incorporating stakeholders, incentive structures, and a participation design, all of which are critical to successful deployment. Their study proposed a framework for ICT service identification and design.

3.3.1.6 Research methodology used in reviewed papers

Avison and Fitzgerald (2006) defined "research methodology" as a set of recommended means, which includes definitions for procedures, activities, techniques, tools, and guidance, in a research process. One of the difficult aspects for any researcher in selecting a secure methodology is that aspects of different methods often overlap. For example, Foth and Axup (2006) debate for Participatory design and action research: identical twins or synergetic pair? Similarly, several authors have compared AR and design science research (DSR) modes of knowledge production (Alturki, Bandara, & Gable, 2012; Järvinen, 2007; Papas, O'Keefe, & Seltsikas, 2012). These authors argue that as long as AR leads to the designing of an artifact, it is similar to DSR. Selecting a research method also depends on what types of data (quantitative, qualitative, or mixed-method) need to be collected to answer a research question (Jabar et al., 2014).

In light of the above, identifying and categorizing the research methods was sometimes a challenging task. Again, with some papers, we experienced limitations in exclusively determining whether a study adopted only a quantitative survey or whether the researcher(s) also applied a semi-structured qualitative survey. In general, the research methods were classified into six categories: *quantitative survey*, *qualitative survey*, *ethnographic field study*, *participatory AR (PAR)*, *DSR*, and *others*.

The *quantitative survey* method collects generalizable information from a known sample of people or cases. It enables researchers to study phenomena using numerical measures and statistical procedures. The *qualitative survey* research method is used to gain an understanding of underlying reasons, issues, or problems from an individual's viewpoint (Creswell, 2013). Common qualitative data collection techniques include in-depth interviews and focus group discussions. The ethnographic field study method takes place in a real world setting in which the researcher spends a significant amount of time in the field. The phenomena that are being studied are placed in a social and cultural context via their description, which can help to provide rich qualitative data. In Figure 11, the horizontal axis depicts the distribution of the six research methods across the reviewed papers. As the figure shows, a large proportion of the reviewed papers (22, or 45.5%) used the quantitative survey method. An advantage of this method is that the respondents can be asked identical questions; thus meaningful comparisons can be made between them. However, the quantitative survey may rely too much on the subjective views of the respondents, unlike the qualitative survey or the ethnographic field study. Only six and four papers used an ethnographic field study method and a qualitative survey method, respectively.

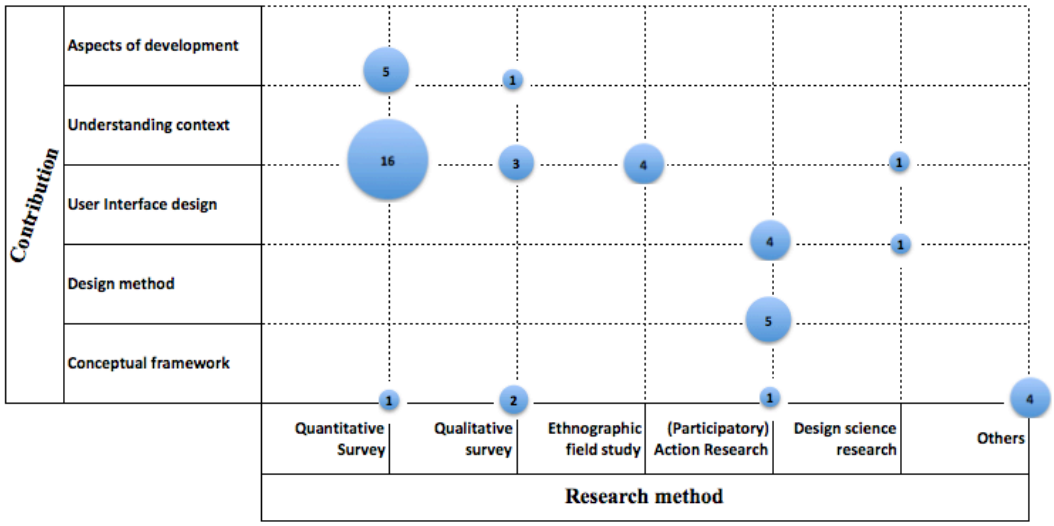

Figure 11: Distribution of research methods by research contributions

PAR - AR is an established research method distinguished by the fact that it works to achieve two goals simultaneously. These goals are aimed to improve the problematic situation of researching a phenomenon of interest (Baskerville, 1999). AR reaches out to local people who are able to understand issues and suggest solutions. A precondition for the AR method is to have an owner (project beneficiaries) who is willing to collaborate in identifying the problem and engaging to solve it. The AR method demands a greater effort than the survey method or ethnographic field study method because the researcher is expected to establish collaborations, introduce interventions, and evaluate the effects of the research outputs.

The characteristics of PAR are similar to those of AR; however, PAR places more emphases on people's participation (Wadsworth, 1998) and empowerment (Stillman, 2013). Empowerment encompasses people's participation in planning and analyzing problematic contexts and then applying the results of relevant research. If the type of intervention requires a technical solution, the PAR process improves the problematic situation through the design and evaluation of a technological artifact (Siew, Yeo, & Zaman, 2013).

We faced difficulties while classifying studies based on the above interpretation of the PAR method. First, we analyzed the methods section of each study. Then, we scanned whole sections of the papers to place them into the most suitable categories. At this point, 10 studies appeared as though they might apply to the PAR method. However, only two studies (See Doerfinger & Dearden, 2013; Maunder et al., 2007) clearly articulated the PAR method. The remaining eight were classified after a review of their overall investigation processes (See Dittoh, Aart, & Boer, 2013; Schmidt et al., 2012; Emmanuel & Hippolyte, 2010; Moens et al., 2010; Agarwal et al., 2010; Veeraraghavan et al., 2009; Gandhi et al., 2009; Plauché & Nallasamy, 2008).

DSR – Scholars, such as Hevner et al. (2007), define the steps of DSR as identifying the problem, defining the objectives for the solution, designing the solution, and developing and evaluating the designed solution. In DSR, some level of abstraction for a desired goal or an outcome of a research process is known, unlike in PAR. DSR often results in some kind of product that is produced and evaluated against the initial goal or criterion. DSR solves a given problem for a generalizable class of stakeholders. Again, the reviewed papers were grouped into this category if the researcher(s) either explicitly defined their research method as DSR or their research process resembled DSR. As shown in Figure 10, only two studies appeared to adopt the DSR method (Medhi & Toyama, 2007). However, neither of these studies explicitly mentioned that they used this method. We understood that the authors first designed their

technical solution and then compared the results between their experimental and control groups. The level of user participation in the design was at the informative level.

The "**Others**" category is the last classification group used in relation to the research method. This category refers to those studies in which the author(s) analyzed the literature but did not collect empirical data. In other words, the research investigation processes in those studies were comprised only of a critical literature analysis along with reflections. As seen in Figure 11, four studies fell into this category. Three of these studies (Blake & Garzon, 2012; Parmar, 2009; Reijswoud, 2009) analytically articulated the PAR method before they proposed new conceptual frameworks. Similarly, Tongia and Subrahmanian (2006) define a list of criteria for ICT-based design processes before they proposed a conceptual framework. The role of PAR will be discussed further in Section 3.4.

3.3.2 ICT4A research beyond the 'systematic mapping study'

This section supplements the SMRS and addresses the limitations discussed in Subsection 3.3.1.2. From the beginning, we understood that there have been studies in other ICT4D venues[4] and discourses. While implementing systematic mapping studies, I scanned the references of the studies that were selected. To scan these references, I used a snowballing technique, though this followed in systematic backward and forward searching techniques. This led me to obtain a number of articles that are related to my research area and interests. The discussion below is organized into three categories. First, I will present ICT4A reports according to international organizations. Second, ICT4A studies in agricultural and rural development journals will be discussed. Third, the studies that were selected through the snowballing technique will be discussed.

3.3.2.1 ICT4A report according to international organizations

ICT4A interventions are often practiced by international development organizations, such as the World Bank and international institutes and corporations of development (Qiang et al., 2011; World Bank, 2011; Blommestein et al., 2006). For instance, Blommestein et al. (2006) reported on lessons from several agriculture information centers (telecenters). These projects operated in rural communities in nine developing countries (including Zambia, Uganda, Bolivia, Jamaica, and Tanzania). In order to sustain and cover the operational costs of the telecenters, service charges for photocopying and printing, Internet access, and phone calls,

[4] https://www.ictworks.org/complete-list-ict4d-journals/

for example, were collected. At the same time, problems related to a large amount of telecommunications and connectivity costs, equipment breakdowns, and low literacy rates were reported. The authors came forward with a set of recommendations that are necessary to know. For example, the connectivity and maintenance of equipment are often overlooked and need to be addressed at the early stage of a project's formulation. The study also pointed out that financial sustainability should support the project beyond the start-up phase.

Similarly, the World Bank published a comprehensive sourcebook on ICT in agriculture that outlines opportunities for ICT to enhance farm-level productivity (World Bank, 2011). As telecommunication networks and the increased availability of handset devices are emerging, the sourcebook states "*Mobile phones are in the vanguard of ICT for agriculture*" (p. 6). The book also highlights several ICT4A research and development cases around the world.

Qiang et al. (2011) discuss another report from the Word Bank that focuses on promoting agricultural and rural development. The authors state the status of existing ICT4A interventions in three stages. *Stage I*, the "proof of concept" (piloting) stage, refers to the fact that ICT4A is deployed to a small group of users, and feedback is collected on this usage. The authors state that the main obstacles at this stage are developing a clear value proposition and organizing key resources to deliver the envisioned service. *Stage II*, which is a "large-scale implementation", refers to a status ICT4A innovation that has gone through a successful pilot activity. At this stage, aspects such as user support and continuous feedback are pointed out targeted for wider use. *Stage III*, the "widespread adoption and sustainability" stage, refers to the status when ICT4A initiates that are sustainable beyond the project's timeframe.

Qiang et al. (2011) report on 92 ICT4A initiatives around the world come to the conclusion that about 33% and 51% of them are at Stages II, and I respectively. Only a few of them (16%) are at Stage III. For instance, in Kenya, mobile application iCow[5] allows producers to buy and sell livestock and livestock product. Baumüller (2012) reported that the TechnoServe [6] coffee initiative in Tanzania used "FrontlineForms", a tool (survey) for collecting data in digital form, to evaluate the influence of training on farmers' behaviors and yield changes. A list of ICT4A initiatives around the world is presented in Appendix F. Again, Qiang et al. (2011) indicated that funding gaps represent one of the factors that hinder movement from the pilot stage to the scalability and sustainability stages. A lack of

[5] http://www.icow.co.ke/

[6] https://www.frontlinesms.com/blog-home/2011/08/31/tanzanian-farmers-report-improved-yields-via-sms

decentralized and privatized agriculture content provisions compared to the often government-owned service provisions are also indicated as a limitation (ibid).

I realize that some of the ICT4A initiatives are not reported in ranked outlets. For example, the "West African Agricultural Market Information System Network (WAMIS-Net)"[7] contains ICT4A interventions that reach Stage III and operate in more than one country. Such initiatives have been operating in West African countries but are not reported in ranked outlets. It is likely that some ICT4A initiatives are not even reported in the academic community. This in turn may indicate that there could be a danger of repeating mistakes and thus, not achieving success. For instance, Doemeland & Trevino (2014) showed that more than 31% of World Bank reports are never downloaded, and about 87% of policy reports are never cited. In fact, I used several exemplary cases during my discussions in the community meeting and design workshop (see Chapter 6, Section 6.3).

3.3.2.2 ICT4A studies in "agriculture and rural development' journals

This section highlights ICT4A studies that were published in agriculture related journals. Our main intention is to supplement our understanding of ICT4A publications in different discourses. I selected four journals[8] whose titles referred either to agriculture extension or rural development. These journals were: the *International Journal of Agricultural Extension*, the *African Journal of Rural Development*, the *Journal of Rural Development*, and the *International Journal of Agricultural Extension and Rural Development*. Unlike the detailed steps that are followed in systematic mapping studies, I selected the articles based on their titles, and followed by reading their abstracts. Finally, 15 articles were selected. After reading these papers, I classified each one into one of the following three categories: quantitative survey, qualitative survey, and action and design research. The discussion below briefly summarizes the research contributions of each category.

Like the results obtained in the systematic mapping study, the quantitative survey method seems to appear more frequently than the other research methods. Research contributions from 13 of the papers were based on quantitative surveys (see Table 7, Column 7). Most of these studies examined agricultural information dissemination media from television, mobile phone, and radio sources. The major findings of these studies focused on identifying the factors of accessibility, and these were followed by statistical evaluations of the relationships between the dependent and independent factors involved.

[7] http://www.resimao.net/network.php?lang=en&lang=en

[8] http://internationalscholarsjournals.org/journals/

Only one paper, by Lemma and Tesfaye (2017), used the qualitative survey method in its description and analysis. This study was conducted in Ethiopia and was based on selected woreda (district) agriculture extension offices. Specifically, the study examined an agricultural knowledge center (AKC) (which is typically referred to as a "telecenter"). An AKC is an ICT infrastructure center that facilitates storage and the sharing of relevant agricultural information and knowledge among agriculture extension office staff. AKCs are equipped with computers, printers, TV sets, DVD players, digital cameras, LCD projectors, Internet connections, project documents, and audiovisual materials, among other things. The authors' findings showed that the AKC service provision was constrained by social and organizational barriers. For instance, limited awareness and a lack of institutionalization strategies created minimal opportunities for the staff to use the AKC. The authors recommended an increased use of the AKC by woreda administrators and the head of the agriculture development organization. As we discussed in Chapter 2, the Farmer Training Center is the lowest ranked government organization in the rural community, next to woreda administrations. I can deduce from Lemma and Tesfaye's (2017) study that there are more issues related to ownership when designing ICT4A solutions than the people in the rural community.

A study out of Uganda followed an action and design research approach (Drake, Obaa, & Ebanyat, 2016). The authors outlined the limitations of weak stakeholder linkages, inappropriate knowledge packaging, and limited interactions between stakeholders in the agricultural sector. In response to this, the study was aimed toward designing a technological solution that could help disseminate university-generated technologies and best practices in rural communities. The research process was comprised of four main stages: collecting requirements for the design, developing technological solutions, establishing knowledge and information centers (KICs), and training the KIC managers, extension workers, and farmers. I found that this study extended the scope of the ICT service, whereas Lemma and Tesfaye's (2017) study was conducted for a rural community in which several "soft constructs" were not addressed. Abbott & Kashefi (2016) also pointed out how the lack of in-depth understanding of soft constructs, such as politics, culture, and people, constrain the use of government-owned and community information centers (the case in Ghana).

Table 7 : List of ICT4A studies in Agriculture and rural development journals

No	Journal	Website	Author(s)	Title	Year	Study type
1	International Journal of Agricultural Extension	http://escijournals.net/IJAE	Hailu, Khan, Pittchar, & Ochatum	Assessing the radio programming and potential role of preferred by farmers radio stations to disseminate agricultural technologies in eastern Uganda	2017	Quantitative Survey
			Hailu, Khan, Pittchar, & Ochatum,	Radio and mobile phone ownership or access by smallholder farmers of eastern Uganda and its potential use for push-pull technology dissemination	2017	
			Jafri,Khan, Muhammad, Munir, Iftikhar,& Ashraf	TV as diversified agricultural information source perceived by farmers: issues and concerns	2014	
			Smollo, Olubandwa, & Ng'endo	Influence of Utilizing Animal Husbandry Information from Mobile Phones on Milk Yield Among Smallholder Dairy Farmers In Njoro Sub- County, Kenya	2016	
			Rashid, Muhammad, & Islam	Information source preference of farmers regarding modern aquaculture technologies in Bogra district of Bangladesh	2015	
			Rashid, Muhammad, & Islam	Does e-agriculture impact on farmers' empowerment in Bangladesh?	2016	
			Olaitan, Jimoh, & David	Appropriateness of information and communication technologies' (ICT) use: a case study of agricultural information dissemination, Nigeria	2017	
2	African Journal of Rural Development	http://www.afjrd.org/jos/index.php/afjrd	Opolot, Obaa, Isubikalu, Ebanyat, & Okello	Quality and dissemination of information for strengthening University-farming community engagement in northern Uganda	2016	
3	Journal of Rural Development	http://nirdprojms.in/	Raina, Chahal, & Kher	Analysing agriculture extension services for media mixes for transfer of technology	2016	
			Sainudeen Sahib	Impact of mobile phone on the density of Honey Bees	2011	
			Michailidis, Nastis, & Loizou, 2010	Mobile Communications Technology in Rural Societies of Developing Countries	2010	
			Singh,Bardhan, & Tripathi	Constraints faced in using modern ICT tools: A study of dairy cooperative societies in uttarakhand	2015	
4	International Journal of Agricultural Extension and Rural Development	http://internationalscholarsjournals.org/journal/ijaerdoa/	Donye, A.O.	Assessment of mass media performance in agricultural information dissemination to rural farmers in Girei Local Government Area of Adamawa State , Nigeria	2018	
			Lemma, Mamusha & Tesfaye, Beamlak	Agricultural knowledge centers : opportunities and challenges for ICT-enabled knowledge management in Ethiopia	2017	Qualitative Surevy
			Mirembe, Obaa, & Ebanyat	Developing and piloting a multi-channel ICT-Enabled Model to enhance University engagement with smallholder farming communities in Uganda	2016	**Action & design science research**

3.3.2.3 Stakeholder or beneficiary collaboration and participation

During the literature study, I started to follow up on research addressing involvement of stakeholders and beneficiaries in the ICT4D and ICT4A literature. I extended the set of articles using informal snowballing throughout the thesis. Stakeholder collaboration and participation can be established at various project stages. For example, during the framing or planning of the problem, people can engage in activities that formulate the project's objectives. During the design of alternative technologies, people could be involved in activities to ideate the prototype or evaluate possible solutions. This in turn calls for an investigation of different ways to encourage collaboration and participation.

For instance, Islam and Grönlund (2007) conducted a stakeholder analysis on an ICT4A project in Bangladesh. The results showed that despite having clear objectives and adequate support at the initial stage, the project failed due to a lack of adaptation to the stakeholders' preferences, needs, and capabilities. Islam & Alawadhi (2008), in Bangladesh, examine the access and ownership of technology, the imbalance in the availability of resources and technological skills, and the lack of awareness regarding the ICT service's potential. Based on these findings, a conceptual framework for an ICT-based intervention in a rural context was proposed. In another study, Islam and his colleague shifted from the context of understanding to an intervention-based study. This study described and compared ICT4D research (using agriculture as the domain) with a DSR approach (Islam & Grönlund, 2012). It demonstrated research and design activities of ICT4A research via a DSR epistemology.

Dearden and Rizvi (2008, p.3) raised the concern that ICT4D project are at risk when many core design concepts are determined before engaging with the community. In another study, Dearden and Rizvi (2009) applied a socio-technical perspective to design a rural ICT4A project. The study adopted the sustainable livelihood approach to development, which gives attention to the structures of local assets operating in a human, social, physical, natural, or financial context. The authors argue that the most important issue in ICT projects is to ensure the collaboration between the stakeholders and set the study's expectations in advance.

Dearden, Matthews, & Rizvi(2011) reported on an ICT4A project experience that supported an agricultural extension piloted with a co-operative of Indian farmers. The overall research process and outcome focused not only on providing technology, relevant content, and adequate financial resources but also on the significance of human, social, and organizational issues. The authors further recommended examining the engagement of NGOs at all levels and

maintaining constant dialogue to ensure that the decisions regarding the design reflect the partners' priorities.

Joseph (2010) interviewed members of organizations in South Africa and India who had either implemented or owned ICT4A initiatives. They emphasized the need for participatory learning and AR, which encourage "farmer-researcher-developmental worker" participation to address the socio-economic development of farming communities. The author stated that the decision-making power in the implementation of ICT4A often lies in the research institutions and companies that develop ICT. This indicates that the general aim of an ICT4A project is defined before the specific community is engaged, and participants have only a marginal influence.

Both in research and in practice, the concepts of collaboration and participation seem to appear often in international development discussions. However, the spirit of user participation is to actively engage local actors and beneficiaries while conducting research. Based on empirical data from India, Knoche, Rao, and Huang (2011) stated that the primary focus on technology leads to a lack of attention paid to user's needs and insufficient user participation. This in turn results in unconvinced target users who are not interested in the new technology. The study's findings suggested that artifacts (such as scenarios or prototypes) could act as boundary objects for different internal and external actors. Likewise, Dearden and Rizvi (2015.p7) argued that genuine user participation demands clarity of motivation, attention to a fine detail of the context, awareness of the complexities of social power dynamics. The authors recommended further research to explore alternative ways in which technologists and project participants can productively interact and communicate.

3.3.3 Summarizing core ICT4A research issues

In Section 3.3.1, we discussed several aspects of ICT4A research to provide a coherent picture of existing studies. As every ICT4A project has its own context, the limitations of the "one size fits all" ideology have been discussed in the research community (Reijswoud, 2009). Beyond this, the existing literature attempts to address ICT4A issues using quantitative surveys but few qualitative survey or action and design-based approaches. As a result, five interrelated research contribution categories have been reported. These categories are: *aspects of development*, *understanding context*, *user interface design*, *design method*, and *conceptual framework*. Although there have been attempts to address issues related to engaging local beneficiaries, I recognizes that grassroots participatory approaches to address the issues related to culture and development are still a subject of discussion. To prepare and position my

research focus, I will summarize my concern in two themes: strategies for the designing and collaboration with local actors and appropriate technological solution.

Approach for collaborating with rural community - The discussion above is oriented toward establishing more coherence in ICT4A research in the hope of benefiting target beneficiaries. Based on my review, the ICT4A issues are multiple and interdependent where addressing one problem may not address the general expectations of ICT4A initiatives. However, Joseph (2010) stated that decision-making power while implementing ICT4A often lies in the research institutions and companies that develop ICT. The main difficulty of what exactly, having decision-making power is that a project that has been defined outside the community it is meant to benefit will often overlook the real needs of the local people (Dearden & Rizvi, 2008). Such a participation type can only provide a discussion of the means (e.g., how technology may be used) to achieve given ends; however, it does not answer the question of which ends should be prioritized. As a result, transferring the ownership to the target community becomes a major issue (Islam & Al-Awadhi, 2008; Tandi, 2010).

What the types of design strategies that should be used has been a subject of debate (Doerfinger & Dearden, 2013;Knoche, Rao, & Huang, 2011; Moens et al., 2010; Parmar, 2009; Reijswoud, 2009; Maunder et al., 2007). As the choice of research method clearly influences the subsequently produced research results, a combination of methodological foundations is required. For example, an extensive ethnographic field study triangulated with a quantitative survey could be a better way for us to understand context. Similarly, ethnographically informed PAR could help us to understand complex social situations while introducing technology and reflecting on changes. On top of these, engaging beneficiaries must move from co-operation of the people in the activities to actively involving them in decision making and influencing the design process. Recently, scholars such as Dearden and Rizvi (2015) argue on the following questions: “Who participates in what, how, and why?” One of the critical issues here is establishment collaboration with local beneficiaries to take up different roles as well as the scope of the project’s outcome in resolving local needs.

In Ethiopian rural community context, the commitment of people’s participation throughout the design process is affected by social and cultural issues and opportunities(Zewge, Dittrich, & Bekele, 2015). I view the ICT4A design strategies as a set of empowering processes and empowered outcomes that require actions and changes through collaboration and participation. Negotiation is a continuous planning process that in it is a goal as well as an objective of development. Thus, I understand that there are many unknowns at a start of a

development program (such as an ICT4A initiative). My response to this is to investigate the role of culture and local participation practices for trusted social groups to emerge. Again, addressing community problem through alternative technology is the second areas of investigation where this study is looking for.

Appropriateness of technologies: There have been several attempts to support and provide agriculture-related information to smallholder farmers around the world (see Sections 3.3.1.4 and 3.3.2.1). The type of medium is an essential consideration if people in rural communities are to take advantage of ICT-based information services. For example, the notion of public access to ICT distributed the telecenter movement throughout the world. Studies have shown that the number of telecenters in use fell due to several factors, including the lack of assistance, awareness, and skills, language barriers, weak ICT infrastructure, and inadequate service delivery (Amariles et al., 2007; Srinivasan, 2007; Tandi, 2010; Blommestein et al., 2006). A web portal with a telecenter as an access point can provide compressive and in-depth information, but establishing Internet connections is still expensive, and the ability of the information to reach rural farmers is minimal compared to mobile phone-based information services (see the Ethiopian case; Chapter 3, Section 2.4.) In several countries, mobile phone (voice, IVR, and SMS)-based information dissemination has also been attempted. However, ICT4A initiatives still have limitations in reaching the grassroots level because not all technologies are suitable, desirable, or feasible for their potential beneficiaries (Pimienta, 2009; Walton & Heeks, 2011; Aker, 2011). In addition, technology that may be theoretically usable may be too expensive for local resources to support (Qiang et al., 2011).

To further supplement my arguments with a local case, I now introduce the recent ICT4A project in Ethiopia, which was sponsored by the Bill and Melinda Gates Foundation (Bernard, Makhija, Orkin, Seyoum, & Spielman, 2016). The "Digital-Green approach, which was designed in and for India" (Gandhi et al., 2009), has been implemented in Ethiopia since 2014. In my view, adopting the "digital green approach", in Ethiopia, has limitations at both the technology and processing levels. First, compared to mobile phones, this approach is not at all interactive for sharing information and events. Second, due to the high costs of the devices (Pico cameras), all the materials, including the digital resources, are managed at the woreda level, which makes their usability and accessibility problematic for most rural communities. This indicates that intervention based ICT4A researcher should not state what might be possible, but what actually exists on the ground. This in turn requires starting with realistically available technology while searching for options. Introducing technological alternatives using an incremental approach, with simple functionality but preparing for featured functionality.

Issues related to peer-to-peer and social communication practices are other aspects to consider. This in turn outlines the importance of conducting empirical field research for appropriating alternative technologies.

Finally, considering all above ICT4A research issues, community-based collaboration and participation is considered a core subject of my research. In fact, Scandinavian participatory approaches have shown exemplary practices and are becoming part of an international research community (Halskov & Brodersen, 2015). Empowering communities to take control of their developmental agendas and understanding local needs can lead to better results. Specifically, due to the issues mentioned in the ICT4A literature and motivated by problem areas in rural Ethiopian communities (see Chapter 2), We have been inspired to extend Scandinavian PD practices to the Ethiopian context. Detailed aspects of participatory approaches and further research issues are discussed in the next Sections

3.4 Community-based participatory approach

As discussed before, ICT4D have lacked meaningful community participation in conceptualizing and designing ICT projects (Heeks, 2008; Mutenda, Mpazanje, & Chigona, 2011). Rural communities are the closest to grassroots' problems, so they are the best judges to evaluate technology alternatives and provide contextual solutions for the problems in their respective areas. Similarly, Reijswoud (2009) argued that the "ICT4D community has to shift away from traditional one-size-fits-all solutions to solutions that fit the context in which the technology is to be used." This is because a top-down approach overemphasizes the role of technology but misunderstands the constraints of local contexts. A paradigm shift from developing technologies for community people to designing technology with local people can facilitate collective ideas generation and provide a better understanding of the cultural context that can easily affect the usefulness of an intervention. The rest of this section focuses on perspectives on community-based PD toward supporting ICT4A initiatives.

Participatory design (PD) concepts were developed in Scandinavian countries in the 1970s based on the foundational principle of democracy for the betterment of workplace settings and opposing top-down blueprint approaches (Kensing & Blomberg, 1998). PD places strong emphasis on active engagement of users in system design and consideration of real-life contexts by employing fieldwork and ethnographic methods. PD gives designers a better way to understand users' practices and to focus on the particular relations between technology and human activities. User participation covers generating design ideas during project definition, requirement definition, and building or testing, rather than simply using informants or

reviewers of prototypes created by others. Simonsen and Hertzum (2012) argued that user participation in PD research and practice has been focusing on early stages rather than interconnecting with the whole life cycle, including real-world deployment.

Halskov and Brodersen (2015) reviewed PDC papers from 2002-2012 and identified five categories of PD contributions based on how participation was defined and practiced: politics, people, context, methods and product; see Table 8.As PD is context-dependent, conducting PD in many situations remains the main issue for PD results. In light of this, the four-interrelated aspects of PD are discussed in the following subsections.

Table 8 : Fundamental aspects of PD research

Politics	People who are affected by a decision should have an opportunity to influence it.
People	People play critical roles in design by being experts in their own lives.
Context	The use situation is the fundamental starting point for the design process.
Product	The goal of participation is to design alternatives, improving quality of life.
Methods	Methods are means for users to gain influence in design processes.

Source: (Halskov & Hansen, 2015)

3.4.1 Democratizing participation in design

Democratic participation invites different actors in society to take part in a decentralized decision-making process that affects their own lives. The early Scandinavian PD researchers state that software development, at that time, was reflecting only the interest of management and teaching technological solutions to trade unions, rather than empowering unions in negotiation. In response to this, workers and their local trade unions were considered not only to critically challenge proposals and projects in terms of their own concerns, but also to be involved in formulating their goals, and control over their working conditions was viewed as an alternative. This led to the concept of "collective resource approach" (Bansler, 1989; Ehn, 1989; Floyd, Mehl, Reisin, Schmidt, & Wolf, 1989). The central idea of the projects under the collective resource approach (CRA) was the involvement of workers in the design and implementation of technological solutions to be used in their work. Thus, democratic participation in decision-making emphasizes the right to maintain a different opinion than those in power, to forward opposing positions, and to build knowledge on an alternative basis to support a different viewpoint (Kraft & Bansler, 1994). Organization was seen as a meeting place for different opinions, and democratic ideals aim at giving all opinions a voice.

Workplace democracy gives the right to all workers to influence their work situation through work arrangements and participation in decision-making (Kraft & Bansler, 1994). In spite of all arguments, concepts, and democratic participation practices, fostering egalitarian participation in marginalized areas is still an ongoing issue.

Bratteteig and Wagner (2014) argued that design process includes a power issue that requires several decisions of different types. This in turn requires the designer to give up some power, and at the same time invites other actors to acquire some power, providing opportunities for the expression of marginalized voices (Björgvinsson, Ehn, & Hillgren, 2010). The authors argue that design and use of computational media becomes a form of political action through which the desires and agendas of a community are explored for action. Scholars like Steen (2011) point out the different distribution and tension of power in the design process: "Certain knowledge of certain people is privileged over other knowledge of other people. With each decision, power is exercised, and some actors have more agency in the decision-making process than others". Furthermore, balancing (sharing) of power between participants' ideas and designer knowledge is treated as an exercise of democratic processes (Chiara, Jefferson, & Franzato, 2014; Steen, 2011).

Merritt and Stolterman (2012) argued that decisions and ideas of designer-researchers and participants carry cultural influence. Designer-researchers should explore the role of cultural positions embedded in the design process as much as the design itself. Community empowerment and knowledge transfer is also considered a means of democratic participation (Dearden & Rizvi, 2008b). Likewise, Cleaver (1999) recommends a transformative approach in which democratic participation is associated with building capacity and empowerment. The author states that community people acquire more power over their lives because they develop problem-solving and decision-making activities that promote their self-consciousness, so building capacity and empowerment can help them to learn how to make collective decisions.

3.4.2 Forms of participation and participation practices

User participation as defined by Cavaye (1995) is a set of behaviors or activities performed by users in the system development process. Participation involves decision-making with target stakeholders; specifically, it deals with the users' role as being legitimate, rather than being an informant and acknowledged participants in the design process (Simonsen & Robertson, 2012). Scholars like Clement and Besselaar (1993) introduced three important attributes and concepts of user participation: forms of user participation, user roles, and purpose of user involvement. They argue that the purpose of user participation in the design process is

not only that their skills and experiences are considered valuable, but also to empower them. He distinguishes between functional empowerment and democratic empowerment. The former means that the users' participation in the design process supports their work practices. Democratic empowerment deals with the mandate of the user to participate in decision-making. Scholars like Damodaran (1996) define three levels of user participation: informative, consultative, and participative. Informative is the lowest level of user participation, used only to provide information; participative users can actively participate and have decision-making power regarding the solution. Although, it is difficult to gauge the nature of the local community involvement employed in a research project solely from reading papers, I understood that much of reviewed studies adapted the informative or the consultative. A "ladder model" is another perspective on user participation, but this model does not allow those at lower levels to control research decisions (Bergold & Stefan, 2012).

A set of socially accepted practices shared by a group of people and the practices of how things are done shapes different views of user participation (Franklin, 2005). In light of this, Björgvinsson, Ehn, and Hillgren (2012) adapted user participation to the traditional and pre-Christian Nordic and Germanic practice of community participation: *Thing*. The basic meaning of Thing is a "meeting place", which in turn refers to the governing assembly of people in the community (Wildte, 1928). At the Thing, disputes are resolved and an elected coordinator, or a Judge moderates political decisions. A Thing can thus be considered as a local participation practice and model of community participation.

Similarly, in Southern African, Ubuntu, which means collective personhood, refers specifically to the relational nature of being: "I am because we are" (Winschiers-Theophilus et al., 2010). Ubuntu has been used as a philosophy of life and means of user participation that describes the interconnectedness of humans in the community (Mabelebele, 2006). Through Ubuntu, Winschiers-Theophilus, Bidwell, and Blake (2012) demonstrate a "community consensus". Both Ubuntu and Things concepts are used as worldviews (philosophies) for adapting user participation into local practices. In general, (Winschiers-Theophilus et al., 2010) argues that user participation should be configured dynamically through interaction with local communities and shaped by local understandings, rather than following pre-defined assumptions.

3.4.3 Participatory design method

Recently, Bratteteig et al. (2012) defined the method concept in PD as "a coherent set of organizing principles and general guidelines for how to carry out a design process from start

to end." During the PD process, new knowledge and ideas are expected in which the designer is committed to working closely with users. To this effect, PD methods are used as a third space between user and designer to facilitate communication, to involve them in developing design ideas, and iteratively design a solution together (Simonsen & Robertson, 2012, p. 131; Muller, 2002). PD researchers in the method area have a double agenda: solving problems within the workplaces, and developing PD methods that can be adopted by other practitioners (Kensing & Blomberg, 1998). For instance, the *MUST* method supports cooperation among three groups: users, managers and internal IT professionals who have different backgrounds, experiences, interests, and roles (Bødker, Kensing, & Simonsen, 2004). For users (participants) to see the connections between their work-oriented descriptions of new systems and to establish shared spaces of interaction, PD designer-researchers use tools like scenarios, mock-ups, future workshops, prototypes, etc. Practically, PD deals with a range of techniques and how these techniques have been brought together in ongoing designing and evaluation processes (Robertson, Mansfield, & Loke, 2006).

Floyd, Reisin, and Schmidt (1989) developed a STEPS (Software Technology for Evolutionary Participatory Systems Development) process model. It considers software development as a learning process for both developers and users. The STEPS process model is based on the insight that technical system design cannot be separated from its quality-in-use. STEPS recognize joint role-specific responsibilities to bring in different perspectives throughout the design activity. The model was also conceived as a methodological framework emphasizing not only the PD of the software artifact, but also the co-determination of the software development process. In the STEPS model, both work context and technology are seen as subject to the evolutionary design. Scholars like Dittrich, Eriksén, and Hansson (2002) viewed design as continually ongoing and intricately interwoven with use, questioning the framework and methodologies of PD and challenging the contexts in which design takes place and the roles of designer and user. To whom should we teach our methods, and what can we learn in the process? The authors further underscore necessity of developing sustainable organizational support for "PD in the wild" cultivating PD in everyday use of information technology.

The concept of Future Workshop (FW) was first used in Germany in the seventies as a tool to enable groups of people to develop new ideas towards fighting for their political issues (Jungk & Müllert, 1987). It requires intensive preparation and trained moderator before the FW can be applied to a problematic situation. FW is also a well-known technique in the PD community (Kensing & Blomberg, 1998). The FW would be used as tool to build democratic

engagement to conduct PD activities. By establishing FW, we can focus on a specific problematic situation, generate visions of the future, and discuss how these visions can be realized. The objective of conducting the FW is to "create an initial joint proposal for changing a situation that a group of people finds unsatisfactory"(ibid).

FW has three main phases. First, in the critique phase**,** participants are welcomed to describe problematic issues in their practice. Responses from the participants would be written on large sheets of paper, which in turn could be used as a common open note. The main point here is to enable the participants to express their own criticisms and be inspired by other participants' points. Finally, the responses are clustered into a number of problem areas. Second**,** the fantasy phase focuses on developing utopian ideas or proposals for the future situation. The workshop facilitator could ask inspirational questions such as what forms of arrangement and ways of information service would they like to see? What kinds of technology would they like to be able to access? As alternative ways of generating ideas, we can convert negative criticisms found in the first phase into positive ideas in the second phase. Third, in the implementation phase*,* the ideas from the fantasy phase are seen with more realistic eyes in order to realize aspects of the vision. Specifically, economical, technical, social, and political issues are some of the topics that require serious discussion to produce a realistic implementation plan.

Currently methods have often been developed with specific aims and contexts in mind, which need considerable care when using them in other contexts. Scholars like Reijswoud (2009) and Walker et al. (2008) argue that not only computer hardware and software but also methods and techniques to design and implement information technology should be crafted in the developed countries in order to be used in developing countries. The limitation of this approach is that context and culture are not the same even within a single country, let alone between developed and developing countries. Similarly, Winschiers (2006) highlighted that not only the technological design needs to be adapted, but also PD methods and tools have to be appropriate to the sociocultural context in which the technology is to be embedded. For example, due to differences in communication structures, the common participatory design method *Future Workshop* is incompatible with Namibian social habits (Winschiers-Theophilus, 2009)

3.4.4 Participatory design and community context

PD has been propagated from Scandinavia to other parts of the world, which have different organizational structures and politics. As PD has entered a new context, it has brought

significant research directions to reconsider the way of conducting PD in context (Halskov and Hansen, 2015; Kyng, 2010). Every design situation presents a unique flavor of participant identities, agendas and roles within their contexts (Winschiers-Theophilus, 2009; Winschiers-Theophilus et al., 2012). Similarly, based on three case studies in developing countries, Puri, Byrne, Leopoldo, and Quraishi (2004) demonstrated the contextual nature of PD. They conclude that there is no single cookbook best practice regarding PD in information system, which is applicable to all situations. As the situated design is more important than ever, the different interpretation of the context such as cultural context and community context has become a concern of PD (Godjo, 2010; Hakken & Maté, 2014; Merritt & Stolterman, 2012; Winschiers-Theophilus, Bidwell, & Blake, 2010).What constitutes cultural knowledge and how that knowledge is acquired are become important to the PD process when PD is applied in cultural diversity context. Community is another aspect of context that requires different treatment compared with workplace practices.

Moving from a workplace context to a community context brings several design challenges. Scholars like DiSalvo, Clement, and Pipek (2012) define community in relation to geography as "a group of people defined by a bounded space or distinct locale, such as a neighborhood, town or region where social relations are more fluid and ambiguous than those found in formal organizations". *C*ommunity-based PD is viewed as all the design processes that go beyond the formal organizational workplace such as the factory, office, and hospital. Several scholars pointed out some of the issues and difficulties with organizing PD in the community context. Identifying boundaries of what is to be designed and by whom become blurred; it is difficult to manage heterogeneous stakeholders with only partially shared interests; knowledge gaps arise between designers and community members that bind local sociocultural protocols (Dalsgaard, 2010; Karasti, 2014; Sabiescu & Memarovic, 2013). Furthermore, interpersonal associations and community affiliations are often largely voluntary and driven more by intrinsic rewards than by extrinsic factors such as pay (as in an organizational context). Thus, achieving active participation can be difficult, since stakeholders might not recognize the immediate relevance of their involvement (Dalsgaard, 2010; DiSalvo et al., 2012). In response to these new concepts, an approach that considers a wider range of social relations and values while retaining the original democratic ideals of PD studies in the workplace is recommended.

Researchers like Dantec and DiSalvo (2013), DiSalvo (2009), DiSalvo et al. (2012), Pelle Ehn (2008), Karasti (2014), Karasti and Baker (2008), Karasti and Syrjänen (2004), and Pipek and Wulf (2009) offer some valuable insights to think of PD as "infrastructuring".

Infrastructure here refers to immaterial elements and abstract artifacts such as information, as well as its processing through tools and social arrangements. Infrastructure through design employs a shift from thinking of designed systems as fixed products to treating them as ongoing infrastructure as part of a sociotechnical process. This understanding of the design process emphasizes people coming together to meet in conversation, not only for design, but also an ongoing articulation process where the public forms a socio-material responsive entity. Thus, infrastructuring is viewed as "the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design".

For instance, DiSalvo et al. (2012) and Dantec and DiSalvo (2013) conceptualize publics as groups of people who together are interested or influenced by a specific set of conditions. These groups of people or publics come to be organized around and through an issue in order to address that issue and its consequences. The authors argue that a dual understanding of the relation between infrastructure and publics need to be maintained. Infrastructure, particularly information technology infrastructure, may support the emergence of publics; it creates publics around issues such as access, ownership, and usage. All this highlights a conceptualization of community-based PD that opens up common ground for addressing relevant actors in establishing an information technology design and usage.

3.5 Summary

The potential of ICT to overcome geographic barriers and establish information-rich global communities and interconnectedness has positioned it as an agent for development. To this end, there has been a growing consensus among international development organizations and government bodies that ICT can support development. To articulate development goals and outcomes, several development perspectives (including economic growth, the capability approach, human development, the sustainable livelihood approach, millennium development goals, and sustainable development goals) have been proposed. My interpretation of development is underpinned by millennium development goals and the capability approach. This means that development requires change, which in turn raises the questions of: "Why is there a need for change?" What aspects need to be changed? And "Who are the target people?" I will use an example of one of the key goals within MDGs and SDGs— to eradicate extreme poverty and hunger. Here, poverty is considered not only economic and social deprivation but also a lack of access to information (UNDP-Ethiopia, 2012). This in turn requires an investigation of environmental, social, and personal issues within that context, together with

target beneficiaries (Sen, 1999). Investigating local opportunities and aligning people's capabilities with achievable functions also need to be done by the local people. Again, the interpretation of development depends on its specific context, which includes the application domain and the target beneficiaries. In fact, the aspects of development that should be considered have been debated in the academic community.

In ICT4D literature, different research focuses and associated challenges have been reported. For instance, Walton and Heeks (2011) pointed to the lack of adequate infrastructure, lack of beneficiary participation, poor technical feasibility, and absence of a sustainability strategy as main factors. Technology designed for the industrialized world is often a poor fit for developing countries' communities. The majority of ICT4D projects continue to be externally driven and technology-centered rather than community-centered (Dodson et al., 2012). Limitations pertaining to the requirement-gathering process and the lack of attention to user needs have also been reported (Gichamba et al., 2016; Knoche, Rao, & Huang, 2011). This in turn has ultimately led to failure because technology developers often understand poorly the technological needs and constraints of developing countries.

Defining ICT for developing countries' (often in organizational settings) and ICT for underserved communities' research agendas is also another issue that needs a clear demarcation. The former has focused on evaluating the feasibility and adoption of Western technologies to fit developing countries' cultural, political, and social environments (Brown & Grant, 2010), whereas the latter refers to research focused on underserved members of societies (Walsham & Sahay, 2006). Again, the ICT4D literature is an umbrella for a wide range of research disciplines, topics, and contexts. Establishing a clear, relevant domain of a context can also help us to understand problems that exist in one domain but may not necessarily exist in others.

In light of this, we further zoomed in to ICT4A to consolidate our understanding and obtain a rich picture of the research practices of different countries. The review process encompassed a systematic mapping study from four journals and one international conference. As a result, five interrelated categories of research contribution have been reported. These are: aspects of development, understanding context, user interface design, design method, and conceptual framework. In addition, related research studies were collected for review using the snowballing technique. ICT4A studies in agriculture and rural development journals and reports from international developmental organizations were also reviewed.

Although there has been an attempt to address issues related to engaging local beneficiaries, the most suitable design strategies to use has been a subject of debate (Doerfinger

& Dearden, 2013; Joseph, 2010; Knoche, Rao, & Huang, 2011; Moens et al., 2010; Parmar, 2009; Reijswoud, 2009; Maunder et al., 2007). On top of this, grassroots participatory approaches and cultural issues are still open for discussion. One of the key goals here is to establish collaborations with local beneficiaries to take up different roles and to ensure that the scope of the project meets local needs (Dearden & Rizvi, 2015). Again, how to win the commitment of community members and build a trusted relationship with them throughout the design activities is still a debated issue.

Taking these points into account, I stand for a community-based participatory approach for the ICT4A design process. In fact, Scandinavian participatory approaches have shown exemplary results, and their discourse has become part of an international research community (Halskov & Brodersen, 2015). In response to the current top-down and technology-centered ICT4D/A design process, PD can facilitate an understanding of the powerful relationships between decision makers, system designers, and system users. However, addressing aspects and issues regarding development in a community setting is a complex process that depends on the consideration of several social and technological issues. Designing technology cannot be seen as a final solution; rather, it is a tool to be adapted into local social processes and practices.

I view PD as a flexible and collaborative design process that encompasses aspects such as concerns, stakeholder participation, methods, guiding principles, and facilitation. We may start from a very messy, and problematic context in defining our concerns. Addressing and redefining concerns requires multiple participants' perspectives. Involving people in a design who have different backgrounds, experiences, interests, and roles requires an appropriate method of establishing productive dialogue. PD methods and techniques open up a third space for mutual understanding (Muller, 2002). This in turn requires the facilitation and negotiation of concerns, guided by central PD values. Culture, local practices, people, technological alternatives, and local opportunities are part of the investigation. These elements cannot be imported from the outside; rather, they must be cultivated and strengthened locally within people in a community. In light of these considerations, Chapter 4 prepares and develops the overall research approach.

4. Theoretical Frame of the Research Approach

This chapter discusses broad theoretical research concepts that underpin the structure of the research approach of this study. As reviewed in Chapter 3, ICT intervention in the rural community is a complex process that is constrained by several issues. I present four foundational concepts that help to contextualize the research approach. At a broader level, different research paradigms along with their distinguishing characteristics will be discussed in Subsection 4.1. This, in turn, informs the development of the theoretical stance that this research uses. The role of the theoretical framework, which extends the research paradigm, will be discussed in Subsection 4.2. In Subsection 4.3, we further explain the role of a theory that uses soft system thinking as a base. In Subsection 4.4, again, aspects of culture are discussed to supplement the "soft systems thinking." Finally, in Section 4.5, all the foundational concepts mentioned above allow me to discuss the epistemology that undergirds the study. Again, the different theoretical concepts and approaches inform the methodological approach, which is a plan of action.

4.1 Research Paradigms

A paradigm is a set of shared ways of thinking about some aspect of a real-world problem. The difference between paradigms is rooted in their respective worldviews, i.e., the understandable nature of the knowledge and the nature of the research world of each (Oates, 2006, p. 291). One can distinguish the understanding of the empirical world either as objectively describable and independent of humans or as subjective and existing only through the action of people in creating and recreating it.

Understanding concepts such as ontology and epistemology enable us to differentiate between paradigms (Gregg, Kulkarni, & Vinzé, 2001). The concept of ontology refers to explanations of the nature of reality or existence of a particular phenomenon, or simply put, the way things are. When we seek the truth in answer to our research questions, "we are referring to a particular type of knowledge that exists external to the researcher," whereas, the concept of epistemology refers to explanations of how this reality is apprehended or known. In other words, epistemology is about how one proceeds to reveal knowledge and learn about reality. That means that epistemology is "internal to the researcher." The type of beliefs held by one or more researchers could be classified into three paradigms: positivism, interpretivism, and pragmatism, as discussed below.

4.1.1 Positivism (objectivism)

Positivism assumes that reality is detached from the individual who observes it (Creswell, 2013). The subject (the investigator) and object (the phenomenon) are considered separate entities. The positivist approach is to find universal laws, patterns, and regularities, which are then tested through experimentation. Accordingly, positivist researchers attempt to remain detached from participants in their research. Positivism assumes that the actions that bring about a phenomenon and observation (measurement) of it have no bearing on the outcome of the phenomenon (Creswell, 2013). Positivists hold a deterministic philosophy in which causes determine effects or outcomes. Thus, proponents of positivism identify problems to be studied by reflecting on the need to identify and assess causes that influence outcomes.

Knowledge that is developed through a positivist approach requires objectively observing and measuring reality. That means that studying and developing numeric measures of observations is paramount. A researcher begins with a theory and collects data that either supports or disproves that theory. He/she takes a controlled and structured approach to conducting research. Finally, the goal of positivist researchers is to make time- and context-free generalizations (Creswell, 2013).

4.1.2 Interpretivist perspective

The interpretivist view of ontology is that the reality surrounding us is subjective and multiple for different observers (Robson & McCartan, 2016; Oates, 2006). The knowledge acquired through this perspective is subjectively constructed rather than objectively determined. The interpretivist perspective assumes that the researcher and his/her informants are interdependent and mutually interactive. People directly or indirectly influence the object, which implies that the subject and the object are inseparable. Interpretivists, unlike positivists, believe and share the view that meanings are constructed by people as they engage with the world they are interpreting. It posits a knowledge paradigm that is required to encompass the relationship between actors as well as the outcome of their actions. Thus, the aim of the interpretive researcher is to obtain meaning as it is constructed by people engaging with the world and to depend on the participants' views of the situations being studied, which is in contrast to the world of the natural sciences. Interpretivists believe in acquiring knowledge of reality through the construction by humans of the meaning of the phenomena under study.

In applying this approach, interpretivists adopt flexible research structures that are open to capturing meanings in human interaction and making sense of what is perceived as reality (Robson & McCartan, 2016; Oates, 2006). The interpretivist researcher enters into a research

world with some sort of prior insight that is insufficient when applied to the research context, so he/she remains open to new knowledge throughout the study and lets it develop with the help of informants. The interpretive philosophical assumption suits qualitative strategies of inquiry, such as individual interviews and focus groups. Again, as the knowledge of the truth is subjective and varies across different cases, the main output of interpretivist research is an understanding and interpretation of meanings in human situations rather than generalizations and predictions of causes and effects. However, subjective analysis of data could be influenced by the researcher's personal interpretations (Robson & McCartan, 2016; Oates, 2006).

4.1.3 Pragmatism

The pragmatist perspective emanates from actions and consequences based on workable solutions to problems in a context (Robson & McCartan, 2016). Pragmatists show a concern for practical matters and prefer to be guided by practical experience. An early American philosopher, John Dewey (Dewey, 2007), stated that pragmatism is looking beyond principles, consequences, and facts. This implies that it looks not only to gain knowledge but also to use that knowledge to address real-world problems. As a result, pragmatism holds both the meaning and truth of any idea as functions of its practical outcomes (Dewey, 2007). The cornerstone of pragmatism is the concept of active engagement and actions that grow out of one's experience. Creswell (2013) also stated that the pragmatist assumption is geared toward connecting theory and practice. Pragmatism encompasses a course of action wherein theory originates out of practice and is then reapplied to practice to create new practice.

Pragmatism combines the strength of both positivist and interpretivist perspectives to study what works in particular contexts. For instance, Dewey (2007, p. 5) stated that pragmatism is an extension of positivism but with a fundamental difference: "it does not insist on antecedent phenomena, but on the consequent phenomena; Not on the precedents, but on the possibilities of action". Similarly, the interpretive paradigm is essential to researching subjective reality using pluralistic methods. In the pragmatic paradigm, reality is constantly renegotiated and reinterpreted, and the best method to use is the one that solves the local problem at hand. A pragmatist follows a logical and practical alternative to empirical inquiry by using mixed research methods (Creswell, 2007). In the pragmatic epistemology, investigative processes are fundamental as experience grows out of encounters with real-life situations. Table 9 shows a high-level comparison of the three paradigms discussed so far.

Table 9: *Basic Distinguishing Characteristics among the Three Paradigms*

Characteristics	***Paradigm types***		
	Positivism	***Interpretivism***	***Pragmatism***
1.* Ontology: What is the nature of the reality?*	The world exists independently of humans- there is a physical and social world that exist "out there". The world exist independent of human- *There is a single external reality*	Structure exists only in the mind of the observer, leading to different perceptions of reality. *No single external reality*	There exist entities that are independent from as well as dependent on human mind. Both meaning and truth are a function of its practical outcomes. *There is multiple reality*
2.Epistemology*: How can we obtain knowledge of that reality*	Reduce phenomena into simplest elements and look for causality; Thought is governed by hypotheses and stated theories.	Researcher interact with that being researched; seeking to understand specific context. Understood through 'perceived' knowledge	Reality is knowable through interaction with the specific of a given situation; Reality is constantly renegotiated, debated, interpreted.
	A researcher discovers a world by making observations and focus on facts.	Concentrate on understanding the context and interpretating it. Tries to understand the totality of each situation	A researcher builds knowledge by recognizing the world as complex system. The best knowledge is one that solve problems. Find a desirable and feasible intervention to improve a situation
3.The **role** *of the* ***researcher***	A researcher is neutral and *keep a distance from* personal values and beliefs	Researchers need to experience what they are studying	Researcher interact with that being researched with expression of changing the situation. Researcher is reflective on the interaction, renegotiation, understanding and practices with people under study.
4.*Means to achieve knowledge* **(Methodology)**	Often Quantitative data analysis	Often a strong qualitative data analysis	Mixed methods
	Inductivism(generalization) : Understanding as an extension from individual cases to universal law	Deductivism *: Understanding as the derivation of the individual view from the universal*	Abductive reasoning: Starts with a set of observations then seeks to find most likely explanation. The pre-understanding of a context influences understanding of a certain phenomenon

(Compiled from author's understanding)

Now, let us position this ICT4D/A research based on the discussion so far. As discussed in Chapter 3, Sections 3.2 and 3.3, the literature has already acknowledged the limitations of a top-down, technology-centric approach that can be considered to follow the tenets of positivism. For example, Reijswoud (2009) argued that the "ICT4D community has to shift away from traditional one-size-fits-all solutions to solutions that fit a context in which the technology is to be used." This is because a top-down approach overemphasizes the role of technology and somewhat misunderstands the constraints of local contexts. Again, in the interpretive paradigm, although multiple perspectives can be used to understand a local context, a researcher has no intention of remedying local problems. However, intervention based ICT4D/A research requires reflection-in-action. As discussed in Chapter 3, Section 3.4, participatory design and infrastructuring emphasize different perspectives and interests in defining what a problem is and how it can be solved. The pragmatist paradigm sees "what" and "how" to research based on the intended consequences and the direction in which the investigator wants to take the research (Creswell, 2007). To this end, the pragmatic paradigm suits the objective of my study, which is to obtain a holistic view of reality. Further discussion about the research process and other issues will be discussed in Section 4.5 and Chapter 5.

4.2 The Role of Theory

A conceptual framework can be considered a lens through which we can focus on which aspects to observe (Truex, Holmstrom, & Keil, 2006). Similarly, in her article, Gregor (2006) defined theory as a set of principles in background research which consists of a paradigm, objectives, methodology, and application areas. This, in turn, guides what kind of research we conduct. Once the research question is decided based on a given body of knowledge, which type of theoretical framework is appropriate remains to be determined. However, selecting an appropriate theory or combination of theories to underpin a study is not easy. For instance, Sibongile and Iyamu (2013, p. 9) pointed out issues related to understanding and differentiating theories. These issues come into play while attempting to adapt a theory that is defined in one discipline (e.g., sociology) to another (e.g., information systems). This is due, in part, to the challenge that faces researchers in understanding the contexts and focuses regarding the origins of a given theory. Furthermore, as some theories are quite similar, it is difficult to distinguish one from another (e.g., actor network vs. structuration theory).

Gregor (2006) classified theory into four categories (see Table 10). The *first* and lowest-level category is thick description and analysis—the most basic type of theory—which is used to describe or classify specific characteristics of situations by summarizing research insights. The *second* classification of theory, which is of a higher level, belongs to understanding and

explanation. Theory in this category is used to explain how and why given phenomena happen in particular real-world situations. In one example from the ICT4D area, Urquhart et al. (2008) presented a framework that relates ICT infrastructure to social capital formation and cultural dimensions. The framework has four stages: information system development, information system intervention, evaluation of the impact of the ICT intervention, and the process of poverty reduction. There are several iterations and interactions between stages, and each stage of the framework is exemplified using practical development projects.

Table 10: *Taxonomy of Theory in Information System Research*

Theory type	**Main attributes**
Thick description and analysis	Answers the issue. This kind of theory can be used for analysis and description.
Understanding & explanations	Used to answer *what*, *how*, *why*, *when*, and *where* issues. The theory provides explanations but does not aim to predict with any precision.
Explanation and prediction	Used to answer *what is*, *how*, *why*, *when*, *where*, and *what will be*. Provides predictions and has both testable propositions and causal explanations.
Design and action	Explains how to do something. The theory gives prescriptions such as techniques, principles, methods, and functions for constructing an artifact.

Source: (Gregor, 2006)

At the *third* level are found theories of explanation and prediction. They are used to describe underlying theoretical constructs along with relationships. For example, Avgerou, (2010) have stated that a significant percentage of ICT4D research has kept to the Technology Acceptance and Diffusion: TAM discourse (Avgerou, 2010). Similarly, Andersson and Hatakka (2013) proposed that TAM was the right option in the early days of ICT initiative research to report field experience, which is not the main issue in contemporary ICT4D research.

Finally, theories used for design and actions belong to the *fourth* classification. Such theories consider all aspects of the previously mentioned theory types as well as views on how to carry out actions. In response to calls to move away from a techno-centric and toward a community-centric focus, theories in this category give specific techniques, methods, and principles of form and function for constructing a new artifact. Systems theory, social technical

theory, and soft system thinking are examples of theories in the fourth category. Now, let us discuss soft systems theory in a separate section.

4.3 Soft systems thinking (SST)

The present research is motivated by three core constructs (ideas) that underpin soft systems thinking. These core constructs are the *systems idea*, the *multiperspective*, and the *process of analysis as a learning system*. Checkland and Haynes (1994) noted that in a complex situation, the actual problem to be addressed may not be easy to agree upon, and identifying what kind of feasible improvement to make in the situation is difficult. The discussion below provides explanations and relationships between each construct.

First, the *systems idea* as the notion of a system as a way of understanding real-world phenomena is founded on concepts of biological living system theory (Lloret-Climent, 2002). A discussion of living system theory is beyond the scope of this study, but our focus is on information system theory, which has used similar system concepts. A *system* is a group of interacting components operating together for a common purpose. The systems concept provides language to describe and analyze the area of concern through concepts such as system boundary, internal structure, system hierarchy, inputs, and outputs (Jackson, 2003).

As Ackoff (1994) put it: "A system is a whole consisting of two or more parts: each of which can affect properties of the whole; none of which can have an independent effect on the whole; and no subgroup of which can have an independent effect on the whole."

Understanding the world in terms of wholeness, relations, contexts, and functionality of the whole is more important than focusing solely on its parts. Thus, the systems idea provides a way to abstract reality and capture a system's multidimensionality. Specifically, Nguyen et al. used the story of the blind men and an elephant as a metaphor to explain the main concepts of the system idea:

> If six blind men are asked to feel an elephant, they will end up with different conclusions about the elephant according to whether they touch the trunk, the leg, or the tail. This is because, individually, they did not get a whole picture (2012, p. 2).

On the other hand, splitting an elephant in half will never result in two small elephants, which clarifies that a system is not merely the sum of its parts. In light of the above, the notion of systems enables us to structure not only our thinking about reality but also about parts of reality and their interrelationships (Jackson, 2003).

Second, *multiperspective*, SST inquires into human affairs and explicitly recognizes the multidimensional nature of reality. Most real-life scenarios are unstructured problems and highly dependent on human activities (Checkland & Holwell, 1998; Stowell, 2009). Understanding complex situations demands consideration of how each of us makes sense of them. Learning about such "messy" situations can be done from within and by being a part of the case. This rejects the belief that there are "systems out there" waiting to be discovered; instead, *systems* are understood as constructs. SST takes a phenomenological view in which the world is complex and appears different to each observer. Accordingly, soft systems thinking is described as a form of inquiry concerned with enabling the observer to view a situation of interest in its entirety (Checkland, 1994, 1998, 2000; Stowell, 2009). For instance, Jackson (2003, p. 185) defines soft systems as "mental constructs" of observers' worldviews. Again, the notion of a system is used as an interrogative device to enable debate among concerned parties. Different subjective views of the problem environment enhance understanding of the problem situation. Complete and rich in-group problem-solving is addressed using negotiation, dialogue, creativity, and learning.

Third, the idea of *process of analysis as a learning system* further develops the systems idea and emphasizes a multiperspective by bringing into play a process of analysis. Following a multiperspective, the analyses are varied among different stakeholders. This, in turn, invites discussion (or debate) between the stakeholders. Discussion and debate can facilitate relevant human and soft factors to form structures during system analysis. As a result, learning or knowledge can be obtained from interpreting people's thoughts, followed by evaluation of ideas (Checkland & Holwell, 1998; Checkland, 1994). The main aim here is a systemic process that leads to purposeful action. A systemic (holistic) problem analysis through experience is considered a learning system. The investigation makes the process of learning itself prime rather than searching for a solution. By adopting the ideas of systemic problem analysis, the researcher accepts that others will see the world in different ways and there is no universally agreed-upon description.

In summary, all three constructs of soft systems thinking further complement our research paradigm. As discussed in Chapter 3, the limitations of the ICT4D/A initiative in having any impact for the intended community indicates that its issues are wicked problems (Pitula, 2010, p. 20; Tongia & Subrahmanian, 2006). The system and multiperspectivity concepts can be used to make sense of the complexity of such real-world issues. Again, ICT4D/A problems are multiple and interrelated such that tackling one issue may not address

others. Instead, systemic problem analysis is seen as a better approach that, in turn, indicates which type of research epistemology to follow.

Again, the ICT solution is embedded in cultural relations in a particular society, which requires detailed investigation. Cultural analysis in SST is concerned with cultural change within organizations and identifying a problem situation, which incorporates cultural as well as political aspects. Van (2006) argued "when technology is transferred from one society to another, it also reflects social values, institutional forms, and the culture of the former society." The situation should be described in all its richness, including structures, cultural contexts, processes, people, and issues. Let us now discuss culture as a separate topic and, after that, link it to an overall epistemological view in Section 4.5.

4.4 Conceptualizing Aspects of Culture in Design

As PD has entered into new contexts, it has also brought significant research directions to reconsider specific culture of contexts.(Hakken & Maté, 2014;Winschiers-Theophilus, Bidwell, & Blake, 2012). A shared vision of what constitutes cultural knowledge and how such knowledge is communicated and learned has become more important than ever. Nowadays, information technologies are being introduced in various contexts, such as social media, community settings, and service sectors. The design process and technological alternatives do not exist in isolation but rather in the context of human environments where people's attitudes to and perceptions of technology as well as their interactions with one another all influence the final design outcome.

4.4.1 Cultural systems

Culture is a collective phenomenon that shapes attitudes and behaviors shared by all social groups. Franklin (2005) describes culture as "the set of socially accepted practices and values shared by a group of people." Practices are the observable manifestations of a culture together with symbols, artifacts, societal structures, laws, and rituals. Values, by contrast, are largely unobservable, consisting of the set of knowledge, beliefs, norms of behavior, and ways of thinking that underpin the practices and give them meaning (Kersten, Kersten, & Rakowski, 2002). The different views of culture models that encompass its conception, formalization, and interpretation are discussed as follow.

Hofstede (2011) defined culture as "a collective programming of the mind that distinguishes the members of one human group from those of another." Culture in this sense is a system of collectively held values in which he identified six dimensions: (1) power-distance,

(2) collectivism vs. individualism, (3) femininity vs. masculinity, (4) uncertainty avoidance, (5) long- vs. short-term orientation, and (6) indulgence vs. restraint. This last dimension refers to the gratification vs. control of basic human desires related to enjoying life. However, this cultural model has significant limitations, as pointed out by Myers and Tan (2002). First, it considers the nation (state) as its unit of analysis, which disregards cultural differences that occur within or transcend national boundaries. Second, its view of culture as static over time conflicts with the anthropological view that considers culture as emergent and dynamic.

Andreatta and Ferraro (2012) defined three intimately connected components of culture: "people's material possessions; everything that people think – such as ideas, values, and attitudes; and everything that people do, such as patterned ways of behaving." Figure 12 depicts the integrated components of culture systems. This model views culture systems as having many subsystems within them, such as social, governing, symbolic, aesthetic, technological, and linguistic subsystems, among others.

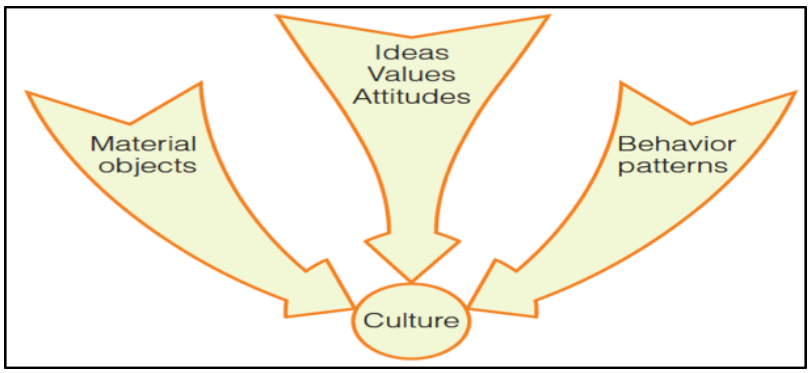

Figure 12: Three components of culture (adapted from Andreatta and Ferraro, 2012, p. 34)

Finally, the notion of the *cultural stream* has also been pointed out in soft system thinking. To understand culture in the workplace context, three ideas are defined. First, *stakeholder analysis in the problematic context* involves identifying the plausible problem owners, selected by the problem solver, as the main source of ideas for relevant systems. Second, *social system analysis* focuses on roles, norms, and values in a problem situation. A social system is seen as a continually changing interaction among roles, norms, and values. Each continually defines and redefines the other two (Checkland, 2000). Here, a role is the social position recognized as significant by the people in the problem situation, which is characterized by expected behaviors or norms. The third idea that is important to understanding culture in the workplace is *power*. The political system analysis of soft system thinking views power as a process by which differing interests reach an accommodation. Power-related activity is also concerned with managing relations between different interests. For example, formal authority, intellectual

authority, personal charisma, and memberships on committees can be considered as sources of power in the political system. Based on these three levels of cultural stream analysis, the author states that systemically desirable and culturally feasible options can be implemented to improve problematic contexts. Here, some triggering questions might be asked, e.g.: To what extent does the actual situation match the logic models, and how do social, political, and cultural factors assist?

4.4.2 Aspects of culture for technology design

There is a growing awareness of the need to consider culture when implementing technology. This is because differences in national cultures and values can have a significant impact on IT products and design processes (Boehm, 2006). One of the approaches to considering culture in design is to explain technology as a social process. These approaches view technology as both reflecting the society that produces it and as one aspect among others that shape and influence society. Van (2006) state when technology is transferred from one society to another, it also reflects social values, institutional forms, and the culture of the former society. Given the fact that the majority of software applications and technology practices have been developed for use in Western culture, localization of software has been discussed (Kersten, Kersten, & Rakowski, 2002). However, the limitation of software localization approaches is their focus on "external manifestations" of culture, such as language, currency, and symbols. Furthermore, "deep culture" factors that affect the user interface and core functionality are challenging to address through a software localization approach. Such assumptions lead to the view that "all cultural aspects are encapsulated in the external software layer" and can be localized by simply changing the user interface.

For ICT to be accepted and used in a given social context, it must fit within a community's value system and local cultural practices. Aykin (2006, p. 6) observed that integrating culture in the design of ICT remains an emergent phenomenon. Internationalization and localization of information technology reveal that abstraction from the receiving societies' culture leads to the design of unusable and unwanted sociotechnical systems (Winschiers-Theophilus, 2009). Many information systems are reported to be failures in Africa as a result of the cultural mismatch between the imported and indigenous cultures. In addition to this, a focus on the outer layer of culture without going deeper will result in a weak understanding. This, in turn, leads to design ICT that provides weak and shallow support for the intended users.

Walsham (2002) argued that dramatic changes in many societies have been seen in areas such as family life, religion, social attitude, etc. He concluded that culture is not static but

should be viewed as dynamic. This also shows the connection between a people's culture and its IT systems because as the number of interactions with the IT system increases, it is increasingly difficult for any group to remain isolated and uninfluenced by the technology. Thus, IT design should see culture as contested, temporal, and emergent (ibid).

Similarly, Heeks (2002) stated that one of the risks of ICT initiatives in developing countries is *hard–soft gaps*. The hard–soft gap refers to differences between the actual technology (hard) and the reality of the social context (e.g., people, culture, politics) in which the system operates (soft). Many methods and frameworks offer different approaches to eliciting culture and context in designing IT (Gibbs, 2009; Young, 2008). These approaches have explored elements of the problem domain, but making these visible, integrating them, and translating them into socio-technical implications for design decisions at different stages of systems development remain challenging (Camara et al., 2010).

The culture issues are better exposed when methodologies are also localized and/or combined. Winschiers-Theophilus (2009) also argued for cultural adaptation of IT design methods and processes. Young (2008) argued that there is still much to learn about how to integrate culture into design IT and in order to develop IT for people to use. Again, as discussed in Chapter 3, Section 3.4, participatory design or infrastructuring activities depend on a given context and culture. A shared vision of what constitutes cultural knowledge and how such knowledge is learned and used in design is becoming more important. Thus, beyond understanding culture as a single construct, formalizing and interpreting culture as a collective phenomenon is needed to underpin community-based product development (PD).

4.5 Defining the Research Approach

As discussed in Chapter 3, our ICT4D/A research rests on community-based PD from a capability-development perspective. The *D* in ICT4D is seen from the capability approach in contrast to the prevailing quantitative views (e.g., income or access to a mobile phone). This, in turn, demands a pragmatist perspective and participatory process to locally define developmental goals. Pragmatism focuses on consequences of actions and takes a pluralistic, real-world, and practice-oriented stance (Creswell, 2013). This requires understanding the problem context through strings of actions and embedding intervention into the concrete social situation. Action research (AR) and design science research (DSR) build upon a perspective of pragmatism, although each approach has a different focus. A few previous scholars have proposed to combine AR and DSR (Bilandzic & Venable, 2011; Cole et al., 2005; Papas, O'Keefe, & Seltsikas, 2012; Sein et al., 2011). Now, let us first discuss the characteristics of

AR and DSR, followed by participatory action and design research (PADR) approach of this study.

4.5.1 (Participatory) action research

Action research (AR) is distinguished by two goals: making improvements in a problematic situation and, at the same time, researching the phenomenon of interest. Thus, a researcher enters a real-world situation both to improve a problematic situation and to acquire knowledge. The fundamental contention of the action researcher is that complex problems can best be studied by introducing changes. Although the basic assumption in AR is to discover a problem area, there is a diversity of form of AR methods for introducing changes and observing their effects. For instance, Dittrich et al. (2007) defined AR methods for understanding social and cooperative aspects of software development in three stages. Leitch et al. (2010) proposed their Effective Technical and Human Design of Computer-Based Systems (ETHICS) with 15 stages. Davison, Martinsons, and Kock (2004) defined AR with five interrelated stages: diagnoses, action plan, intervention, evaluation, and reflection (learning) (see Figure 13). The action can include an introduction of interventions and evaluation of the feasibility of the solution that emerges (Hayes, 2011). An important principle in AR is establishing relational and inclusive values, with the action researcher perceiving himself/herself in relation to social contexts. McNiff and Whitehead (2006) stated that the idea of "establishing inclusive relationships refers not only to the social world where we see ourselves in relation with others but also to the mental world where we see how ideas are in relation with other ideas." That means the action researcher influences and is influenced by others in order to gather knowledge about the situation.

Participatory action research (PAR) is a specific form of AR in which end objectives are not directly specified at the beginning, but action is co-determined by the affected people. Both AR and PAR require a researcher to collaborate with the intended beneficiary of the research process and a tangible problem-solving goal. However, PAR places more emphasis on the participation of people (Wadsworth, 1998) and empowerment (Stillman, 2013). The empowering of the participants is an essential part of the desired outcome. PAR acknowledges that people affected by a problem are in the best position to understand it and suggest solutions. Furthermore, PAR creates new knowledge through the process of solving real problems while also improving the capacity of participants. The participants and researchers process significant theoretical issues together. Second, unlike AR, PAR relies on the reflective practice of the researchers in action and does not wait to apply new understandings to the next situation but

incorporates them into the ongoing process (Stillman, 2013). This reflective practice transforms views of structural problems in the system under study and leads to more creative solutions (Baum, MacDougall, & Smith, 2006).

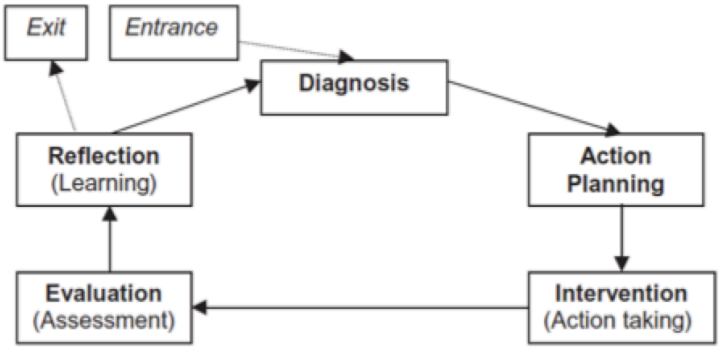

Figure 13: Action research process (Davison, Martinsons, & Kock, 2004)

4.5.2 Design science research (DSR)

DSR is a pragmatic research method for investigating issues related to designing artifacts and organizational contexts (Hevner, 2007). The design element refers to a process of initiating a technical solution to meet social demand. DSR seeks to extend the boundary of human and organizational capability by creating artifacts. DSR involves three cycles, as shown in Figure 14. The *relevance cycle* begins with requirement analysis from the contextual environment as criteria for the research artifacts. Then, the *design cycle* includes a tight loop of research activity for the construction and evaluation of design artifacts and processes. The *rigor cycle* focuses on specifying new knowledge that might consist of extensions to the original theories, methods, or framework. The fundamental questions for DSR are as follows: What utility does the new artifact provide, and what demonstrates that utility? Creating a new artifact is unnecessary if existing artifacts are adequate. If the new artifact does not map adequately to the real-world problem, it cannot provide utility. If the artifact does not solve the problem, it offers no service.

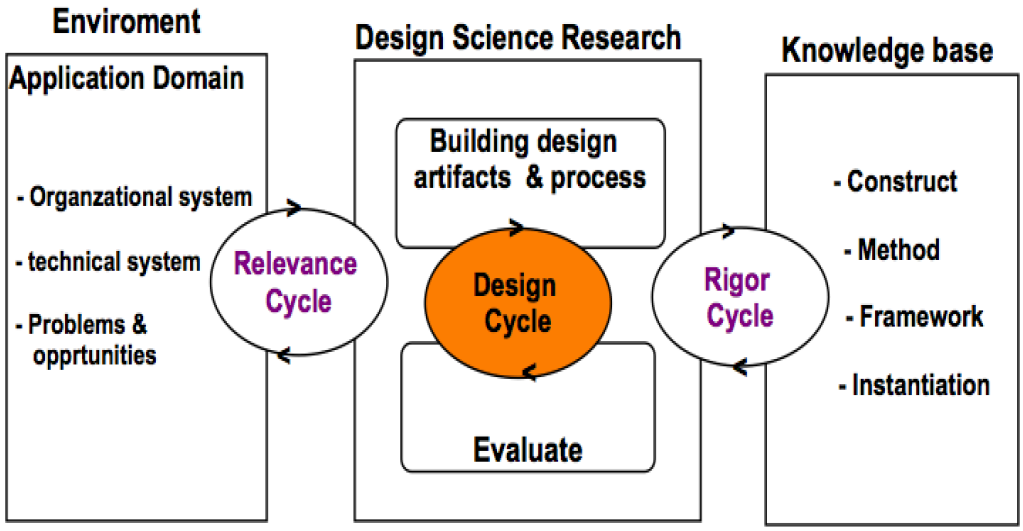

Figure 14: Design science research cycle (Hevner et al., 2007)

Table 11: *Basic Characteristics and Comparison of Research Methods*

No	*Characteristic*	*(P)AR*	*DSR*	*PADR*
1	**The role of technology (designing artifact)**	*Peripheral:* an artifact is a by-product of the intervention.	*Central:* Designing of artifact is expected. Several artifacts might be created which might include physical artifact	*Mandatory:* artifacts are required to be created and evaluated; looking for field problems as knowledge-creation opportunities. It seeks opportunities at the intersection of technology and community problem.
2	**Researcher relationship and collaboration with stakeholders**	Research occurs in a real-world environment and rooted in interpretivist ideas or pragmatism. Collaboration between action researcher and target beneficiaries is required	Research occurs in a real-world environment and is rooted in pragmatism. Researcher(s) develop technological rules for a certain type of issue.	Research occurs in a real-world environment and rooted in pragmatist perspective. Reality is knowable through constantly negotiating, acting and reflecting. Research needs collaboration between action researcher and target beneficiaries.
3	**The center of learning**	Learning is expected to emerge from an action undertaken by the researcher and collaborators.	Building and evaluation are the two main activities to generate knowledge.	Learning is expected to emerge from a reflection-in-action undertaken by the researcher and collaborators. Collaborative can be put at the heart of the research approach
4	**Research Contribution &Transferability (generalizing)**	Reflection and learning allow a researcher to make both a practical and theoretical contribution.	Research can results in the areas of the design artifact, design foundations, and/or design methodology	Reflection and learning allow a researcher to make both a practical and theoretical contribution. Lesson learned from a process of designing a specific solution to a problem encountered in a context.

Source: Author understanding, Papas et al. (2012)

4.5.3 Combining: (P)AR , DSR and PADR

In this section presents the limitation of PAR and DSR followed by how can that be addressed by combining them. In fact, solving relevant practical problems is inherent in the values for both (P) AR and DSR. From a research process perspective, problem diagnosis is a common entry point. Both research methods share a similar goal of addressing real-world problem situations. However, there are also difference where combing them is needed. In fact, previous scholars Bilandzic & Venable(2011) proposed for combining the two research method: **P**articipatory **A**ction and **D**esign **R**esearch (PADR), in the urban informatics (UI) domain. The discussion below focus on four key issues presented in Figure 11.

Frist, designing technical artifacts, technology can play a role in and is at the core of DSR. However, in AR, the artifact (if any) is normally a by-product of the research (Papas et al., 2012). The nature of the target of the technical artifacts in (P) AR is viewed as an emergent system that is produced as an end product. Instead of viewing design practice only as something going on in a lab "out there," technological artifacts should also be used to clarify a problem context. The (P) AR emphasizes the utility aspect of the future system from the point of view of the people involved, with little concern for design evaluation. On the other hand, the primary focus of DSR evaluation is on utility (assessed against prior defined criteria), with little attention is played on impact or "lessons from use." This indicates that evaluating technical artifacts using either AR or DSR would compromise the other. Schön (1983, p. 165) explained how knowing and doing come together in reflection-in-action. Drawing on Schön, means and ends are mutually dependent, and both need to be set for the same research process. That means coupling action and design activities to enable technological artifacts to be theory-ingrained and emergent from interaction in the relevant context. Thus, it is my view that pushing designing artifacts forward both theoretically and practically requires both action and design research.

Second with regard to collaboration, establishing relationships, and participation, PAR needs an explicitly collaboration between action researcher and target beneficiaries which is also an entry point for research (Davison, Martinsons, and Kock ,2004). On the other hand, DSR problem identification is explicit starting point where, researcher(s) develop technological rules for a certain type of issue with little on attention to collaboration. In my study, the approach to collaboration and establishing relationships with the target beneficiaries needs to respond to ICT4D researcher claims that "ICT programs need to develop local partnerships with existing community-based organizations working in their project area"

(Dearden, Matthews, & Rizvi, 2011; Gigler, 2011; Knoche et al., 2011). In light of the above, the democratic PD value discussed in Chapter 3: Section 3.4.1 underpin methods of establishing collaboration with local people and building trust relationships between the researcher and the local community. As PD research is context-dependent, collaboratively analyzing a problem context is required (Bratteteig & Wagner, 2016). Dialogues are crucial for establishing mutual understanding through extensive forms of active participation throughout the design process and discussing the implications of actions (Gregory, 2003; Kyng, 1998). Thus, in PADR, establishing collaboration with local stakeholders becomes a basis upon which to set up roles for the designer-researcher and local key actors.

*Third***,** the *center of learning, i*n (P)AR, learning is expected to emerge from action undertaken by the researcher and the participants. This, in turn, is associated with a continuous feedback loop. However, in DSR, learning is expected to emerge from searching for available means to reach desired ends, with little concern about the participation of people. The method supports abstraction and innovation but encourages little focus on issues from a use context. As shown in Figure 14, the focus of the relevance cycle is to develop solutions (not research) to relevant business problems. This guideline fails to address the principle of multiple interpretations: How do different subjects that are involved in the situation interpret the problem situation? As we discussed in Chapter 3: Section 3.4, the idea of user participation is central to PD research. We cannot solely focus on technological solutions because the artifact has to be understood as part of a context. Understanding that context requires engagement with the (potential) users of the artifact. Design is, essentially, deliberate change brought about by conscious action and participation in a design discourse. Researching such a discourse may well include participating in actual design activities. In this case, PAR enables us to socially construct problem situations and solutions through interaction between researchers and participants.

PADR recognize dual processes by generating lessons from designing a specific solution to a problem encountered in a given context. The reflection-in-action is based upon what has been learned, whereas the evaluation of tech

nological solutions is based upon the creation of knowledge embodied in an artifact. For instance, designer-researcher and participants may iterate back and forth through mutual dialogues to generate incremental suggestions for social-technical processes and outcomes. Again, the iterations can be incrementally conducted to formalize learning outcomes, where

the iterations may be one too many. In my reflected PADR, learning is viewed as embedded outcome and not as a separate stage or phase of activities.

*Fourth***,** (P) AR and DSR differ when it comes to *generalizing research outcomes*. In the case of PAR, reflection and learning allow a researcher to make both a practical and theoretical contribution. As discussed in Chapter 3: Section 3.4, situated design and interpretation of the context as a cultural context have become concerns. For instance, DSR must provide verifiable contributions in the areas of design artifacts, design constructs, or design methodologies (Hevner et al., 2007). Again, based on a pragmatist perspective, design research needs to show particular sensitivity both at theoretical and contextual levels. As we discussed in Section 4.1, Dewey (2007, p. 5) stated that pragmatism is an extension of positivism, but with a fundamental difference: "(a) It does not insist on antecedent phenomena, but on the consequent phenomena; (b) It does not declare the precedents, but on the possibilities of action." Due to the contextual nature of PD, Puri et al. (2004) noted "there is no single cookbook best practice regarding PD in an information system which applies to all situations." This indicates that DSR needs to address possible contradictions that could arise from theoretical preconceptions guiding the design research and socially grounding the design process and outcomes.

In PADR, the analysis and presentation of empirical data collected through the design process are largely influenced by the research problem, theoretical perspective, and research strategies (Creswell, 2013). Reflection and learning allow a researcher to make both a practical and theoretical contribution. Lesson learned could also be design theory derived from a process of designing a specific solution to a problem encountered in a context. Thus, at various levels of the PADR process, learning in various forms (eg., local practice, ways of collaboration and participation, specified needs, identified features of artifact) is required.

In summary, all the above discussion clarifies the need for combining PAR and DSR into PADR. Bilandzic & Venable (2011,p.9) organized PADR into phases (stages). The PADR process starts with diagnosis and problem-formulation activities. The second phase stresses participatory planning activities together with target stakeholders. During the third phase, PADR is concerned with the actual design of a technological solution. The activities in this phase underline PD and prototyping followed by conducting usability evaluation in a real-world setting. The overall goal at the fourth step focuses on assessing interventions together with researcher and stakeholders to redefine actions. The fifth step highlights reflection and learning with and for the people involved in the research project. Finally, the authors suggested the knowledge generated through the PADR method could be formulated and delivered as

design theories for Urban Informatics (UI). This research method is only defined in the paper but not empirically implemented or evaluated.

Although the authors carefully analyzed and outlined the PADR research method, there is also a point that needs redefining to fit and reflect the experience with PADR in this study. First, the reflection and learning are formalized at the last phase (Phase 5) but not formulated to iteratively generate knowledge throughout the PADR process. During the PADR in this study reflection underpinned the whole research process. Based on principles of Scandinavian PD research, reflection and learning require the engagement of the designer-research with stakeholders in a reciprocal space during the early design activities of the research (Gregory, 2003). This indicates that an iterative process from the beginning is required while acting overlapping activities. Finally, drawing from some of the foundational concepts of PADR(Bilandzic & Venable, 2011) and my reflections, Chapter 5 presents a detailed account of my research design and activities. Specifically, Section 5.1 describes the group of interwoven activities, with a tight feedback loops.

4.6 Summary

Here, we highlight again a few points as a stepping-stone to the next chapter. In response to my areas of concern in ICT4D/A, a paradigm of pragmatism has been chosen. The three core ideas of soft systems theory were discussed to further clarify the nature of the reality and the systemic process for understanding a complex real-world problem. The culture concept was discussed as an additional theoretical perspective to facilitate an in-depth outlook from a rural community. The need for the purposeful investigation of aspects of culture is both to understand the context and inform the other component activities of this research. To reveal knowledge and learn about that reality, the importance of a course of action where theory originates out of practice and is then reapplied to practice is also argued. All these considerations led this researcher to argue for the type of epistemology selected for use in the study. Again, the PADR method has been developed based on pragmatic epistemology. There remains a third component of the research approach, namely, methodology. A plan of action with mixed methods will be discussed in Chapter 5. This includes detailing the methodological framework, which encompasses further description of PADR, the people involved, empirical data collection, and analysis methods, among other aspects.

PART III: Action and Design Research Process and Empirical Findings

5. Research Methodology

As discussed in Chapter 4, a research paradigm encompasses three significant components: paradigm stance, theoretical underpinnings and methodology. We recognize the problem context as a complex system in which actions, design, and reflection are required. Interaction, negotiation, and understanding practices with people under study using both qualitative and quantitative methods were adopted. As previously noted, this requires a systemic (holistic) understanding of the context and design intervention to achieve research objectives and practical outcomes (Checkland & Haynes, 1994). To this end, the theoretical background that combines a systemic inquiry of both action and thought was justified in Section 4.5. Now, we discuss methodological issues of specific concern and present the research design and empirical data collection in connection with action and design activities.

We constructed a methodological framework that meets the needs of community-based PD research. As discussed, several scholars have already attempted to combine (adapt) AR and DSR methods. For example, Cole et al. (2005) demonstrated the action design research (ADR) method by interweaving the two and letting them inform each other. Similarly, Bilandzic and Venable (2011) combined both to appropriate the relevant technology in an application domain consisting of people, socio issues, and technical systems. Scholars such as Sein et al. (2011) provided methodological guidance on ADR, recommending the coupling of research and design activities. All of these studies have provided excellent insight into how to organize (P)AR and DSR cycles, although they follow relatively different phases or cycles.

In light of the above, the research methodology presented here is underpinned by my reflections on bridging research and community problems. The first pillar of my research is PD, which I have introduced already in Chapter 3: Section 3.4 and Chapter 4: Section 4.5. I used PD both as a mindset and as a technique to carry out my community-based PD research. Through PD research, I envisaged involving local people for collaborative action, taking care to ensure that solutions meet user needs. The second pillar of my research methodology is AR to guide the process of working with an actual community to produce new knowledge and develop theory through reflective practice. AR has two strategic functions in my study: (a) It is used to understand local practice and identify preferable interventions; (b) It encompasses a string of action and reflection to inform designing artifacts. Thus, I reflected on the design process and outcomes from the viewpoint of broader socio-technical phenomena around the community-based ICT intervention. The third pillar of my research method is DSR, which deals with the making of design artifacts. Strings of design artifacts were used to convey an

agenda or to obtain knowledge about technical solutions and issues in relation to the context. This, in turn, was used as a means to better understand the use-oriented issues.

a flexible and reflective research method, PADR, was adapted for this study. To understand the interplay between research activities, design activities and the process of obtaining empirical data, I was also inspired by ethnography studies (Sharp, Dittrich, & Souza, 2016; Blomberg & Karasti, 2013). Here, both my active engagement and the design process were influenced by a series of choices that I made along the way.

In light of the above, this chapter is organized into seven subsections. In Subsection 5.1, the research design and associated activities are discussed. Subsection 5.2 provides a detailed account of empirical data collection techniques, which, in turn, elaborate the research activities mentioned in Subsection 5.1. This Subsection also provides a chronological order of events and outcomes (results) in a time frame of between 2014 and 2016.Subsection 5.3 presents some of the people involved and their roles in the study. Section 5.4 highlights a project timeline that indicates several events to provide alternative perspectives. Subsection 5.5 presents analyses of empirical data that were collected based on research and design activities mentioned in Subsection 5.1 and techniques specified in Subsection 5.3. In Subsection 5.6, the overall trustworthiness of the research process concerning empirical data collection and analysis are discussed. Finally, a summary and reflections on the research methodology are highlighted in Subsection 5.7.

5.1 Research Structure and Activities

It was challenging to represent my research activities according to (P)AR and DSR activities. Initially, in 2014, I formulated my research method with DSR. Later on, I came to understand that DSR lacked strategies to understand practices such as collaboration with the target people to generate knowledge from practice. In October 2014, I attempted to combine AR with DSR , which was the second version of my research method. While preparing to enter into the community context, I again encountered the limitations of ADR. For example, the role of ethnographic study and establishing trust relationships with community people are not supported by ADR. This attempted revision of my research method as depicted in Figure 15 to include the principle of PD research. This version has three interrelated component: AR, PAD and artifact development. Although it appeared working in the beginning, I was supposed to participate in community work, establishing relationship, as an agent of development, which was beyond my plan. This in turn forced me to rearranged the my research activities (see Appendix G: versions of my research methodology).

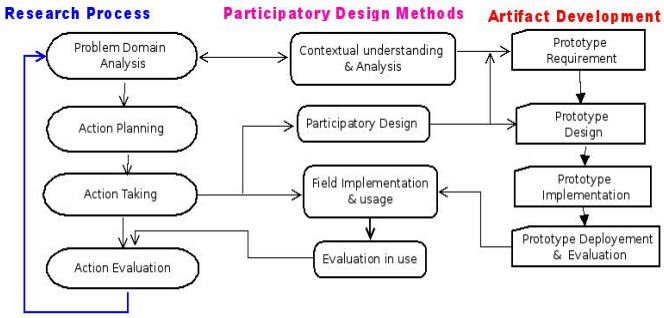

Figure 15 : My research method when entering into the field(November, 2014)

Finally, due to the need for several overlapping (parallel) activities, my research process did not involve a sequence of phases or cycles as outlined by Bilandzic and Venable (2011). Specifically, reflection-in-actions were carried out at every stage, not just during the last phase. My research method also borrowed insights from previous ADR studies (Sein et al., 2011). The research structure encompasses four interwoven components or groups of activities, which are labeled I, II, III, and IV. In other words, *Activities-I*, *Activities-II, Activities-III*, and *Activities-IV* are used to present the overall skeleton of the research process, with back-and-forth feedback loops. The results obtained from one group of research or design activities inform the other groups of activities. Figure 16 depicts the interleaved groups of activities among the four components. For the sake of simplicity and readability, the discussion here is limited to the overall structure of the research activities and processes. However, the detailed empirical data collection and analysis methods applied in each group of activities are presented following this section.

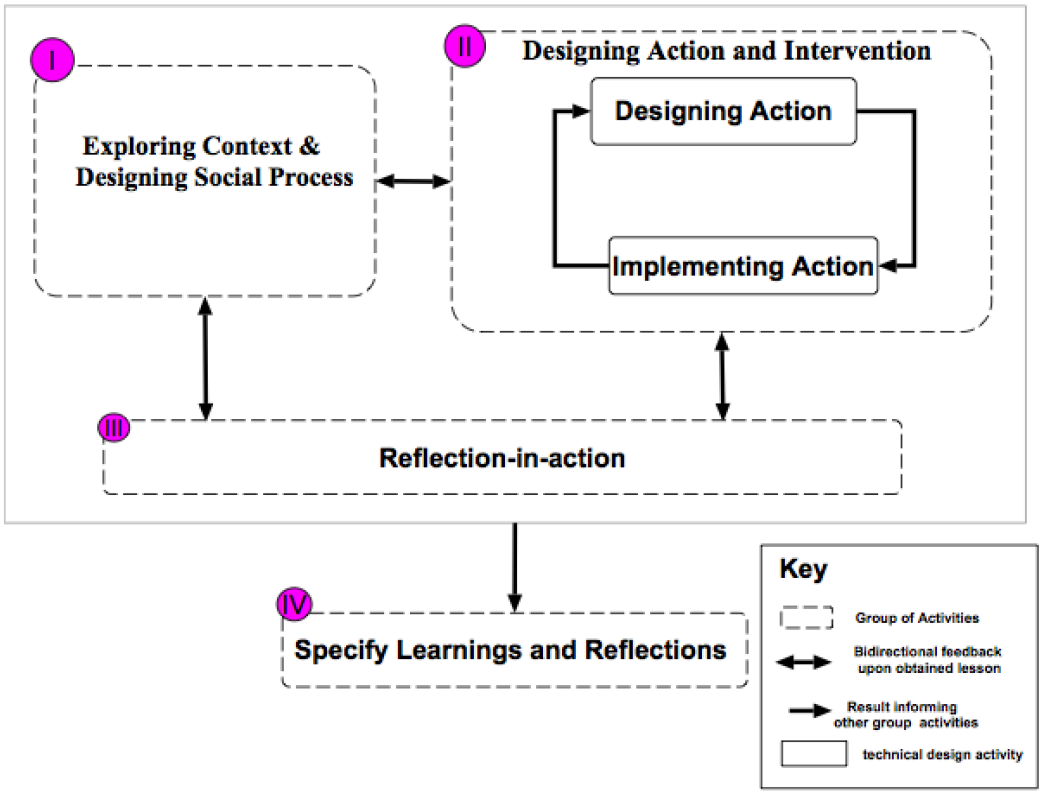

Figure 16: Research design and activities

5.1.1 Activities-I: Exploring Context & Designing Social Process

Exploring Context & Designing Social Process' refers to groups of activities that correspond to understanding the situation in terms of community social characteristics, culture systems, and other aspects. The groundwork positioned the overall research path to seek an intersection of social problems and technological opportunities. Drawing from action research principles, establishing collaboration with intended beneficiaries is required (Davison et al., 2004). This includes defining the roles and responsibilities of the researchers and the people of the local community. Developing shared understandings about problems to be solved and how a community could be engaged as collaborators rather than subjects was given due attention. A detailed empirical data collection method and process will be presented in Section 5.2

The results obtained from the Activities-I were purposively used as an input to inform the other research component, *Designing Action and Intervention (Activities-II)*. As shown in Figure 16, the arrow that points from Activities-I toward Activities-II indicates that the result of Activities-I makes the necessary preparations for the next research activity. Furthermore,

the research process was not a one-time investigation; rather, it involved iteratively understanding the social practice, issues, and opportunities. Based on the notion of PD, action and intervention should be designed and implemented democratically and inclusively. Motivating and sustaining community participation, managing conflict and politics among the community leaders, and conducting various awareness-creation sessions were carried out throughout the design process. Again, all these groups of activities were carried out under Activities-I. Once the problem was investigated during the Activities-I and reflected on during Activities-III, the result for scoping the problem space for knowledge creation was presented. In Figure 16, this is indicated using a bidirectional arrow that connects Activities-I and Activities-III.

5.1.2 Activities-II: Designing Action and Intervention

The second group of activities was a tight loop between envisioning and creative design of alternative solutions through iterative feedback loops. Major tasks resembled those of *Action Taking: Design* (Bilandzic & Venable, 2011) or the *Building, Intervention, and Evaluation* (BIE) activities of Sein et al. (2011). This phase involved participative design, prototyping, and usability evaluation. Participants were kept actively involved by using several PD techniques that kept participants in particular and community people in general actively engaged in communicating ideas.

This group had two more core sub-activities: *Designing Action* and *Implementing Action*. *Designing Action* is important in that the participants are involved as co-designers of the action, starting from validating the problem to evaluating alternative solutions. PD literature has several techniques and tools for communicating and collaboratively working toward a shared solution. However, we are already aware that user participation and techniques for carrying out design processes need to be adapted to suit the diversity of particular social, cultural, and political contexts (Winschiers-Theophilus 2006). We focus on what kind of PD techniques could be applied to engage community people in the design process. Thus, adapting PD techniques was part of the investigation (see Section 5.2.4).

Implementing Action encompassed a group of activities to facilitate the envisioning of design alternatives, designing prototypes, as well as preliminary testing. We progressively prepared participants to gather an understanding of existing and future conditions through a technological probe that involved designing prototypes. When the original design goals were not met or new problems arose from the technical introduction, the design process iterated back to an early design. Here, learning through action and reflection is a part of the design

process. We attempted to arrive at an interpretation or understanding of the phenomenon and the design of the artifact. They are the two sides we understand the dual nature of creating artifacts and interpreting phenomena. As can be seen in Figure 16, the bidirectional arrow between Activities-II and Activities-III indicates that designing artifacts and the knowledge generation process were performed through continuous reflection-in-action.

5.1.3 Activities-III: Reflection-in-action

To obtain a thorough understanding of the community context and to effectively design participatory spaces, I engaged in the activities as a reflective researcher. I reacted to some events at the time they occurred before proceeding to other activities. This was carried out purposively because setting up a community-based PD project in a remote rural community was a complex task. Here, the group of activities was accomplished by means of an iterative process of data collection, reflection, and interpretation to make sense out of everything. It was a continuous process in which research activities affect the results this in turn affected the research activities. Reflection-in-action on Activities-I focused on lessons learned during data collection, the design process, and participation, whereas the reflection on and evaluation of technological solutions is based upon the creation of knowledge embodied in an artifact. The reflection-in-action continuously informed this step. Before deploying the designed intervention, the formative and summative evaluations were carried out, followed by deployment of the prototype for public use or pilot evaluation. Due to time constraints due to attending Ph.D. courses and other unfinished academic activities, a final summative evaluation was not actually carried out in the field. Instead, users' statistics and exchanged messages from the server computer were analyzed.

Activities-III recognized a dual process whereby community-based PD research was not only considered to solve community social problems but also seen as a way of creating knowledge. As the community-based researcher, I attempted to generate knowledge by emphasizing community problems as a knowledge-creation opportunity. Activities-III was centered on both Activities-II and Activities-I with the aim of specifying local lessons and findings. This, in turn, prepared the foundation for a path in Activities-IV toward conceptualizing and ensuring the transferability of local learning for a broader class of problems.

5.1.4 Activities-IV: Specifying Learning and Reflections

The final group of activities, Specifying Learning and Reflections: Activities-IV, focused on abstracting knowledge (learning) to make a practical and theoretical contribution.

The analysis and presentation of empirical data collected through the design process was largely influenced by the research problem, theoretical perspective, and research strategies. As can be seen from Figure 16, the results of Activities-IV are informed by the empirical data collection during Activities-I and Activities-II and supplemented by the reflection-in-action of Activities-III. Here, we outline the overall accomplishments from the community-based PD outcomes to formalize learning.

To organize transferable lessons from local learning, an inductive step similar to that suggested by Lee and Baskerville (2003) was followed. The two building blocks for specifying knowledge transferability are empirical statements and theoretical statements. The transferability of knowledge from empirical statements to other empirical statements involves descriptions of local insights including issues and opportunities, whereas, transferability of knowledge from empirical statements to theoretical statements is focused on describing interrelated themes and relationships as a theoretical model. The resulting theoretical statement encompasses ICT4D issues and relationships that account for actions while designing community-based technological alternatives. Furthermore, we refer to the discussion of the role of theory (Gregor, 2006) in Chapter 4: Section 4.1. Based on these resources, the learning from the design was framed to yield both explanations and prescriptions.

Before concluding this Subsection, let me also highlight the connection between Chapters 5 and 6. Chapter 6 presents a full narrative of the research activities and process. The different kinds of activities were extremely intertwined, both in process and results. For example, difficulties in progress with establishing the community knowledge center (CKC) were discussed in a private meeting with supervisor, which in turn resulted in developing understanding of evolving ownership specific access to use as they unfolded overtime. Each of the section in chapter 6 consisted of a series of iteration through activities-III.

Similarly, investigating user participation in collaborative design and refining user needs (designing features of the technical artifact) continued all the way from the beginning to the end. Again, my reflection-in-action at different levels is not only reported in the narrative but also influenced particular actions in certain situations. Throughout this activity, I was involved in several actions to improve the level of community empowerment in collaboration with key actors or community people. Outcomes from implementing reciprocity shaped both the outcome of the design process to revise the initial local problem and designing the prototype. The iterative reflection and learning based on a broad source of inputs and

accomplished tasks were used to address a newly identified issue. To this end, Chapter 6 presents both the social and technical processes that, in turn, consisting of Activities-I, Activities -II and Activities-III.

5.2 Empirical Data Collection

This section details the research activities and the interwoven process discussed in Section 5.1. As a student working as a community-based PD researcher, I was primarily responsible for empirical data collection as well as documenting and designing the intervention. I followed an iterative data collection and analysis strategy, moving back and forth between the social and technical design processes, and reflected on the final analysis. Engagement with the community resulted in several empirical data collection techniques, such as visiting and walking in the villages, interviewing key informants, and collaborative design workshops. Attending community meetings and discussions with community leaders also strengthened my understanding of the context. Detailed data collection techniques are presented below.

5.2.1 Meetings and individual interviews

This technique was selected to create opportunities for sharing and comparing knowledge on a focused topic to look for options. As part of my role, I held several meetings with people within and outside the community throughout the project lifecycle. I had both formal and informal meetings that were either arranged in advance or ad hoc. A multilevel community meeting or focus group discussions were held with community leaders, the kebele chairperson and committees, youths, and social group leaders. Meetings with people outside the community were also held, such as with Adama Science and Technology University officials and five computing department staff. The main aim of this meeting was to involve a university unit in supporting the establishment of a community knowledge center. Likewise, a meeting was also held with the Ethiopian Telecommunication Corporation to look for possible ICT infrastructure support for the study site. In total, 12 formal meetings were conducted within and outside the community. The empirical data were documented as field notes, photos, and some audio recordings. A detailed description of events within their time frame is presented in Table 12.

5.2.2 Survey using questionnaire

The actual study activities started with understanding context through a pre-study. A questionnaire (see Appendix B: Survey Questionnaire) was designed to collect data such as

sources of agriculture information for farming, current practices of information gathering, attitude and behavior toward modern agricultural practices, extent of technology uptake, and existing familiarity with and usage of mobile phones. Prior to the field studies, I collected relevant data on the possible study areas, and then we selected Hetosa-woreda as the study site. The term *woreda* refers to the second lowest-level government administrative area of Ethiopia. This woreda was purposively selected because it represents the majority of Ethiopian agricultural areas. When choosing this site, we took the availability of ICT infrastructure and transportation services into account. A total of 110 randomly selected farmers were interviewed within three months, from February to May 2014. The data from the questionnaires were analyzed with descriptive statistics. The analysis results are presented in different chapters and sections (see Chapter 2: Section 2.5, Chapter 6: Section 6.3, Chapter 7: Section 7.4).

5.2.3 Ethnographic field study

In empirical research, ethnographic methods can provide an in-depth understanding of the socio-technological realities surrounding a given context or practice. For example, Sharp, Dittrich, and Souza (2016, p. 9) explain the roles of ethnographic study to strengthen investigations into social and human aspects for designing technological solutions. Specifically, the authors state that ethnographic study "can expose mechanisms used to make things work, explicating practices that may be shared, explanations that allow key activities and potential problems to be detected early." In our case, an in-depth understanding of the context was attempted by immersing the researcher in the rural community to gain an insider's perspective (e.g., describing from the members' viewpoint). Thus, the phenomena being studied were placed in a social and cultural context to provide rich data explaining the situation.

To develop relationships with local community members and to build long-term connections, I attended community meetings and participated in community work sessions, such as construction of a fence at a farmer-training center (FTC). Another aim of this participation was to gain in-depth access to issues of the community. Sometimes, the field studies were purposively carried out in the form of participation in activities to discuss local matters informally rather than in a formal interview or through observation. Here, my understanding of the context was based on my active engagement, which influenced a series of choices that I made along the way. For example, local cooperative practices and key social actors in community settings were examined. The role of key local actors as well as collective

resources and their administration practices for PD emerged as a result of my experience in the community. Reporting on an ethnographic field study calls for detailed description, analysis, and interpretation of a narrative form. Thus, my observations and lessons during field visits were documented as field notes, photos, and audio recordings. The analysis results are presented in different chapters and sections (see Chapter 6: Section 6.1, Chapter 7: Sections 7.1–3)

5.2.4 (Design) workshops

Design workshops were the fourth and most important activities resulting in empirical data. Together with selected community members, a series of collaborative workshops were conducted to strengthen further understanding of the context as well as to identify the primary needs of and barriers to agriculture information in the community. The first workshop was conducted at an FTC with a few community leaders, including a DA, to identify who should participate in the workshop. Initially, it was planned to select representatives from each gere (sub-village), but as the farmers' settlements are scattered, it was difficult to conduct regular workshops. A total of 23 participants from one village were selected for the design workshop.

Figure 17: Participants during a design workshop

Based on the lesson from Subsection 5.2.3, we organized the PD workshops in line with a cultural participation practice. The community sociocultural cooperative practice locally called *Wenfel* was chosen as a means of active community participation (see Chapter 6: Section 6.1). The participating farmers promised to attend meetings regularly, participate actively, and have discussions with their neighbors to collect different perspectives; in return, they expected to see the final project result used in the community. In addition, they also requested that one of their children receive ICT training once a week for about an hour. To organize a group meeting that is informal enough for people to discuss problems and to further

adapt the PD workshop to the local traditions, an Ethiopian culture of the coffee ceremony was arranged.

Table 12, presents a chronological order of events and activities during empirical data collection. The blue (Color) activities in this Table describe the PD workshops, intended purpose and outcome. A total of 11 (design) workshops of two to three hours duration were conducted. One day before each workshop, I offered ICT training to community children. This was also used as a means to create awareness of ICT use and to build community capacity. I also came to understand that teaching children became a means to remind their parents to attend the next workshop.

To identify needs, rich data or narratives about the intended users' situations were collected and various PD techniques adopted. These included storytelling, future workshops, mockups, prototypes, scenarios (Bødker, Kensing, & Simonsen, 2009, p. 198), card sorting, metaphors (Cooper, Reinmann, & Cronin, 2007), and technological probes. We were aware that PD techniques would need to be adapted to the cultural context (Winschiers-Theophilus, 2006). We attempted to redefine and culturally adapt PD techniques and processes throughout the study. Before starting the next workshop, experiences from the previous workshop were analyzed and used into the next activities.

The design of technical artifacts broadly included basic functions and user interfaces. The technological probes or prototypes were devised for the people to understand and be able to experience how the final system would look. The prototype-design activity was done in two steps, namely, low-fidelity and high fidelity prototyping. In the former case, people participated in the design process by using paper prototyping and other design methods. In the second case, the final paper prototype and mockup results were mapped onto a technical implementation, but users were still involved in the design process as they were allowed to make comments on the finished high-fidelity prototyping. Here, the activities included undertaking several activities that worked toward the implementation of the planned action (e.g., a group and/or peer-to-peer-based social media system). Feedback was used to define and redefine the requirements of the systems. I reflected on the lessons learned and issues encountered to generate knowledge from that design practice. The lessons learned from each design workshop were documented in the field notes, including pictures and audio recordings. A detailed narrative, including sets of actions and reflections on actions, will be described in Chapter 6.

Table 12: *Chronological Overview of Events and Illustrative Activities*

Interview | Meeting | Field Visits (Ethnographic) | PD Workshop | Pilot study

Events	Purpose	Description of events or activities and PD techniques	Key outcomes / lessons	Key Participants/Actors	Timeline (month & year)	Empirical Data
Interview-(1-3)	Identifying key stakeholders and their stakes	Used to understand government priorities in agriculture sector, ICT for agriculture policy identifying. Semi-structure interview was conducted	Key stakeholders, interdependency and systems boundaries were described	Development agents(DA), woreda agriculture extension Expert (WAEE), Ministry of agriculture(MOA)	Feb-Apr., 2014	Field Notes, Audio
Interview-***(survey)**	Pre-study	A preliminary study with structured interviews. A printed questionnaire was prepared and three DAs trained to collect data form selected rural community people (110)	The responses were complied and documented	Community Peope	Feb-May, 2014	Filled Questionnaire
Meeting -1	Collaboration with WAEE	A First collaboration stared at woreda agriculture extension office (WAEE). This office is relatively a lower government body that works directly with farmers. The agriculture extension expert is the next higher position (rank) compared to DA	One expert was involved in site selection, proving documents and participates in a few community meeting and design workshop.	WAEE	Jan, 2015	Field notes
Field Visits (Ethnographic)	Ethnographic study	An in-depth situation assessment was conducted for identifying community's strengths, opportunities and values towards establishing relationship	Relationship establishing, local opportunities such as participation practice, key actors were identified	community people in general	Jan-Mar, 2015	Field notes, Photos
Meeting -2	Establishing collaboration with FTC administration	I aimed to understand what structural conditions and open dialogue needs to be established for this study. The initial researcher agenda was introduced at a wider *community meeting*. Here, I engaged in the social practice both as a participant in the situation and as a researcher of the situation.	Awareness creation at a community gathering, and community representatives for the upcoming design activities were handled.	Community peopl, DA, WAEE	March, 2015	Field notes, Photos
Meeting -3	Selecting trusted community facilitator	Sought to integrate local efforts (local facilitator) into larger networks of power and politics. Two politically elected community leaders who act as community gatekeepers were selected as local coordinator	I was involved in several actionable activities where I influenced processes based on my previous community and theoretical understanding	Community leaders	Mar, 2015	Field notes, Photos
Workshop -1	Storytelling workshop	Storytelling was the first intervention workshop keeping in mind the response from the per-study and preliminary finding of the ethnographic study. I assumed that a storytelling technique encourage people to express themselves with their own terminology, enable open and spontaneous reactions. Participate were asked to tell us one good and one bad story. Here, the main purpose of this workshop focused at two points. First, to gain insight into storytelling techniques (the research focus); Second, to understand community practical issues by involving them early in the design process.	My role as a researcher was to make sense of the workshop session and to generate lessons. I reflected on the limitation of storytelling techniques and then started read other techniques from participatory development (Chambers, 2002) including future workshop	Community Peope, DA, WAEO	April, 2015	Field notes, Photos
Workshop -2	Collaboratively conceptualizing community issues	Following lesson from storytelling session, the future workshop was adapted. Here a tree metaphor, and agriculture season as a calendar were used to redefine procedure future workshop. Again, the focus was to understand how local people could be involved to describe practical issue and their needs in a structured manner. Three groups with one skilled facilitators were formed for discussion	Initially, I have assumed that market information is the one that farmers were frequently looking it (pre-study), but in the ground, they only need in December and January. Clustering issue in different timeline through the adapted future workshop simplifies eliciting issues or concepts into people needs	Community People	April, 2015	Field notes, Photos
Workshop -3	Inspirations & motivational conversation	The focus was to study the influence of inspiration and motivation conversation as techniques to fine-tune issues and needs. As it was the first time that people were exposed to the ICT based solution, clarifying the real world experience and ICT possibilities was necessitated. Videos and photos from selected ICT4A initiates were demonstrated. And then, a rich picture of people views, attitudes and values for their daily practice were discussed	Inspirations and motivational conversation encompasses practicality that is relevant to affect two processes: Firstly, inspiration can influence people's views of experienced reality. Secondly, it informs designer-researcher to develop design ideas after being inspired by target users. Again, '*Future workshop'* is redefined.	Community Peope, DA, WAEO	April, 2015	Field notes, Photos
Meeting 4	Sustaining and negotiating term of participation	The expected numbers of people were not attending and became an issue. A discussion was held with selected participants.	Attention moved from participation towards people empowerment. In-kind incentive (teaching ICT for kids) incorporated in the next design process	Community Peope	May,2015	Field notes

Events	Purpose	Description of events or activities and PD techniques	Key outcomes / lessons	Key Participants/Actors	Timeline (month & year)	Empirical Data
Meeting 5	Meeting with kebel administration	A decision to establish to the CKC only at one village out of the three brought another areas at kebele administration. Again, this demanded an approval from the kebele committee not only to proceed but also to bring used computer from ASTU. In fact, the chair person pointed bad experience from a pervious ICT intervention	Stories from previous ICT intervention were reconsidered towards the role of Edir judge and administration.	Chairperson, Community leaders and DA	May, 2015	Field notes
Meeting -6	Aligning incentive model	Once teaching ICT for community youth was agreed as incentive for participation, in direct beneficiary of the initial design outcome community children (12-16 age) were involved in separate session. Again who should get training, who collect the service fee, who should handle the room key was sorted out	Later on, youth were used as a reminder of their parent to attend the next workshop. They were also played intermediary in awareness creation within the community.	Community youth,and Community leader	May, 2015	Field notes
Meeting 7	Sustaining relationship & commitment with Edir Leader	After the meeting places was shifted from the farmer training center (FTC), it was a necessary condition to selected one key leaders from the small village who act as a leader of the informal institutes (Edir Judge). However, the difference in power and agenda between community leaders and Edir judge became another issue. Particularly who manages design outcome and CKC	A community meeting for collective decision was arranged by Edir judge. Again, the role of the community leaders was very productive	Community leader , Edir Judge	Jun, 2015	Field notes
Meeting -8	Involving ASTU and its staffs	Here I established a link between ASTU (unit) with community people needs. For example, computing staffs to provide training for the community youths	Linking University resource and agendas to community needs supplement researching and solving practice at the same pace	ASTU staffs	Dec, 2016	Field notes, Photos
Workshop -4	Envisioning (Fantasy)	The main focus was to prioritizing needs and translates people expressions into general requirements. The known needs and identified strengths from the inspirational and motivational conversation were a basis for the vision of the system. The issues centered at how could users validate their needs at the early stages of the design process.	Some ambitions of local people may not relate with ICT based services. Core community needs were translated into concepts and focus shifted from appreciating opportunities to the designing a lower level description of requirements.	Community Peope,	April, 2015	Field notes, Photos
Workshop -5	Business model analysis	The main objective was to acknowledge the difference between what actually exists and what could exist. Three different design ideas were discussed. a) Farmers' shop center b) FTC- based service c) community-owned information center. One of the core issue was addressing financial sustainability	The third option found to be used as a hub for awareness creation and capacity building. Thus, two alternative were proposed: Low-end and high-end technological alternatives	Community Peope,	Mar, 2015	Field notes, Photos
Workshop -6	Collaboratively specifying requirements	The objective of this workshop was to refine the people's positive future and to help the participant to expand their perspectives to unaware needs. Lesson from the envisioning and inspiration workshops was a basis for requirement specification. A scenario was used as stimulus material to set the participants into stories from their everyday life	One core lesson was that to continuously reformulate the problem definitions and design ideas as more understanding of people and their situations gained. Concepts refined to a list of requirements (fifteen functionalities)	Community Peope	Jun, 2015	Field notes, Photos
Meeting -9	Understanding Etho telecom Service	A discussion was made with Ethiopian telecommunication (Etho-telecom) service provider. Some of the agendas were focused on mobile telephone (2G/3G/4G) coverage, mobile device operating systems, subscription and service cost	The Telecom subscription cost such as Internet and SMS gateways are expensive (eg. SMS gateways costs 88USD /month only for subscription)	EthioTelecom	July, 2015	Field notes
Workshop -7	Designing information flows	The community source of information and social site among the key actor was discussed. The community is a not a homogenous groups rather categorized by different social groups and their practice of getting information depend on the community social practice. Here, the investigation process focused not to replacement face-to-face information sharing practice with ICT service but to support the existing communication practice.	Community people have a strong traditional information-sharing approach and trusted relationships among social group. The three key community social groups and actors (DA, Model farmers, and fellow farmers) were used to match human-networks to virtual networks. At a later time, the first prototype, SM@SMS, was designed and evaluated which finally ended with only six functionalities	Community Peope,	Jun, 2015	Field notes, Photos

Events	Purpose	Description of events or activities and PD techniques	Key outcomes / lessons	Key Participants/Actors	Timeline (month & year)	Empirical Data
Workshop -8	Matching concepts with near by pictures	The aim of this workshop was to map agriculture concepts and identified needs to a nearby picture or icons. For each concept, three nearby pictures were prepared before the workshop day. Two group of participants were involved in interpreting nearly by pictures into its concept. The main purpose was to find the commonly understandable nearby pictures (icon) towards designing text free user interfaces. Match techniques were used to interpret concept to the nearby picture; Naming techniques were used to explain the nearby view to concepts	The on-going activity from one workshop or meeting to the next contributes knowledge. My reflections on that action prepare the stage for an actionable event in the next workshop or sessions. Each actionable situation has added to my research that in turn has contributed to actions. Finally, a list of nearby pictures were selected some revised	Community Peope, DA	Nov, 2016	Field notes, Photos
Meeting -10	Establishing Collective Ownership	In this workshop, the central point was addressing issues who will take responsibility on the final design outcome for a wider community use. Three alterative were investigated: DA, community leaders, and community social structure (Edir). Governance and the community structure and roles and power of key community actor were part of the agenda. In fact, this issue had been on air in previous meetings but sorted out at this workshop.	The ownership issue moved at three levels: from FTC to community leader and then to the informal (institutional) social structure (Edir). Even to convince 'Edir judge', series of empowerment and dialogs took placed. People response to an ICT base intervention can be influenced by how well it merges into their context and their activities.	Community leader , Edir Judge, DA	Dec, 2016	Field notes, Photos
Meeting -11	Physically establishing CKC	Following the open agenda in the previous time, a community meeting was held for collective discussed issue related. Specifically, who is responsible, who can use the CKC, commenter rooms, and operation cost such as electricity was discussed. The leaders of the sociocultural social grouping (Edir) facility the meeting for decision-making practices.	Relying on individual administration and a single source of finical support can be challenging for designing ICT intervention. Edir Judge took responsibility and ownership as their resource. This became an empowerment and capacity building at the later time study to address technological illiteracy.	All Edir Memebers	Dec, 2016	Field notes, Photos
Workshop -9	Designing Prototype & user interface	The workshop focused on refining requirements identified in the previous workshops. Mockups and a total of 28 printed picture cards, each representing one concept was given to the participants to group them into categories. Paper screens were organized to facilitate concepts of interaction across screens and arrangements of paper screens.	This resulted in building and evaluating a second technological alternative (M-CIH). Learning occurred in two processes: (a) an ongoing process in discussion in each design workshops and meetings (b) in my on-going research process while reflecting on the design process and design outcome.	Community Peope	Dec, 2016	Field notes, Photos
Workshop -10	Usability Evaluation	The usability assessment was not limited to the functionalities but observing evaluations in real-world settings with opportunities and threats. Feedbacks were collected at CKC from participants, others community people, and youths. The assessment differs from actual usability goals, it was concerned with how local people experience the technological solution from their perspective.	ICT service should be designed with the whole community in mind than single user perspective. In objective usability evaluation, ICT intervention is communicated with individual user. But user is just one in a community of people who will be affected by the intervention. The community is the best vehicle for spreading ideas and opportunities for a wider use.	Community Peope, Youth	May, 2016	Field notes, Audio, Photos
Meeting -12	Collaborative reflection at WAEE	The final summative evaluation and associated formative were carried out in the Woreda agriculture extension office. The main aim was first to collect their feedback second to strengthen their support in rolling out the pilot phase. The technological alternative was demonstrated to WAEO experts and other DAs	New functionality and new actors were reconsidered in SM@SMS prototype. The head of WAEO officially assigned one DA to support CKC and the pilot study.	WAEE, DA	April, 2015	Field notes
Pilot study	Deploying for community use	The working prototype (SM@SMS) was deployed for a wider use	We will not get our impact from the intervention right after deploying the intervention. Still, it needs developing a strong support system	-	Jul-Oct, 2016	Data from Server

5.3 People involved and their roles

We already recognized that conducting community-based PD requires contributions and participation from several local actors (Brewer et al., 2005; Thapa & Sein, 2010). I attempted to collaborate with local stakeholders from the beginning. My role as an action researcher on the project went through several variations; specifically, my role can be labeled as a student researcher, as a community helper (agent of development), and as a designer. Some of my typical roles centered on designing several actions for the implementation of the project, designing community knowledge sharing, and investigating the real-world problem situation that necessitated the project. My involvement with community members offered me the opportunity to access information, which I would not have gotten if it were researched in an experimental or ethnographic context. I carried out the study in close collaboration with several key local actors. Throughout the study, several people participated as informant, consultant, and as a co-designer in the design workshops. Table 1 shows those who were directly or frequently involved during the research period.

Table 13: *People Involved and Their Roles*

People Involved	**Description**
Community members	23 community members were engaged in the collaborative workshop session, providing their personal input and feelings with respect to the project. From a total of 669 households, men headed 82%. In our PD workshop, 20 men and 3 women were involved
Model farmers	They are members of their community who are usually considered as technology followers and trusted persons with respect to farming activities. There were 5 mode farmers from a total of 23 participants. Besides participating in the PD workshops, some of them played a role in establishing the community knowledge center.
Community youth	A total of 32 community children (ages 12–16) who attended the computer skills training, which, in turn, was used as the pointer to remind community members of PD workshop time. They also played the role of intermediaries in awareness creation within the community.
Community leaders	Politically elected community members who play a vital role in mobilizing and motivation to attend the PD workshop. They acted as local facilitators and community gatekeepers. Three community leaders played very pivotal roles throughout the research period.
Edir Judge	The leader of the sociocultural social grouping (Edir) who took responsibility for the community knowledge center. Responsible for the community knowledge center to be in place, including mobilizing members to contribute to construct a house.
Development agents	Development agents who took the facilitator role during the meeting at the farmer training center and meetings in the village center. They were sharing their community development experience and their work practices with the community farmers.
Agriculture extension experts	The lower-level government bodies that work directly with farmers, are involved in site selection, proving documents, and playing a facilitator role by attending some of the community meetings or design workshops. An Agriculture Extension Expert is the next highest position (rank) above DA

People Involved	Description
ASTU	Adama Science and Technology University provided ten used computers
Computing staff from ASTU	Five of the computing staff members from ASTU department of computing offered basic computer training for the community youths
Myself	I was working as a Ph.D. student, as a community helper, and as designer
Coffee service servant	One of the community women who refreshed the participants with coffee service

5.4 Project Timeline

This section explains the research process by viewing time as another dimension. It depicts the people involved, activities, and outcomes within the research time span (2014–2016). Most of the activities were carried out in an iterative manner, and a continuous feedback loop was part of the process. For instance, the pre-study (survey) and focus group discussions were part of the early activities. We contacted major stakeholders across the government administration hierarchy in the agriculture sector. These included local community people, development agents, woreda agriculture extension offices, zone-level agriculture offices, and the Ministry of Agriculture, among others. The analysis of the pre-study was further refined through ethnographic field study. Following this, a series of PD workshops and meetings were carried out to better understand the context and design of technological alternatives. The people involved mentioned above varied in their project participation timelines and their roles. Selected pictures (Figure 18) and a condensed diagram of events in a timeline (Figure 19) present another view of some of the research tasks.


Community meeting


Focus group discussion


Community youth at ICT training


Participatory problem investigation via problem tree


Paper prototype: a man

Figure 18: Pictures captured during the research period

The overall project activities that were performed during the study are presented in Figure 19. Each of the PD activities was designed to produce its own result and, at the same time, to be used as an input for the other events. The interconnected rectangles at the center represent the results of each PD activity. The outgoing arrow from each rectangle indicates that the output of the previous activity was used as an input for the next PD activity. As mentioned before, the empirical data is presented in several chapters. Specifically, in Chapter 2, the pre-study results are presented to clarify the research setting and motivation. In Chapter 6, the core PD activities and results are discussed. This chapter also presents use patterns after the designed technological alternative had been deployed for use. Finally, in Chapter 7, lessons from the PD process and results are organized to form transferable knowledge.

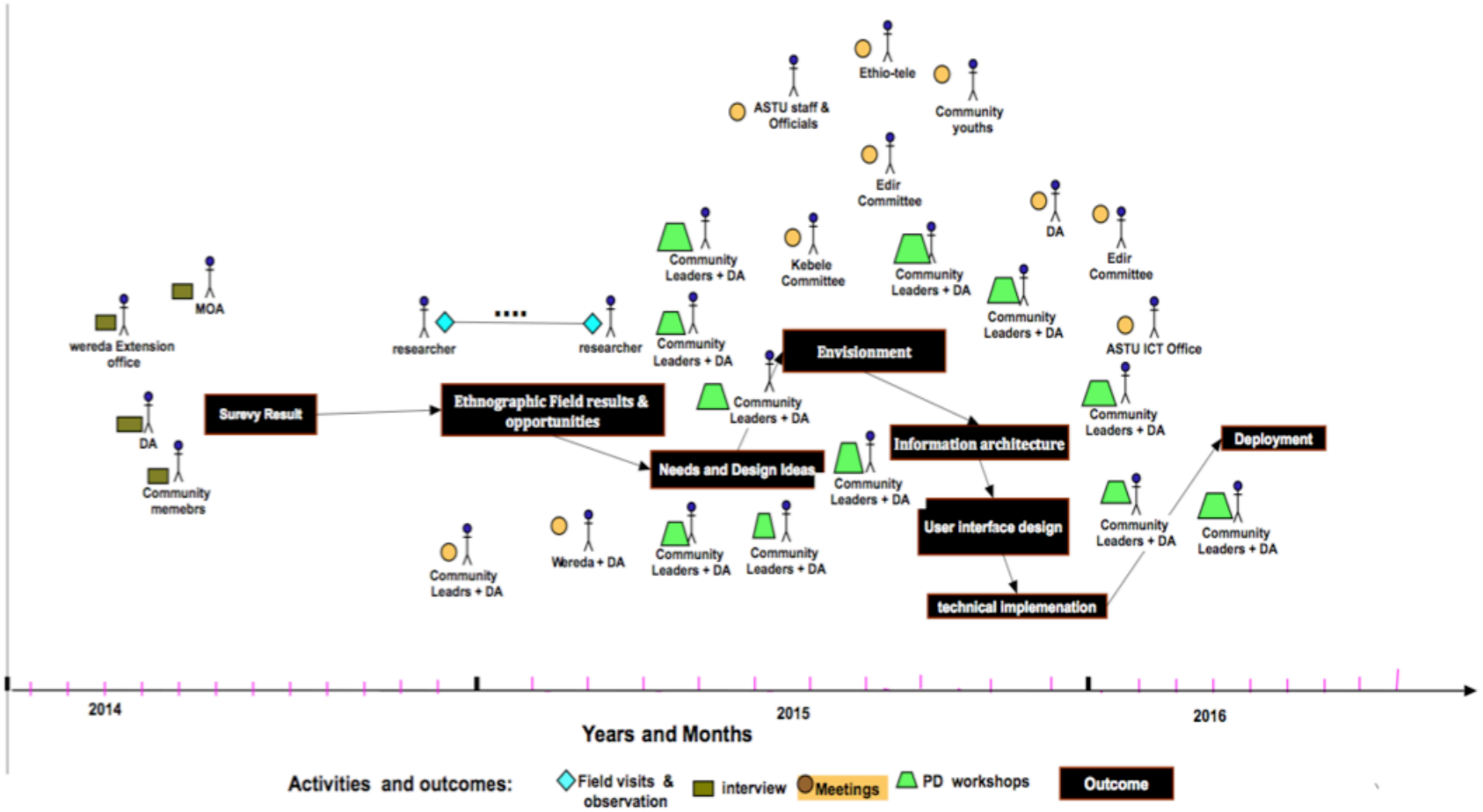

Figure 19: Project timeline by activities, people involved, and outcomes

5.5 Analysis of Field Materials

The field materials (field notes, photographs, and audio recordings) obtained while conducting the activities described in Subsection 5.2 were analyzed. We examined the research issues from different sides, compiling multiple interpretations obtained from pre-study, observations, field notes, and document and design workshops. This, in turn, was used to map our understanding of people and their social and cultural contexts to inform the design process. In interpretive research, theory is often considered to play a significant role in analyzing the empirical data and gaining insight into a social situation (Walsham, 2006). Specifically, following reflection-in-action *(Activities-III),* my early analysis of findings had been very much focused on a holistic understanding of the community context, identifying local opportunities, and exploring strategies (Robson & McCartan, 2016). In Figure below depicts two pages from my field notes when collecting stories about the community's sociocultural structure and practices. Specifically, this was collected during ethnographic study while people were describing the community's (self-help) cooperative practices. The core values that people attached to such practices and the underlying preconditions were analyzed.

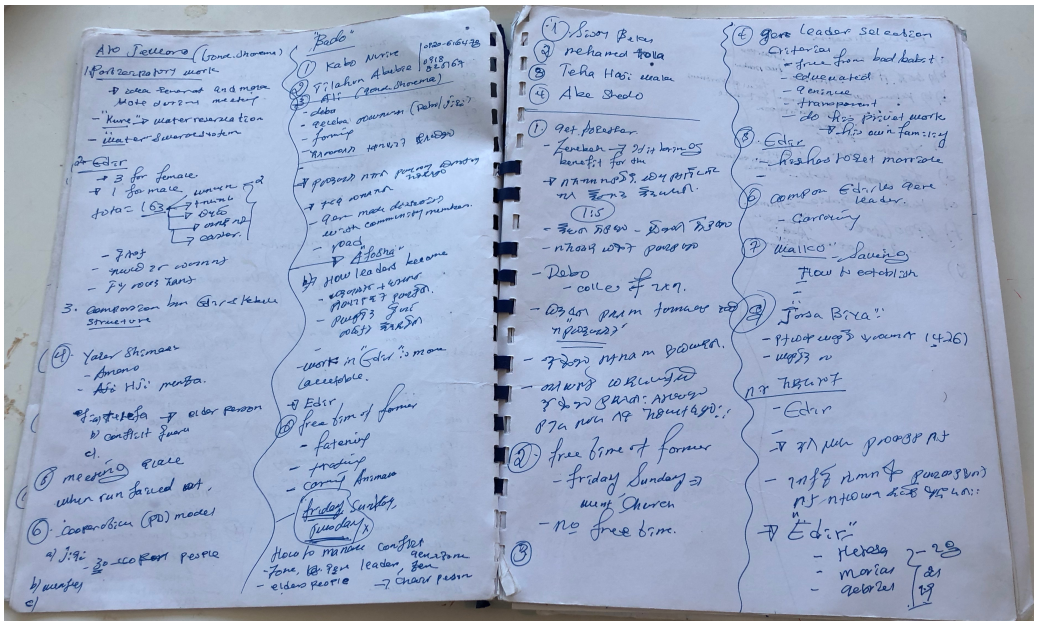

Figure 20 : Sample field notes

The emphasis on identifying and formulating context-sensitive strategies had significantly inspired me to look into how to approach community-based PD. To this end, I focused on sense-making as situations emerged and design processes were shaped. In a pragmatic research approach (see Chapter 4: Section 4.1.3), the research process itself relies on the researcher's pre-understanding (Creswell, 2013). This indicates that active engagement

and actions grow out of researcher experience, which is a cornerstone of ethnographic study. I sought to understand (analyze) the dynamics of social issues and technical solutions from the perspective of the participants within the community context. A pragmatist stance encompasses a course of action in which theory originates out of practice and is then reapplied to practice to create new practice (Creswell, 2013). Thus, analysis of empirical data started early in the study timeline. For example, the pre-study informed the ethnographic field study. The design processes, again, were informed by ethnographic field study and collaboration with community people. While discussing my community experience with my supervisor (via Skype), some of my initial themes were identified. For example, the role of sociocultural participation practice, the role of the community leader, ownership, and negotiating terms of participation were identified for further refinement.

To analyze the learning and reflections discussed in Section 5.1.4 (Activities-IV), we organized all the insights gathered from empirical data into a smaller set of common issues and themes. We conducted thematic analysis based on research documentation (field notes, photos, recorded audios). The relevant recorded audios of particular instances were also transcribed. The process of thematic analysis described by Braun and Clarke (2006) was adopted. The coding process started with the initial list of concepts, which was followed by continuous coding and recoding. The analysis of qualitative field materials was performed through a proprietary thematic analysis tool, namely, Nvivo. Figure 21 shows a list of top-level themes, such as the community structure and participation practice (e.g., community meetings, social groups, roles, and politics), ownership, stakeholders, technology, information sources, design processes, and local challenges.

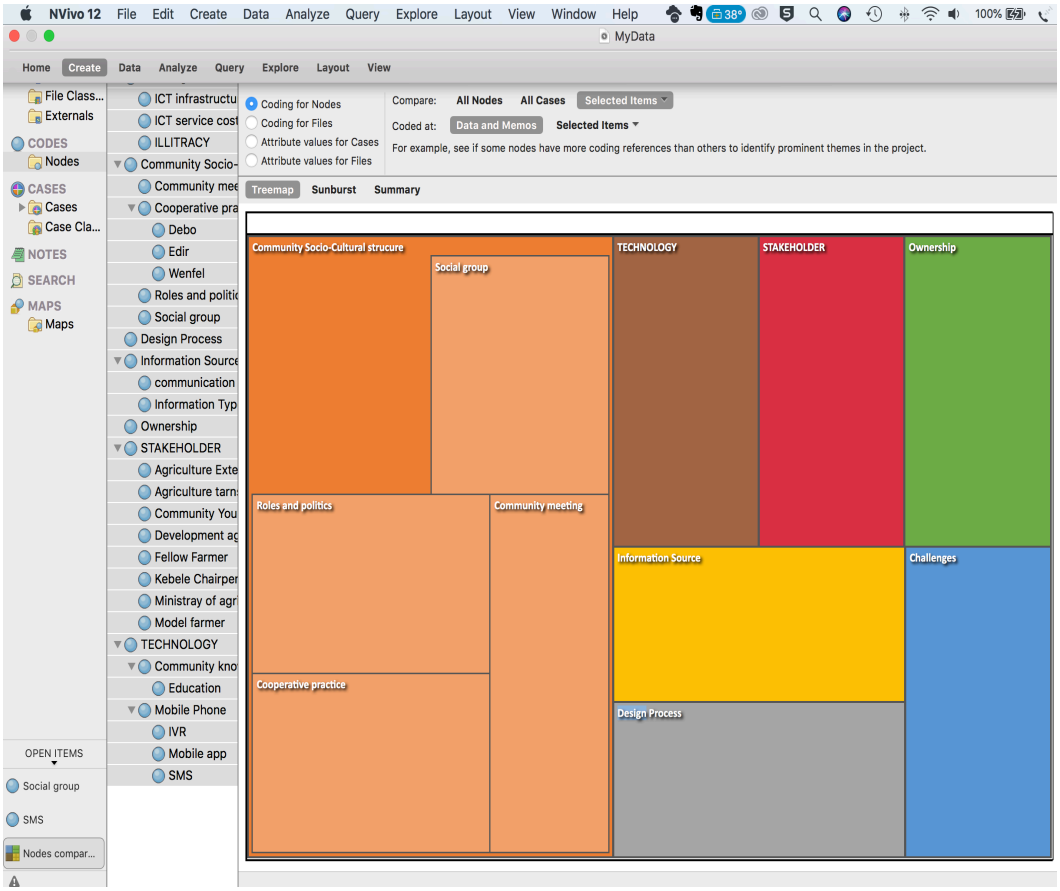

Figure 21: Themes from analysis of empirical data

Finally, a few related themes were categorized and statements were clustered together. The results of the analysis were discussed and the findings were merged. The contributions of the empirical results and our reflection-in-action are presented in both Chapters 6 and 7. As discussed before, Chapter 6 and its sections were structured to show the process as it unfold overtime. Chapter 7 is organized into four core themes (the role of culture in PD, technological alternatives and ownership, and the design process in the *D* in ICT4D context. Again, the lessons on these themes were discussed in conjunction with existing literature for the purpose of formulating my research contributions.

5.6. Trustworthiness of Research Process

Incorporating embedded action research engagement in a rural community setting is challenging. For example, important activities may not take place in a formally defined research project setting. An action researcher is expected to engage in both setting up and carrying out research project work. This, in turn pushes the researcher to focus more on problem solving than researching. This is because the researcher not only shares the ownership but also has a stake in the project outcomes: both the technical solution and lessons learned

from the process. The PADR followed iterations within different activities starting from contextual understanding up until the deployment and evaluation activity.

Empirical research methods included visiting and walking in the villages, interviewing key informants, participating in community meetings, conducting questionnaires, and holding collaborative design workshops. This is in line with the suggestion made by Walsham (2006) and Klein and Myers (1999) on how to deal with empirical data in interpretive research. I came to understand the complex social and technological issues and their interrelationships though constantly moving from the whole to the parts and the parts to the whole. Furthermore, the research process and results of the empirical data followed a continuous member-checking through collecting feedback and obtaining opinions from participants, which were then presented in different chapters of this thesis.

Member-checking through debriefings to the community. This research is significantly embedded with a participatory approach, which is guided by sociocultural cooperative practices. Targeting local people to participate in a research process was considered a design method from the beginning. This, in turn, ensures that the research materials are socially constructed through interactions between the researchers and participants.

Triangulation. During empirical data collection, an analysis of interpretation was supported by different sources. For instance, with predefined and structured questions, subjective and objective views were collected from different community people as well as DAs. Similarly, during design workshops and meetings, we gathered multiple perspectives. Finally, the auditing of the research process design outcome, including results from deployed technological solutions, provided a holistic picture of the research results.

Traceability. The results of the data obtained through ethnographic field study, surveys, collaborative workshops, and design and deployment of the technological alternatives were presented in Chapters 2, 6, and 7. These chapters are structured based on results obtained from the research and design activity.

5.7 Summary and Reflections on Research Method

To address real-world problems with a flexible and reflective research strategy (Robson & McCartan, 2016), participatory action and design research (PADR) approach was applied. We studied contextual aspects such as environmental constraints, people, design of artifacts, and sociocultural factors as an ecology of social, environmental, and technological interdependency. Collecting empirical data was started first by conducting a pre-study survey

from February to May 2014. Following this, a deeper level of investigation was carried out in the rural community through ethnographic field study for three months in January to March 2015. The sequence of interrelated participatory design workshops and meetings were undertaken and lessons were documented in field notes both for understanding local needs and designing technological alternatives. This was carried out for a year (April 2015 to May 2016) with frequent discussion and collaboration with community members. Finally, a pilot study was rolled out in July 2017 for community use and further investigation.

My reflection on AR is that it works best in collaboration with people who are problem owners. The collaboration enables people to work together as co-researchers on a project in which they have an equal share. In the rural community setting, however, there is no formal organizational structure where a division of roles and responsibilities are in place. Establishing problem owners to be part of AR is another precondition for their participation in the actual AR activities. I, as the individual researcher, worked in different roles, such as community helper, project owner, empirical researcher, and designer. However, it was challenging for me to not switch into the "researcher" mode in the course of the fieldwork and reflect on the process. Having said all this, let us now move on to Chapter 6, which provides a broader discussion of the narratives from PD encounters.

6. The community-based PD and Intervention

The empirical material is based on community-based engagement, action-design research, and personal reflections-in-action. We begin with understanding the context from the target people in the context of the rural community by exploring different knowledge areas. The knowledge areas focused on the users' cultural practices in context; identifying specific community needs, investigating local context, and crafting a culture-sensitive design process, which can support the development of information technologies. While exploring these knowledge areas, mutual learning between researcher and participants is supported by various participatory methods and techniques. In the process, participation practices, ways of collaborative design, and technological alternatives were the centers of the investigation.

The overall socio-technical problem investigation and community participation process is considered as infrastructuring activities. In the inquiry process both design and use context were part of the study. At the same time, several direct and indirect local people were involved over time. The results of the narrative and reflection are presented in five subsections. The first subsection discusses the process of understanding and identifying local opportunities for PD design activities. The second subsection examines local needs and problems to be addressed by ICT. The third and fourth subsections examine possible solutions and designing technological alternatives, respectively. The fifth subsection briefly presents the final system deployment and results of the pilot evaluation. Finally, subsection six presents an exit or handover strategy.

6.1 Exploring the rich picture of the local context

As mentioned before, we started understanding the complex rural context through a preliminary survey, the results of which we presented in Chapter 2. Here, we present an in-depth investigation of the rural community using ethnographic field study. A point of entry to the studying community was decided together with the Woreda agriculture extension officer. The study area is one of the rural farmers' associations within Hetosa woreda, which is located around 60 kilometers away from the Adama City. This farmer association has three subdivisions, locally named zones. The Association was formed 30 years by the government program called "*sefera*". The term *sefera* is a local word that means making rural people live (inhabit) in a common place to provide common community services like school, water, health care, and electricity at a single location.

The farmers' settlements in the two villages (zones) seem to be nearby and can be reached

within a 20-minute walk if we want to go from one zone to another. However, the farmers' settlement in the third zone is a bit scattered and takes at least an hour to reach from the center of the association, which is the farmer training center (FTC), to the village farthest away. Each zone has its own local gathering place for meetings and other activities. If the need arises for a meeting at the kebele level, the entire kebele assembles at FTC.

Each farmer in a community is grouped by 1:5 ratio based on their physical location where they live and led by one farmer. Five farmer groups combine to form a bigger group, which is locally named as gere. In total there are 26 geres within this farmer association. These 26 geres are grouped together to form the aforementioned three zones. The 7 farmers' committee members lead each zone. Selection of gere or zone leaders is by vote. Each zone or gere level leader is responsible for negotiation of community problems on behalf of other farmers, mobilizing the community for group work, and serving as the main gatekeeper to enter into the community.

Figure 22: Community leaders meeting after cooperative work

In most case, villagers usually gather and walk together to the nearby village center. These walks helped me to come closer to the community and to know various issues in the community. To establish trusted relationships with the local community entailed regularly attending community meetings, which in turn enabled me to get in-depth access to community issues. Sometimes, the field studies were purposively done in the form of participation in activities to discuss local issues informally rather than strict interviews or observations. Community members engage in cooperative activities and discussions and share ideas through community meetings. In general, the community has a culture of participatory decision-making to find solutions to problems.

6.1.1 Exploring local concepts and practices of participation

The rural community in the study area is a well-established network of people who share a common interest in improving their infrastructure and livelihood. Community members engage in cooperative activities and discussions and share information. The community has a culture of participatory decision-making to find solutions to problems. The three most commonly known sociocultural cooperative practices are *Debo, Wenfel,* & *Edir*.

Debo* (*Jigi) :This is a system of farmer's cooperation during the time of farming, weeding, and house construction, etc. Mostly this kind of cooperative work occurs when a farmer owns a large plot of land, which is difficult to cultivate or harvest alone. In this case, he selects a trusted person from his social network as coordinator to mobilize farmers for said work. The trusted person then convinces and calls approximately 50-100 farmers, depending on the size of the task. Once the coordinator accepts the coordination role, it is a shame or taboo if he fails to mobilize community members for the work to be done. The basic rule and protocol is that the planned work has to be finished in one day, and the volunteers demand good food and drink for both lunch and dinner.

Wenfel: This is a cooperative practice that requires fewer participants compared with a Debo. The basic rule is that a farmer calls people from his local social network group for a two-way service work. Once he receives such support, he in turn has to work for them when their turn comes. Before they start working together or in due course, the participants plan and share whose turn it is next. It seems this cooperative work is purely a win-win situation, and it requires the provision of food and drinks during work time. Neither Debo nor Wenfel have a system of formal administration; rather, they are based on self-help.

Edir :This is one of the most common traditional forms of cooperatives practices in Ethiopia, both in urban and rural areas. The main objective of the Edir is to help each other when events like death, wedding, natural or manmade disaster happens to a group member. Edir members may also get material and financial support from all other members based on the rules and regulations. The Edir may be established by gender, religion, or location, but the main goal remains the same. Each such social cooperative group is led by at least three people who are elected to serve for a certain time. It is a democratic type of social grouping (or participation model) in a community. Any community member has a right to join the group as long as he or she fulfills the defined internal rules and protocols. The members' participation is very high in the Edir's activities because its foundation is based on the willingness of each and every

member. Unlike Debo or Wenfel, Edir has a formal system administration and resources such as offices, stores, and financial deposits in the community.

My visits to the villagers' homes facilitated discussions to investigate local challenges and participate in the social network. The visits also helped me to explore the community problems, priorities, sociocultural cooperative practices, the role of key individuals like DAs, gere and zone leaders, and youth among others. On top of this, building trust and relationship with community members is a precondition of starting the PD workshops. The process of understating context and identifying the actors also helped in establishing trust. Furthermore, it was clearly shown that there is a clear power hierarchy within the community, which is not like a manager-and-employer relationship, but rather a mutual caring, which is not commonly visible to the outsider. The Edir Judge is the trusted and empowered person in the community sociocultural grouping. Participation in Edir, Debo, and Wenfel is being practiced throughout the community, regardless of religion or ethnic group.

Grounded on the thorough analysis of the effectiveness and acceptability of political and cultural participation in the community, we came to an understanding that many community members criticize the political participation model. On the other side of the spectrum, the power of connectedness and commitment to participation in the traditional cooperative works and meetings is very strong. For instance, when an Edir committee calls a meeting, no absences were noticed; at a monthly meeting all members attend or send a delegate.

6.1.2 Establishing local project team members

Taking all the aforementioned lessons and opportunities into consideration, a meeting at FTC with a few community leaders including the DA was organized. Initially, it was planned to select a representative from each gere (sub-village) but as the farmers' settlements were scattered, it was difficult for community members to participate in the expected workshop meetings. Hence, 23 participants from single villages (zones) were selected, and the DA took over the responsibility as local coordinator to regularly facilitate the preparation for the meetings. Different adaption strategies at both the technique and process levels were discussed before starting the PD workshops.

"Wenfel" as user participation technique- before starting the actual PD workshops, some of the motivating pre-conditions were arranged in collaboration with the participants. The community sociocultural cooperative practice of *Wenfel* was chosen as means for collective action and cooperation. That means the participating farmers promised to attend meetings regularly, participate actively, and discuss with their neighbors to collect different perspectives;

in return, they expect to see the final project result–a prototype–to be implemented and deployed in the community. The *Wenfel* form of user participation would further strengthen the positive relationship between both researcher and participants to work toward the common good. This in turn created an additional role that gave me the implicit political power to motivate and mobilize community members to be part of the design process. Furthermore, mobilizing community members for discussion through the local participation practice helped me to pragmatically suit the benefit of information technology to the local context.

Adaptation of workshop implementation- Finding a time and place for workshops is difficult**,** as rural people usual live in scattered places, so arranging an appropriate nearby and common gathering place was a precondition to conducting the PD workshop. My lesson from attending meetings organized by local government administration and DAs was that local people were not attending such meetings mainly due to either distance from their home or lack of interest in the meeting agendas. In response to this, people prefer to attend meetings near to their preferred social meeting place, which is around their Edir house. The time of the meeting was also another issue to be taken into account. For instance, local people were busy during Saturdays and Sundays because these days are weekly marketing days for selling or buying items. In the morning, they were busy taking care of their cattle. Friday was not also a good time as Muslims are attending mosques. To this end, the afternoon from 14:00-17:00PM was found to be the most appropriate time for most of them to attend meetings. Thus, our formal meeting was scheduled and carried out every Wednesday afternoon near the village gathering center where community and/or Edir members' meetings have been conducted in the past.

A praying culture - During cooperative attempts such as holding public meetings when they work, in times of festivals and celebrations, the people often emphasize the issue of belonging (togetherness) through praying. That means according to local culture, every formal meeting starts with a prayer of thanksgiving. Similarly, at the beginning of each workshop meeting three elders give the blessing prayer. During the praying time, the elders thanked God for collective abundance of resources, for their being at the educative meeting, continuous solidarity, and for the well being of the nation among others. One can learn and see that there is a deep sense of mutual concern among the community members.

Finally**,** the coffee ceremony is an integral part of community social-cultural life. It is also a sign of respect and friendship to be invited to a coffee ceremony and a sign of Ethiopian friendliness. It is one of their daily social events in the village and is a formal time to discuss the community issues, politics, life, etc. Thus, to organize a group meeting that was open enough for people to freely discusses, a culture coffee ceremony was arranged for each

workshop session. Interestingly the coffee ceremony usually takes about 2-3 hours, which in turn fits with the length of workshop time scheduled for a day.

6.2 Participatory problem analysis

Following lessons learned and key factors from the pre-study and opportunities found in ethnographic field studies, we shifted to PD workshops. The results of the pre-study show those farmers first prioritize accessing recent market information. Given the long distance between different concerned stakeholders, conducting PD that includes them went beyond the scope of this project. In response to this, we adjusted project focus and the PD workshops to fit the rural farming community.

6.2.1 Adapting PD techniques

In rural society, written documents like do-it-yourself manuals do not work, as the majority of the community members are illiterate. The main means of communication is based on oral discourse, or orality. The community regards issues as substantial when they are discussed in person. Due to either culture or history, rural people have experienced telling and listening to fables. They often exchange stories sitting under a tree after their cattle have been herded. Storytelling has multiple aspects of communicative activity in which the spoken word can be enriched by intonation and gesture. This conveys important insights into how people attribute meaning to their daily experience. On the other hand, my observation while a DA when presenting a video about agriculture best practices (a video from Digital green project) was that farmers most frequently asked about the name and village of the farmer in the video than taking experience. The source of information in particular is the issue, and it is critical for them to accept the source as giving trusted information. With this in mind, problem and need investigation workshops adapted storytelling as one of the PD techniques.

The first concrete participatory workshop process was started using a storytelling session. This stage corresponds to the work in the early activity of the development process in order to supplement knowledge obtained in ethnographic field studies or to enhance awareness of the problem in the application domain. Participation in the workshop was designed in a dialogue form that gave everybody the opportunity to contribute to problem analysis and definition of priority areas. Hence, each participant was asked to tell two stories, one good and one bad story about agriculture-related issues (see Figure 23).

Figure 23: participants during storytelling session

The meetings were conducted in both local languages (Amharic and Afan-Oromo). One of the participants narrated his bad story as follows:

"I have been farming for the last 8 years here in this community. This year I was looking for a weed-controlling drug. I sprayed it four times on my wheat land and the effectiveness of the anti-weed is questionable, which resulted in my wasting my money. Sometimes we can get the quality anti-weed from the farmers' association, but the leaders of the farmers' association are not performing well"

At the end of the storytelling workshop, a number of lessons and limitations were observed. This method is in line with the rural oral community, where thinking, communicating, and learning in writing is unfamiliar. The discussion was full of fun, with action and emotional expressions in their sad stories. The storytelling workshop facilitated participants to share and discuss local and governmental issues, which led me to an in-depth understanding of the context. Furthermore, storytelling was found to be an effective means of expressing community issues as the basis for developing a collaborative analysis. Moreover, storytelling let us elicit diverse contextual and social information, compared with data obtained from the pre-study. This is because it has several aspects of communication such as words, tones of voice, and facial expressions, among others. It also facilitates synchronous communication or a feedback cycle between storyteller and listeners. This in turn improves users' active participation in the collaborative problem investigation.

On the other hang, the storytelling workshop session was challenging to design, since the

messages of storytellers or stories were too general to be mapped into a list of system functionalities. This is because storytellers said many issues cannot be solved by ICT; sometime they discuss issues that were conflicting and/or beyond the agreed general project goals; listening to known stories many times made other participants became bored. Furthermore, as the participant speaks two different languages, sometimes it was time-consuming translating Amharic speaker stories to Afan-Oromo and vice versa.

In response to this, a more structured workshop was used based on the (adapted) future workshop procedure. Although FW is accepted as a structured way of conducting participatory workshop, it has also limitations in some contexts. For example, workshop materials such as whiteboard, markers, and Post-it notes are unknown in the rural farming community. As most of the farming communities were illiterate either in reading or writing, ways of simplifying FW activities explored. I first adapted the critique's activity of the FW to the local context by including cultural metaphors and the seasonal calendar.

In the community, there is a special tree, locally named the oda tree. This tree covers a wide area, which makes it a conference hall or gathering place. People have discussions and make decisions while sitting under the shade of this oda tree. Thus, we see a tree metaphor as an option to structure participant ideas at FW and visualize them. Adapting FW discussion with a tree metaphor (root, stem, and branch) can help to investigate the problem area along with their causes and effects. Furthermore, it creates a visual output that can be understood by local people. Visualization of the problem in the form of a tree helps to analyze, clarify, and identify our areas of concern (see Figure 24). The process is also useful both for investigating the problem area (critique activity), and to collect support for any interventions (fantasy activity).

Seasonal Calendar (Timeline**)-** In participatory development, Participatory Rural Appraisal (Chambers, 2002) was used to involve people in discussion about the importance of information in their lives in general and agriculture in particular. Farmers' agricultural activities and their informational needs depend on seasonal cycling every year. Locally, there are four commonly known seasons: pre-sowing (April-July), pre-harvesting (August-October), and harvesting (November-January), post-harvest (January-April). Furthermore, people are good at remembering events, if they are attached to a known time reference. Thus, the participatory problem investigation activities were carried out based on these seasons. In doing so, participants not only remembered their problems more easily but also structured the discussion and concentrated issues one season at a time. In other words, including the local

agriculture season calendar can further support the aforementioned tree metaphor to easily facilitate the problem investigation activity.

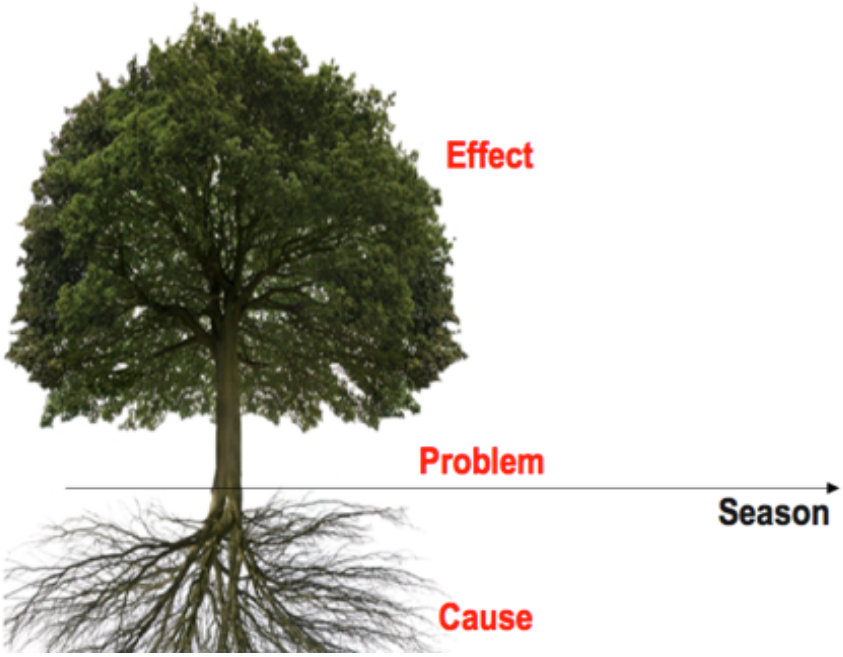

Figure 24: Adapting FW with a local metaphor (Tree & timeline-FW)

We use the tree metaphor to investigate cause-and-effect in their current problems, and stories as a vehicle to trigger communication and self-expression. To facilitate the collaborative problem analysis, we used a large sheet of paper with a printed image of a tree, as can be seen in Figure 25. To this effect, they first selected one problem from the a given season, and one of the literate group members put the name of the problem on the stem part of the tree. Thereafter, they put its cause on the root of the tree, and its effect on the branch of the tree. The same steps were followed for each problem and season until we finished listing local cause-and-effect problems.

Figure 25: Facilitating problem investigation tree metaphor

6.2.2 Mapping concepts to needs

The participatory problem analysis resulted in desirable outcomes and lessons. A list of their problem areas or information needs was compiled as shown in Figure 26. This outcome was taken as a higher-level requirements analysis to formulate manageable design objectives for the next activity. The lesson in this activity led us to learn and reflect on three issues. First, it placed the responsibility for the analysis in the hands of participants who knew the application area most. This in turn supported participants to experience a sense of control of the process and eagerness to find solutions through collective action. Using a real-world metaphor and adapted FW helped them to establish a shared context for discussion and analysis. This can be seen from three perspectives. First, the adapted techniques helped participants to convey their message, discuss and elaborate on the concrete features of their own experiences. Second, the process was useful in building awareness of community problems and how these problems affected their lives. Third, I also got a better understanding of the context and community problem areas.

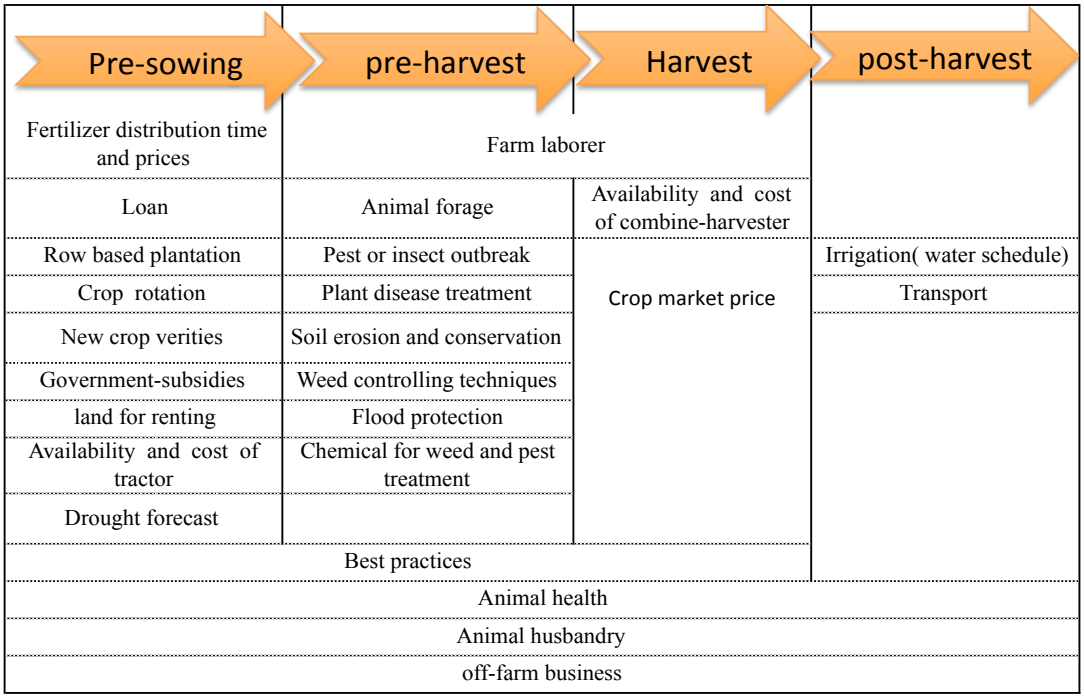

Figure 26: Communities information needs across agricultural seasons

The results of the participatory problem analysis also showed community needs that are not possibly addressed by IT solutions or are beyond the scope of this study. For instance, some of the community needs government subsidies or loans during farming time; some complained about neighboring kebele being a cause of a flood during summer. The current prioritizing of community needs was done through participatory rural appraisal techniques, namely voting and tallying. The ranking of the identified problem areas was grouped into eight major categories: new seed varieties-related, fertilizer-related, disease-related, pest- related, marketing-related, animal health-related, environment-related and financial-related issues.

6.2.3 Re-negotiating terms of participation

As this ICT4D project work is grounded in sociotechnical system complexity, we were required to address and redesign for social issues as they arose. At some point, we found designing the social process more challenging than the technical design process. At the same time, we also observed many interesting insights and social strength of the community.

After the second problem investigation workshop, lack of commitment from some of the selected participants was observed. For example, some were missing the meetings, while others thought that the local coordinator would remind them about the meeting for his daily allowance, while still others perceived that I was collecting my own research data. One person had a personal conflict with the second local facilitator and was not happy to be in the same meeting

room with him. This kind of implicit conflict issue was coming into the picture after informal and personal communication with the other local member. There was time where days passed only for negotiation of individual and community social issues. At some point I was frustrated, thinking that I was wasting time in the field, which is 65 kilometers away from my home. On the other hand, the local facilitator was not surprised by their missing, saying it is a common practice to not attend meetings regularly. Basically, I had experienced such issues one month before starting this workshop when the local government called meetings at the kebele level three times, but only about a third were attending.

The lesson learned at that time was that they disliked attending political meetings because at that time governmental local bodies were arranging election campaigns. In response to this, a collective consensus meeting about the next workshop activities and their expectations were re-discussed and redesigned. The first consensus was to replace some of the previously selected famers who were missing with another community members. Second, the timing for conducting workshop was re-scheduled in the only once in a week because some of the farmers were busy attending other local election-related activities. Third, one of the participants frankly said, “We are expecting a daily allowance but still we have not gotten anything. We used to get such an allowance from NGOs and other researchers, so you can push the gift.” Some of them were thinking that the local coordinators get benefits from attending and coordinating meetings.

On the other hand, some participants asked me to teach computer skills to their kid, which was found practicable. In fact, this idea came after some of the community kids were watching me use my laptop and discussed it with their parents. The process of establishing a computer center at a local gathering place was arranged. I took the responsibility and started teaching a few kids with my single laptop. This, in turn, triggered me to scale it at the community level, although it took a long time before it came to pass. I extended my relationship with the community member by taking pictures and showing them at the next meeting, showing the video for about 10 minutes before the workshop started, helping some of the local farmers while they were buying a mobile phone from the town, participating in wedding ceremonies, among others. Another interesting idea, which was useful to remind participants about meeting dates, was participatory communication (PC) as a technique. Here, the kids were given basic ICT training one day before the workshop date and before they leave the session, first they were encouraged to tell their fathers about the lesson they learned and their impression the training, and second, to remind their fathers about the next workshop meeting time. After

conducting a few workshops, we came to know that continuous community-based participatory communication (PC) improved participants' commitments and regular attendance.

6.3 Envisioning alternative solutions

In response to the results obtained from the participatory problem investigation activity, this section focuses on analyzing possible design concepts and alternatives. Scholars like Clement and Besselaar (1993) state that users must have access to relevant information for their active participation. So, a different awareness creation session was required. This is because, with limited understanding of computer systems in rural settings, attempting to engage them directly in the envisioning design concept was difficult.

6.3.1 Inspiration and sustaining community interest

We further adapted the "Future Workshop" by including the inspiration activity. This activity aimed to share technological possibilities and insights among participants. This in turn aimed to bring common understanding and awareness. Exemplary cases or experiences from other countries such as India, Kenya, and Uganda were presented. Several multimedia files such as videos and photos were used during the experience-sharing sessions. Besides experience-sharing, the presented multimedia files triggered further discussion. They were very much interested and motivated to watch how farming activities were conducted in other countries.

One of the most important things observed here was that they were raising questions like "Why isn't the Ethiopian government providing this kind of service to us?" One of the participants pointed out, "*I have seen a government initiative here in Iteya, which displays prices of cash crop but it of no use to us*". The development agent also presented one case from the Agriculture Transformation Agency (ATA). He showed us how local farmers can access agriculture information using their phone. Following his talk, some of the participants tried it by calling the predefined number 8028 to listen to an already recorded audio file. This in turn created a very interesting discussion and reflection session. We found this initiative interesting, but none of the participants had tried it before. What we observed was that they were not informed in the first place. Second, the DA himself also mentioned that the information is static (previously recorded) and not contextualized to the local ecology.

On the other hand, mobile phones have been used among the farming community irrespective of their education level. Of the 23 workshop participants, 19 of them own a mobile phone. Among the 19 cell phone owners, only three-model farmers own smartphones; the rest

own only low-end phones. Computers are viewed as a symbol of modernity. Most of the farmers perceived it as being for the youth and as being very costly. Some farmers said that a computer is necessary for individual lives and their communities. Surprisingly there was one young person who got ICT training from a non-government organization, who viewed ICT as tool that helps to learn and is useful in building capacities.

Experience gained both from showing the video in developing countries and local ICT-based intervention from the local context triggered discussion and widened understanding. Specifically, the use of technology artifacts was found as a useful PD tool to share and improve thoughts among participants. Participants were informed about the availability of technological options to discuss how to situate existing technologies in their local contexts. Following this, a stories-based scenario was used as a participatory tool to further facilitate and structure discussion outcomes.

6.3.2 Design ideas and information architecture

This scenario brings visions of future states and is used as a path of development in a systematic way (Bødker, 2000). As the scenario is similar to storytelling and suggestive, we found it a useful PD tool for our participants. Most importantly, the scenario represents work-oriented issues, which can facilitate users to describe and exemplify their own practices. Scholars like Rosson and Carroll (2002) demonstrates that scenario transforms the users from the recipients of information into expert participants.

Now, let us move to the actual envisioned activities, first with the high-level scenario and followed by detailed description of its cases. Using the high-level scenario description was not to list features of the proposed system, but rather to get a common view about appropriate strategies to address the identified needs. The kinds of information system services that could be affordable, available, and convenient to smallholder farmers, were used as a criterion for appropriating alternative options. We inferred from the pre-study, the previous discussion, and our experience that SMS was a good channel of information exchange. However, issues related to other alternative options, the illiteracy issue, who should collect and disseminate information, responsible ownership, etc., necessitated further collaborative discussion.

We facilitated dialogue to focus on a high-level scenario (means/ends) to fit the local context. We also aimed to better understand implicit requirements in situations and comprehensively articulate the alternative solutions to these situations. The following three means/ends-based scenarios were discussed and prioritized.

- ✓ ***Farmers' shopping center*** - One alternative suggestion was to establish a farmers' information shopping center at the nearby town. At that time, the farmers' association was located near the small town where farmers usually go for marketing. This farmers' association was also distributing fertilizer and sometime and anti-pest or weed chemicals. Above all, selected local farmers lead the administration, which is basically supported by government. They also privileged to buy and sell agricultural commodities, although they were not efficient compared with local traders. The assumption here was that when a farmer goes to the nearby town he could stop on the way and ask for advice. It can be interpreted as a "goods shop" where farmers can buy information as far as it is useful for them.
- ✓ ***FTC-based service -*** In the existing context, DAs were official intermediaries for information (knowledge) transfer between various government and non-government organizations to farmers or vice versa. DAs have an office at the center of the kebele, FTC, where farmers were getting advisory services. This service request may be initiated by DAs or by the farmers. In particular DA was proposing the solution to be at FTC; however, inaccessibility to electricity at FTC made this problematic.
- ✓ ***Community-owned information center-*** This information center is envisaged to be established at the center of the local village where people usually gathered for meetings. To deliver digital content to people who were doubly illiterate in basic literacy and ICT literacy, the community human infrastructures were taken as an opportunity. For example, every farmer has kids that are literate and serve as a relay to his (her) community, so as to lower barriers of literacy to a large extent.

In light of this, a community-owned information sharing system is found to work best, but this has not happened without bringing conflicts of interest and political issues. The community knowledge center was taken as a hub for farmers as awareness creation sessions, capacity building and accessing information. For remote information access and sharing, two technological alternatives were found to be appropriate.

- ✓ ***Technological alternative I***- a community social media using SMS that lets community members send and/or receive message to/from their social groups, hereafter labeled as social media using SMS: SM@SMS.
- ✓ ***Technological alternative II***- exploring typical challenges experienced by rural users and availability of smartphones led us to consider the second option. The smartphone-based app with multimedia data sharing capability: text, picture and audio data format. Hereafter, we abbreviate it as M-CIH (mobile-based community information house).

All the process and description of envisioning activities were very high-level narratives. This facilitated an easy way for participants to understand and articulate their design ideas. It was also useful to discuss advantages and disadvantages of different design strategies. After we obtained the bigger picture of the desired future situation, the high-level scenarios were further refined to lead into use-cases. Here, the scenarios were focused on re-structuring problems and describing the future system in detail. We extended the high-level scenarios to the low-level scenario by describing each setting, actors with their wish lists and capabilities, and steps to be taken toward accomplishing users' objectives. Once again, the concept of metaphor was found as a necessary input before starting to develop discussion of the low-level scenarios. We emphasized the role of metaphor particularly for users as in our case, who did not have any ideas how information systems work.

Rosson and Carroll (2002) argued that "... it is often metaphoric thinking that promotes the insights of truly creative design". A "community house" metaphor was used to simplify thinking and understanding about their real-world activities and information technology-based activities (scenarios). In the community, a single house often has many rooms and purposes. For example, they use it as a bank, as living room, as a storage place, as an animal shelter (barn), etc. Every farmer knows his house structure well, and where he can find what he wants to get. Similarly, we represented a mobile-based community knowledge center as community house. A sample description of the scenario, which encompasses a future vision for the identified community's information needs, was offered.

Table 14**:** Sample scenario description

A community information house, which is owned by the community and stores different information, enables members to share or disseminate recent information among them. For example, Mr. Mohammed who is a community leader, one day he wants to sell his ox with best price. One week before, he wanted to go to the nearby market place namely" Boru-jawi" to have a look at ox market prices. Similarly, he wants to approach some people from his social group to get comments. Fortunately, his best friend, Mr. Necho*, tells him that there is an already established community knowledge center where he can post advertisements for the public. Thereafter, with the help of his young son, Mr. Mohammed approaches the community knowledge center to disseminate his message. Luckily enough he gets many responses within the same day. Even some of them come to his home to see the ox physically, and some of them called him for further information.*

To simplify the envisioning process, we first developed high-level scenarios to identify general motivations. These motivations or needs were taken from the previous activity, and then a strategy for future use was described. Over time, the scenarios were described in a more elaborate form towards concrete descriptions of specific activities. For example, developing a concise description of the situation, as shown in Table 14, is used to capture the essential parts of human activities. Throughout the envisioning activity, scenario-based narratives were

developed. It was relatively easy for participants to understand what was proposed as design ideas. They also enriched our understanding of farmers' real-world activities, which in turn was used as a basis for mapping into information system activities. This in turn enabled participants to connect it to their personal work practices immediately. As a result, it brought a greater sense of ownership of PD activities.

After understanding how the local people conceptualize their world and which actions in their world were regarded as purposeful, the envisioning activity ended with specifying who does what and how. In doing so questions arose, like what information and from which source would have to be available for enable someone to use it? To this end, several revisions (iterations) both regarding the scope of the project and involved actors were performed.

Regarding project scope, initially, agriculture market information service was given more emphasis. I was arguing that the problem of the local community was access to agriculture market information. However, the results of the problem analysis show that this information is needed only in two months out of twelve. This, in turn, required extending the project scope to consider other issues from each agricultural season, including animal-related information. When Edir became the owner of the community knowledge center, information concerning community social events such as deaths, weddings, births, and other information were to be considered. At this point, sharing community social events was an important means to reach technological solutions for the local daily practices, or Edir's activities. Finally, the project scope was bordered on general-purpose community social media.

Similarly, the type of actor to be considered also showed up at different levels. For example, initially, the farmers in the community were taken as the target actors. Even in the community, there were two groups of farmer, normal farmer and model farmer. The three DAs working the community FTC had established several social interactions with local people, which we also considered. Although community youths were not directly involved in the design process, we found them to be important actors. Finally, we were discussing the proposed community social media at the woreda extension office, where DAs at the woreda level also are actors. Basically, we held a meeting with 22 of these DAs to collect their interests and reflections.

The main actors and their information wish list are organized to present the overall data flow; see Figure 27. It shows how the process can facilitate circulating information among or between them. These actors are Development Agents (DA), Model Farmers (MF), Farmers (FF) and Edir committee (Edir). These actors can circulate information using either low-end

mobile phones using SM@SMS or a smartphone-based app (m-CIH). The big inner circle in the figure shows their information wish list to be shared among them. The administrator including me can reconfigure settings and access the exchange data from the data store through web interface. The mobile phone, which is attached to the web server computer, is used as an SMS gateway for SM@SMS to work locally.

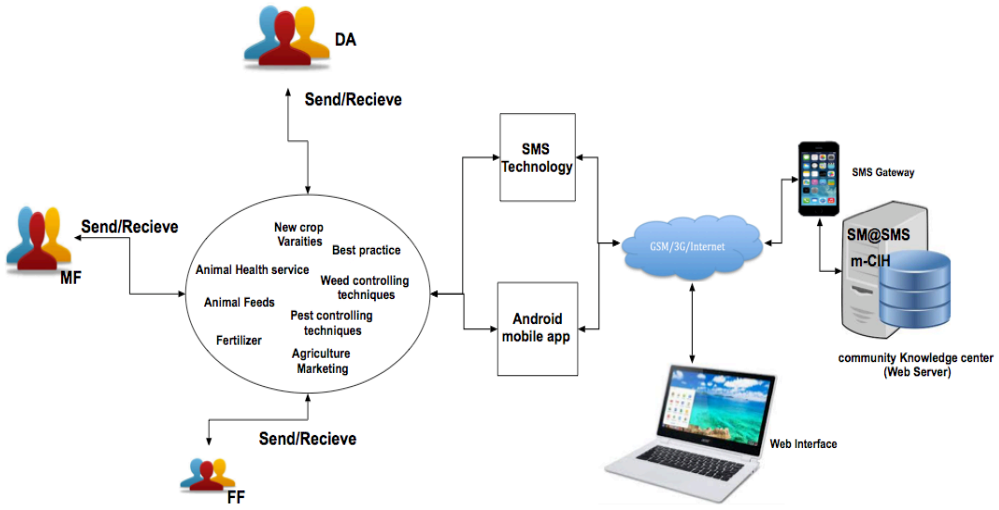

Figure 27: Actors information wish list and flow model

6.3.3 Politics and conflict of interest

As it was not planned to establish the community knowledge center in the beginning, it took five months to get these used computers. This is because getting the computer to the farming community is still not accessible at the school level. This would not have come to reality if I had not been a staff member at the university. By the time ten used computers are ready to be taken from Adam Science and Technology University (ASTU), we selected one of the trusted community leaders to receive these computers. However, the kebele chairperson person has to author and take responsibility. Thus, the local facilitator asked the kebele chairperson to write an official letter in his name that let him take ten used computers from Adama Science and Technology University (ASTU), but getting the written letter took more than a month. Scholars like Simonsen and Robertson (2012) state that participatory design is a political process. A number of implicit and explicit politics and conflicts of interest events were also manifested in our case. The first observable politics or conflict of interest came from participants as to where to put the community knowledge center and who should be responsible. To discuss these issues, some participants and youths from the village where the workshop was conducted approached him and asked why he was delaying and talked about his anger. One of the standpoints of the chairperson was to share the ten computers equally to all villages. But,

during my discussion, equally sharing (owning) computers without electricity was agreed to be illogical. This also triggered another discussion point saying in the next few months the second village where the chairperson was living would be connected to electricity. Still, we questioned the feasibility of this idea within a short timeframe. Finally, we agreed to place all used computers on behalf of the kebele in a room where the workshop was being conducted.

The other important issues were who should represent the villagers to take computers from ASTU? In the beginning, I together with some of the workshop participants nominated one of the community leaders to take this responsibility and deliver the computers to the community members. Some of the participants disagreed, saying that previously other local community leaders received donations from local NGOs to be used by community. The lesson we learned from this discussion was that some time ago, a local NGO offered some electronic devices like TVs or DVDs but at the time of our discussion one local community leader already took all of these items. Basically, I have been contacting the nominated community leader many times since I stared my fieldwork, and I found him a very nice and active person. Finally, the meeting ended with a common consensus on delegating a person through their written signature.

Following this, where the used computers should be placed in the community was another debatable issue. This meeting was scheduled and facilitated by one of the trusted local zone leaders. He was the coordinator and the second chairperson in the kebele. The initial assumption and discussion was to put the computer where we usually conduct meetings, although the room needs some cleaning. Two members were not happy because the community leaders were usually working temporarily and were less trusted by the community compared with their social-cultural committee: the Edir judge. The idea of shifting the place and management to be done by Edir was discussed for a while. Luckily, the Edir Judge was already a member of the meeting, which was a nice opportunity. Unfortunately, he was not happy receiving those items, saying that we are farmers, we cannot use computers; above all, our Edir is responsible only for social services during death and wedding events only for Edir members. He added, "*Even in this meeting I can see a number of people, who are not our Edir members, so you cannot order me or have a right to say do this or that*". The dialogue went on for a while but with no consensus.

Another option was also put forward, saying why don't we place them in the nearby primary school, where our kids can also use it? But this was not a good option because first, it was relatively outside the community, and second, the main objective of establishing the community knowledge center was interpreted differently. To this end, one of the local

facilitators recommended me informally, saying let us stop this discussion here and approach the Edir judge through elders, locally named *shimagle*. There, after two weeks of discussion three selected elders convinced the Judge to call a general members' meeting to discuss and decide collectively. At the community meeting, the members convinced the judge even they agreed to contribute 2USD to construct a house and salary for a guard. On the same day, they also endorsed a community rule for any person, especially youth, to be penalized 25USD if he/she makes any mistakes in the computer center.

After the above decision was endorsed, conducting meetings with community leaders and Edir committee was observed to be problematic. The community leaders were very active and cooperative, but the Edir committee was not. I established a good relationship with community leaders by eating together, chatting, visiting the local villagers with them, which I didn't realize had a negative impact on the Edir Judge. This problem was becoming clear at a time when we started the computer training class. We tried him via calling, looking at him in church on the weekend. Finally, I went to his home in the evening, when he disclosed my close attachment with community leaders compared with the Edir committee. In addition to this, the judge said, "One of the community leaders whom I was approaching most of the time was not a member of the Edir." As a result, he was avoiding any help or order that came through this community leader. Finally, I requested an excuse, which led us to process smoothly, and he delegated another person to be responsible for the community knowledge center.

6.4 Designing prototype and teaching ICT

All the previous process participatory sessions and user participation were a learning process, which was the basis for envisioning and designing the technical system. The applied techniques and processes were aimed towards providing necessary experience. In this section, we looked into a further lower level of analysis through mock-up, prototype, and establishing a community knowledge center.

This low-fidelity prototype is one key technique that has moved into the mainstream of technology development. This technique enables people to envision different ideas of how future technology might operate. The ICT4A researcher faces challenges of engaging participants with very limited experience of digital technologies in exploring design options. Following the refinement of the scenario at functional specifications, the aspects related to user interface concepts, or interaction issues were assessed through static and interactive paper prototypes. The detailed user interface design and interaction issues for both SM@SMS and M-CIH applications is discussed below.

6.4.1 Designing SM@SMS

The three most local actors considered in the SMS based social media were Development Agents (DA), Model Farmers (MF) and Farmers (FF); see Figure 27. The main objective here was to define message communication within and between these group members. For instance, defining the messaging format for DA to send recent agricultural technology to all model famers simultaneously; or letting any farmer send crop market information to all other local farmers. Table 15 shows a template as to how group messaging was defined.

Table 15: SMS based messaging format between different local actors

Social group		**Message to be sent**	**Description**
Actor	**Group Code**		
MF	2	New message	Model farmer (MF) can send message to any local social network group using ✓ **2 + new message:** message to all FM ✓ 3 + **new message:** message to all FA ✓ **4 + new message:** message all DA ✓ **5 + message: Sending question** to one DA
FF	3	New message	Fellow Farmer (FA) can send message to any local social network group using ✓ **2 + new message**: to all DA ✓ **3 + new message:** to all model farmer ✓ **4 + new message:** to all farmers ✓ **5 + message: Sending Question** to one DA
DA	4	New message	DA sends message to the social network group using ✓ **2 + new message:** message to all FM ✓ 3 + **new message:** message to all FA ✓ **4 + new message:** message all DA

Based on the envisaged system (SM@SMS), the technical solution was designed by customizing open source software *FrontlineSMS2*. This software enables us to establish and centrally administer a text-messaging service. Text sending and/or receiving can be configured to the local cellular network. The server-side configuration requires three main components.

- ✓ FrontlineSMS2- the main server-side application that administers the setting and system features.
- ✓ Mobile phone device with SIM-Card- a smartphone device attached to server-side computer to service as SMS- gateway.
- ✓ FrontlineSmsSync- an Android app that runs on mobile phone which is used for connecting SMS-gateway (mobile phone) to the FrontlineSMS2 through local network address (IP)

On top of administrating text sending and receiving text messaging, group messaging,

auto-replay, and auto-forwarding of message can be customized to fit with the local context. User interaction and data flow from the clients' side can be done through any phone. The customized system was tested iteratively and incrementally to simplify the number of steps and complexity. Initially we identified a total of 15 use-cases. However, as SMS has limited forms of communication, classifying farmer interests by having more codes was problematic. Thus, we merged use-cases to the same format.

Farmers and/or DAs can send any kinds of messages through their mobile phone to the server-side mobile phone number. After the server system receives the SMS, the gateway then sends back a reply message or forwards the same to other group(s) based on the triggering events. For example, farmers can send their questions via SMS to the server-side phone number. The local agriculture expert via a web interface then views the queries made by the farmer. Through the same interface, the expert responds to the farmer, which then goes back to the farmer as an SMS message. On the other hand, if a DA wants to disseminate information about recently released wheat verities to all model farmers, he can use code (**2**) assigned to "model farmer", followed by his recent message to the server-side phone number. The input format looks like this:

> "2 keemikaala gosa adda addaa walitti makuun midhaan irratti biifun miidhaa waan fiduuf of eeggannoo taasisuun barbaachisaa da
>
> "2 before combining different chemical and spraying into your planned crops, please be advised the consequence on your crop's productivity"

6.4.2 Designing M-CIH prototype

The second prototype was focused on a design smartphone-based application. Similar to the SM@SMS, the functionalities remain the same but are relatively simplified with a text-free user interface. To do so, we examined understandable nearby pictures and ways of designing the layout.

6.4.2.1 Designing and evaluation nearby picture (icon)

The existing mobile phone user interface is not easy for users to interact with. This is because keypads on mobile phones are not the easiest method of input for most rural people. Metaphors have strong influences on user interface design. For instance, an icon is a visual object that can be used to signify an action or convey sufficient information to users. Using a known concept in the real world and representing it with metaphors plays a fundamental role in designing a model for a computer system and general user interface in particular. Choosing

the right metaphors based on the users' cultural background would provide several benefits. One direct and simple approach to design metaphors is to use an icon and a local image. Users can then understand the meaning by seeing the image on the active interface. Designing mobile app user interface, UI should value the rural community context and convey their agriculture practices. Selection of lists can be designed following this understandability. For example, the best way to select a given crop from the list is by selecting its picture. To identify a list of metaphors for the UI, different agriculture-related concepts (terms) were compiled from concepts from participatory workshops.

About 28 concepts were represented in the nearby image (picture). For each of these concepts three different alternatives were prepared. In total, 84 nearby pictures (icon size) were designed. In order to evaluate the common understandability of these small pictures, two evaluation methods were used: naming and matching. In the naming method, some participants were asked to evaluate the meaning of each small picture in their context.

Figure 28: Nearby picture evaluation using naming

In the second group, the same set of pictures was given to interpret the nearby meaning (concepts). Participants were asked to add comments if the picture was not correctly translated or difficult to interpret.

Figure 29: Nearby picture evaluation using matching method

Cooper, Reinmann, and Cronin (2007) argue "Metaphorical based UIs are an efficient way to take advantage of the power of the human mind to make inferences". Metaphor can convey instantaneous knowledge to the user on how to interact with UI. As oral communication is the major means of communicating and sharing means among farmers, visual representation of concepts can be used as a way of conceptualizing what we are doing and as a way of visualizing operations. Several metaphors (the nearby pictures) were used to represent concepts from "Farming", Animal" and "Social tie" and were all closely connected with farmers' daily activities. People with low literacy even memorized text as visual patterns and started recognizing them, which we commonly expect as difficult to interpret. For example, they easily identified and classified the types of fertilizer, Urea and Dap, by looking at the written text on a bag of fertilizer. In general, the participants instantly identified most of them, although a few participants were initially confused or took a few extra seconds to recognize.

6.4.2.2 Screen layout and navigation design

Paper prototyping is characterized by a quick and easy translation of high-level design concepts into tangible artifacts, which has also been used as a usability testing method (Mifsud, 2012). Paper prototyping is not only cost-effective but also people who don't have any idea about IT can actively be part of the idea generation process, which makes it an ideal technique to work with participants, as in our case. Since people cannot communicate in a vacuum, lessons learned from the field studies were carefully considered to identify specific design goals. We clearly understood that proper arrangement and categorization of menus UI design would greatly help users to navigate to the contents they desire. This is because users can use their perception to learn and navigate with ease and have a positive experience with UI usability (Lumsden, 2008). Moreover, this technique can be used to get real user feedback quickly and

easily to refine the design based on the users' need.

A total of 28 printed picture cards, each representing one concept, was given to the participants to group them into categories. Thereafter, generic and representative local name for each classified near picture cards were given, namely Farming, Animal, and Social events. Scenarios were developed as an outline of steps that the users should perform to accomplish some part of their daily practices by arranging these picture cards. Following the paper prototyping, exercises were performed to create paper-based user interfaces by grouping and arranging picture cards on printed mobile phone screens. The main idea of using paper prototypes was to facilitate sharing of ideas among participating users. After presenting 20 printed mobile phones pictures, the user started the exercise to arrange the small printed pictures in each group based on their agricultural practices and daily life experiences; see Figure 30. Finally, 19 paper screens were produced.

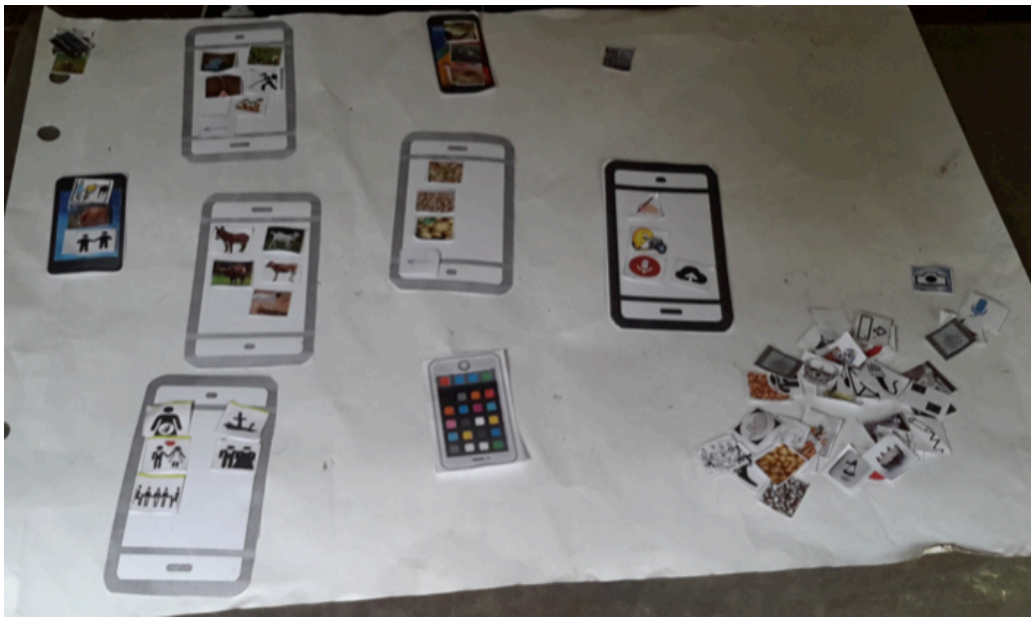

Figure 30: Low-fidelity prototype

The next major task was designing paper screens and evaluating navigation to accomplish a given task. To do so, the above scenario was again used to extract some small tasks like asking user to do farm input request to input suppliers about availability, price, or delivery time of fertilizer, new seeds, and asking users to advertise their ox in public to get a better price. To accomplish such tasks, different paper screens were organized to form a storyboard, which in turn facilitated understanding among farmers about concepts of interaction across screens (see Figure 31) and arranging paper screens. Once a relatively stable consensus was reached, arrows were drawn to connect the different paper screens that were

arranged to undertake a given task. The same processes were followed for the remaining tasks.

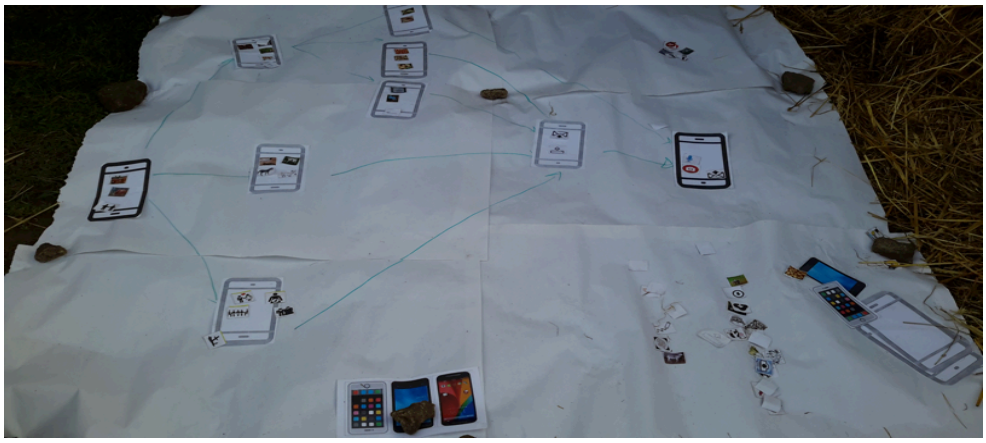

Figure 31: Accomplishing task though navigation across paper screens

Again, the concept of tree metaphor was found to be a better option to structure the navigational layout. An overall summery of UIs' navigational path not only helped to organize, structure, and label navigation into a single page, but also to create another view for participating users to add additional comments. Furthermore, letting users traverse mentally through this diagram was observed to identify some of functionalities buried in deep hierarchies created due to poor categorization.

To enable users to predict what will happen before users perform the function in the user interface design, the mental model is another important dimension to be considered. Here, a mental model is viewed as users' thinking and expectations once they have seen the nearby picture in the context of user interaction. This was tried through organizing tasks of user work practices into a hierarchical structure. Rodil et al. (2014) states that UI can be co-created with users by mapping conceptualizations of their world. In our case, analyzing the sequence of tasks and their hierarchies in farming business practices was a means of investigating the farmers' mental model. In other words, after we designed UI prototyping through low-fidelity prototypes, we investigated the users' mental model via walk-through evaluation. The refined design through multiple iterations gradually moved from low-fidelity prototyping to high-fidelity representation.

The high-fidelity prototype is characterized by a technical implementation of these functionalities. A fully-fledged mobile app using the Android operating system was implemented. The functionalities of this app are similar to those of the SM@SMS, but the interaction modality is based on text, picture, and audio format. Figure 32 shows the first screen

that comes when we start this app. It displays a menu with three options: agriculture- related, social event-related and animal-related categories.

Figure 32: M-CIH, home screen

To demonstrate how the user can navigate across screens, one sample case was described here. For example, if a local farmer wants either to view stored messages or wants to upload a new message about weed-controlling techniques, he can choose the first nearby picture from the home screen. This lets him to jump to another detailed menu, which is about new seed verities, fertilizer, and weed, inset and market information; see Figure 33(B). As the farmer's objective is to get advice about weed-controlling techniques, he/she is expected to press a picture that shows "people doing uprooting". Doing so leads him to the next screen, which displays the newest types of weed in the community; see Figure 33 (C). Then he/she should select the type of weed, which leads him/her either to view the previously stored messages or to upload a new question. If he/she selects to view the previously recorded messages, the UI (D) displays the contents via picture and/or recorded voice. He/she can use the back and front arrow to navigate a list of weed controlling advises. On the other hand, if he/she wants to send a new message, the app displays three screens (E) for writing text or taking a picture or recording his speech to send to all as a single message.

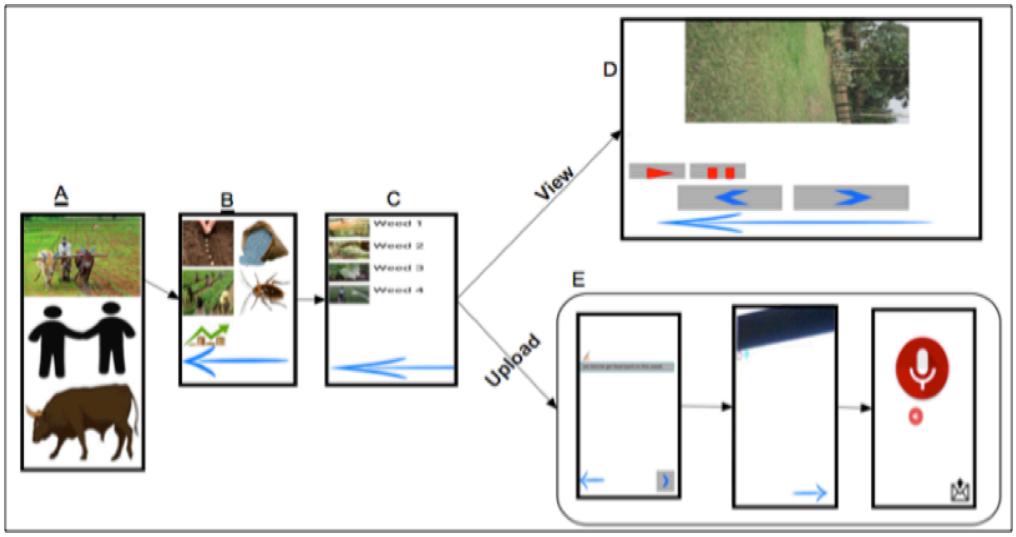

Figure 33: Sample navigation and interaction across screens

Well coming screen shoot (A) well come screen (B) major farming task categories (C) list of common weed types (D) a screen showing advice given by any expert or other farmers (E) screen to upload a text message, or picture or a voice message.

6.4.2.3 The community knowledge center

Before technological alternatives become usable to most of the rural farming community, some of the current barriers need due attention. It was required to establish self-help skill infrastructure. This is because some of the communities either have the understanding of what ICT can do for them or they are in a position to articulate their IT needs about their agriculture activities. An ICT project should provide its approach to and educate the community on the potential use of ICT through awareness, a training-the trainer approach. After the idea of establishing the community knowledge center was endorsed, 100 trainees (30 farmers and 70 youths) were selected. One week before the planned class schedule, the entire previously listed trainees were called to share general ideas and the class schedule, but only 45 of them showed up. On the trainers' side, the endorsed rule that can penalize 25USD if anybody disturbed the community knowledge center demotivated most of them. Furthermore, they were also asked to pay 0.5USD per month for electricity on top of the previous contribution (2USD) by each Edir member. As a result, only 32 trainees attended the course, which lasted for two months.

Figure 34: Picture taken of trainees (youths) in the community knowledge center

6.5 Evaluation, deployment and pilot results

In this evaluation, the intention of usability was focused on an outcome of interaction rather than a property of a product. The process evaluation is concerned with defining appropriate tasks and scenario sessions that let participants do target tasks. Thus, users were given pre-staging education training or guides. This was to consider the limitations of an orality- dominant community and technologically inexperienced people. A small training session via demonstration of how the application works was also shown, followed by displaying and discussing the over all-pictorial form of a navigational tree-map; see Figure 35. This was aimed to further let them get the overall image of their agricultural information communication strategy, which was represented in the digital technology.

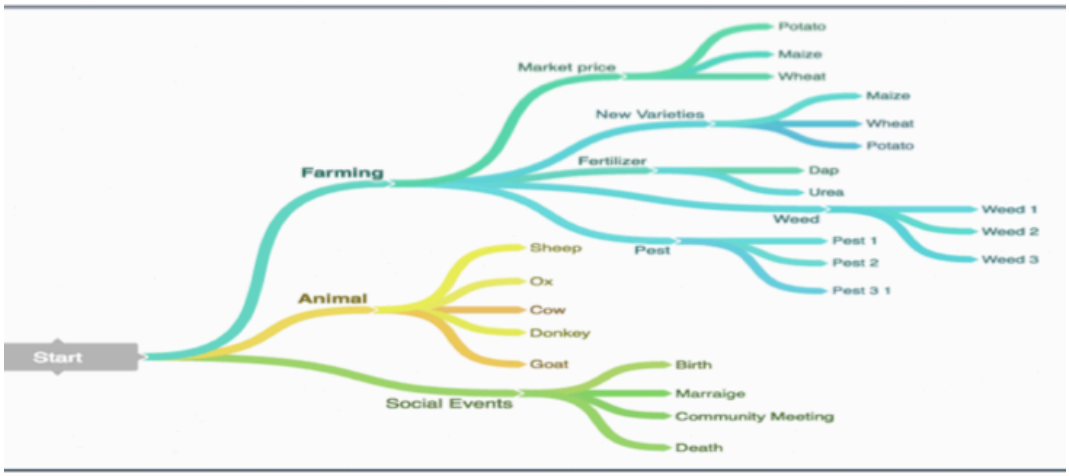

Figure 35: Tree-map depicted to conceptualize tasks and support learning

Finally, farmers were given a small introduction to the task to be performed and what was expected of them. The actual usability evaluation task was conducted with the aid of a scenario-based description; see Table 16. As a last step in usability evaluation, a subjective evaluation about farmers' subjective feelings was made to reflect their level of agreement or satisfaction.

Table 16: Sample usability evaluation tasks and scenario

Sample task	Facilitation method (e.g., Scenario) description
Adverting an Ox for sell	**Scenario:** Assume that you want to sell your ox in the next week with best prices. On the other side, there are a number of farmers who are looking to buy an ox. Right now, you don't know them but you already know that you can advertise your ox through the community knowledge center. To advertise your ox, you may send a picture of your ox and your advertising message via your voice. Now use this phone or your phone to accomplish your objective.

Coming back to the evaluation results, quantitative trial-and-error-based evaluations are difficult for community people who are both technologically inexperienced and educationally illiterate. Our user experience shows that some people first want to observe others before they start trying; others wanted to discuss in-group. Some want to get enough training before they start using it. For instance, Edir Judge preferred his son trying it than trying by himself. As a reason, he said "I bought a laptop for him to study computer, so I found this is very interesting and easy for to him to do it"; see Figure 36-A. One of the 8th-grade students who was selected as the best trainee was very confident in performing what he was asked to do.

Figure 36: Usability evaluation and feedback session.

(A) User interacting with the mobile app (B) Farmers providing subjective feedback

Similarly, using a subjective evaluation also brings biased results; see Figure 36-B. When I ask subjective questions to evaluate our work, they become biased and give mostly positive (yes, yes) feedback. They acknowledged the importance of the technology but feared trying it. In fact, they wished to learn from the community support once this technology became available for public service. One person reflected on his experience of becoming motivated to buy his phone. He said, *" Initially I thought mobile phones were designed for educated persons, and purchasing price and monthly air-time cost was high. However, I became inspired after a year when I saw some people who started using it*".

The result specific only to the second prototype, M-CIH, indicates that culture-oriented and domain-specific pictures were understandable to designing mobile app user interfaces for illiterate farmers. Surprisingly, people with low literacy memorize text as visual patterns and recognize them. For example, they easily identified and classified the types of fertilizer Urea and Dap by looking at the written text on the fertilizer bag. Concerning navigational issues, users were asked to accomplish a given task by going down to different paths (sub-tasks) commencing from one single entry point (home screen). Users were given an option to use the back arrow to return to a previous screen, but there was no choice to return directly to the beginning. Despite participants having no previous experience using touchscreen phones, it seemed relatively understandable for them to move across the screens using the forward and back arrows (buttons).

Finally, at the time of the study, there was low Internet connectivity, and very few smartphone devices were available to the community. Thus, only the low-tech technological solution was for public use (deployed) and for the pilot study. The evaluation results of the pilot trial went from July-October 2016, and usage patterns are shown for the prototype in Table 17. A total of 96 messages were received on the server side. Out of 96 messages, 38 were related to agriculture. DA was the main user of the system, who provided farmers with crop disease, best practice, and upcoming meetings. Relatively few farmers used the system to reply or ask questions. An interesting insight observed in the message was that they used social media to convey key information such as a disease outbreak, locally named as "Wag". Likewise, DA also used it for advertising purposes. He used it for encouraging model farmers to come up with their innovative experiences for promotion and further benefits. One of the typical messages exchanged among model farmers looks like this:

"keemikaala gosa adda addaa walitti makuun midhaan irratti biifun miidhaa waan

fiduuf of eeggannoo taasisuun barbaachisaa da."

"Using different combinations of chemical has a negative effect on the overall productivity of your crop, please take care."

Table 17: Types and frequency of exchanged messages

Message types	***No. of messages***
1. Agriculture-related messages	38
2. Animal-related messages	2
3. Social event-related message	17
4. Others	15
5. Incorrect messaging format	24
Overall number of messages	***96***

Although I was expecting this social media to be used mostly for agricultural purposes, the pilot data shows that 17 messages were received as social events-related texts. Participants made a point of identifying the source of information before responding to or sending their message, and some reported how their association with the service was a source of credibility in their local community. There were also messages that came without having a destination (receiver) code, which we grouped as incorrect. The reflection parts of the evaluation and appropriateness of the solution will be discussed in Chapter 7, Section 7.2.

Other external issues such as political issues also prevailed beyond the project scope of government administration. Thus, use of technological alternatives was interrupted by such facts after our deployment. During the study time, mobile phone networks and Internet were frequently shut down due to antigovernment protests. In a two-year time period (2016-2018), the Ethiopian government declared a state of emergency twice. This in turn made mobile communication and Internet services, including social media (e.g., Facebook, what-up) to be repeatedly blocked. According to a Freedom House evaluation report, Ethiopia is one of the top African countries to censor the Internet and communication services during sensitive political events (Freedom House, 2017). The report shows an aggregate score from 0-100 where 100 refer to the freest country, and Ethiopia stands at the lowest level (12 out of 100).

6.6 Exit and handover strategy

Although it is difficult for community-based projects to begin with defined end points in mind, the realities of the academic process necessitate the researcher leaving the site at some point. As a student, I began with a timeframe for the community collaboration to end. I had

been preparing work with local community people whom I invited into the collaboration. The assumption here was that the community should be able to maintain the project results when I leave the site.

As we discussed in previous sections, mobilizing the community, creating ICT awareness, sustaining motivation in participation, organizing meetings and workshops, etc., were all embedded in the project activities towards establishing community ownership of the project results. The formative and subjective evaluation was also targeted to address issues related to appropriate alternative solutions in context. In fact, one last evaluation was carried out after the final system had been deployed for a year. However, regular traveling to the center took time when I had to attend to other school engagements (e.g., attending courses, conferences, reading, writing the thesis). Thus, we made the official handover of the project to the community at the time of deploying the system for public use (the pilot study). In doing so, we arranged some of the local opportunities both from the community and Adama Science and Technology University (ASTU).

Given the fact that I am an ASTU faculty member, I explored some of the local opportunities from ASTU and attempted to establish connections with the community. The Technology Transfer and Community Service Office is one of the offices in the ASTU established mainly to work on adopting and transferring of appropriate technologies, and need-based community services to solve local problems. In light of this, the five academic staff members who provided ICT training to community people "came to work" through ASTU objectives. Here, the University not only provided used computers but also paid small allowances and transportation costs to the five trainers. One of the university community service coordinators also came to see the CKC as part of his work and reported back to the unit.

Many individuals were also getting involved in sharing ideas about the status of the community knowledge center. For instance, one of the community members who were nominated to take used computers from ASTU was introduced to the community service unit coordinator and computing department head. While he stayed for two days at ASTU, I facilitated him meeting in person with some of the computing staff. One of the ICT trainers mentioned above, an ASTU Lecturer and MSc holder, was happy to offer community service free of charge. He added, "*This is my second time to participate in community service and wish to conduct applied research. Maybe in the time ahead, I would apply for an ASTU community service project call*". Similarly, we had a discussion with one of the Ph.D. students from Addis Ababa University who has been working in m-Health. At the time of discussion, she was very

interested in the established infrastructure with the community, but as of September 2017, she had not yet decided on her study site.

From the community side, the availability of the human infrastructure, particularly youth and DA, were found to be an opportunity. For instance, at the end of the training from the community knowledge center, the five best trainees were chosen to demonstrate their skills in a meeting where their parents and Edir committee were invited. The session showed very interesting progress, and both the parents and the Edir committee were very impressed with the kids' performance. The basic idea behind this meeting was to acknowledge these five children (youth) to take the responsibility of training others. One of the community leaders added his feedback as "I see that technology is coming to our homes some years back when local committees were organizing people to bring electricity into the community, but some of the people were refusing due to fear of risk or fire. But now it is totally different." Similarly, Edir Judge and the "community knowledge center" guard showed their commitment but also disclosed their frustration regarding electricity consumption. They said, "*Before, we have been paying only for one lamp, but now it seems that the meter reader is rotating fast. So, users of the CKC need to regular pay for at least 0.5 US dollar each month*". In fact, during the entire training time the trainee paid this money.

Youths from the other two villages in the same kebele also showed interest. However, we only focused on one of the three villages where electricity was available. The main concern here was to establish a trusting and self-helping community structure that can take responsibility after I left the site. The DA had been enthusiastic from the beginning and showed a particular capacity for handling the system. However, there was no electricity in the Farmer Training Center (FTC) where the official office of the DA was located. Thus, the DA was accountable for providing support or advice regarding adopting technological solutions for wider use. Ultimately, we chose to leave the equipment in the hands of the community to be led by the Edir committee. The existence of a strong collective culture also contributed to the feeling of collective ownership.

Finally, I sum up this chapter by pointing out a few social and technical lessons. We have attempted to distill our experience in the design of technological alternatives based on local culturally and socially guided practices of engagement. We observed a situation in which our participatory process oversaw the definition and design of the ICT. Throughout this process community members were engaged in a learning and knowledge-sharing experience. The outcome of the process was driven by the needs and knowledge of the local community, as

well as constraints emerging from the context. Traditional approaches could have resulted in solutions in line with current techno centric design and development paradigms. This, in turn, could end with lack of ownership of the users and failing to find support from the local community. To this end, this chapter demonstrates the process of learning by doing.

PART IV: Anchoring ICT4D design to community context

7. RE-CONCEPTUALZING PD for ICT4D INITIATIVE

In this chapter, we present lessons learned based on the previous studies and results from our empirical research. Our research is situated between the PD and ICT4D research fields, which examined open issues in designing ICT interventions in a community context. PD processes involve many people having different backgrounds, experiences, interests, and roles. PD methods and techniques have been taken as the third space that bridges the designer world and user-world (Muller & Druin, 2002). As PD is context-dependent, so also are its methods, practices and guiding principles (Bratteteig & Wagner, 2016; Halskov & Brodersen, 2015; Kyng, 2010). Specifically, the challenge here is finding appropriate ways of bridging different worldviews (e.g., participants and PD researcher) into productive dialogue. Situatedness of PD practice in theory building is at the heart of PD research (Dittrich, Eriksén, & Wessels, 2014). Similarly, in the ICT4D research field, what kinds of design strategies to use has been the subject of debate (Sein & Hatakka, 2016; Doerfinger & Dearden, 2013; Gomez & Day, 2013; Merritt, 2012; Sutinen & Tedre, 2010; Heeks, 2009).

We turn our attention to what constitutes community-based PD and how it is achieved in socially, culturally and politically complex situations such as Ethiopian rural communities. Specifically, how do we prepare stages for the design process in collaboration with community people? How do we share responsibility with community people in design and cultivate their commitment? How can the designing of a socio-technical solution be evolved to address the problem space of underserved community? To this end, we explored the theoretical and pragmatic issues and approached in a local context. The knowledge obtained in practice is reflected as practical knowledge in the form of new insights, as well as principles and strategies.

A move from the specific (unique) to generic (abstract) is also the core component of my participatory action and design research. I suggest a generalization of the problem space, and generalization of the solution instance at a different context (scope). *First*, at a local level, my practical experience with a community people and the way I approached the problem context can be used in a similar ways to other project in a context. Specifically, the collaboration between community people and the ICT4D researcher including the local university provides a theoretical and methodological basis for designing or adapting technical solutions to relevant local needs. This in turn used to identify and refined local problem and conceptualize design ideas while formalize knowledge. *Second*, this study also informs the commonly overlooked ICT4D issues in other developing countries. My study is underpinned by systematic mapping studies of ICT4A research and several initiates in developing countries. This led me to

understand and generalize the interdependency between issues (challenges in ICT base design intervention). To this end, my conceptual framework justifies the need for systemic ICT4D efforts wherever it takes place. *Third*, this study also informs the practice of ICT4D or PD research community as it bridges the two research fields. To further clarify the above implications of the study, the empirical findings are discussed with existing literature followed by my reflection from the practical experience.

In light of the above, the new insights are presented in four sections by theme. Section 7.1 focuses on the role of sociocultural participation practices for adapting PD to a local context. We draw the concept of participation from Ethiopian sociocultural participation practices such as Edir and Wenfel. These participation practices offer much more elaborate notions about why, how, and under what conditions people do things together for coordinated actions. Section 7.2 discusses an appropriation of technological alternatives to the local ICT infrastructure and local needs. Again, the collaborative problem analysis and design bridge the gap of what is known in academic discourses, compared to what is possible and practically useful in the local context. In Section 7.3, we discuss local ownership both at the process and outcome level. In this regard, ownership is presented as a learning process that leads people to have control of alternative solutions in line with their own practice. Finally, in Section 7.4, we reflect on our overall PD interventions and the theoretical grounds to draw a comprehensive picture, a conceptual framework. This framework demonstrates commonly overlooked issues and links between ICT and development. Specifically, it underscores an alternative to viewing "D in ICT4D" as a simple package of individual rights such as economic earnings, accessibility of information, ICT infrastructure, etc.

7.1 The Role of Sociocultural Participation Practices for PD

PD research has been propagated from Scandinavian democracy to other parts of the society and other countries and cultures. Several scholars, however, have noted specific challenges in reproducing Scandinavia's PD results in different nations and cultures (Camara, Nocera, & Dunckley, 2008; Elovaara, Igira, & Mörtberg, 2006; Godjo, 2010; Muller, 2002; Puri et al., 2004; Winschiers-Theophilus, Bidwell, & Blake, 2010). In fact, Scandinavia's PD modes of user participation, discussion, and negotiation are drawn from strong traditions of trade union involvement in the workplace (Kensing, Simonsen, & Bodker, 1998). Every design situation presents a unique blend of participants' identities, agendas and roles within their contexts (Hakken & Maté, 2014; Winschiers-Theophilus et al., 2012). This is because the context of the people, environment, people's attitudes, and their interaction with each other

influence PD process and outcomes. Specifically, local participation is one of the cornerstone issues for any PD activity, which in turn requires culture-oriented interaction and negotiation. Adapting PD practices and concepts to this context demands understanding, interpreting, and responding to local sociocultural values and practice. Issues in the design process can be better explored when methods are localized and diverse forms of cultural practices are investigated (Winschiers-Theophilus et al., 2012).

7.1.1 What aspects of culture to consider?

Understanding how culture is practiced is not a problem to be solved, but a reality that should be central in consideration. Information technologies are currently being introduced in different contexts such as development and community settings. Both the design process and the technological alternative take place in isolation, but in the context of the people's environment, people's perceptions of the technology, and their interactions with each other all influence the final design outcome. A shared vision of what constitutes cultural knowledge and how such knowledge is communicated and learned becomes more important than ever.

Different scholars define ways for formalizing and interpreting the concept of culture as a collective phenomenon that shapes attitudes and behavior shared by social groups. Scholars such as Andreatta and Ferraro (2012) define three intimately connected components of culture: "Everything that people's material possessions; everything that people think (such as ideas, values, and attitudes), and everything that people do (such as patterned ways of behaving)." Similarly, Franklin (2005) describes culture as a set of socially accepted practices and values shared by a group of people. Practices are the observable manifestations of a culture expressed through symbols, artifacts, social structures, laws, and rituals. Values, in contrast, are largely unobservable, consisting of knowledge, beliefs, norms of behavior, and ways of thinking that underlie the practices and give them meaning (Kersten et al., 2002).

Seeing PD as "ways of doing something" has some interesting consequences linked with culture. Considering contextual and cultural issues in PD research is not a new notion. What is missing is that culture is not a unified entity with ontological status; instead, it is a set of analytic constructs that can be examined with respect to culture (Hakken & Maté, 2014). A culture is an integrated system with many subsystems such as society, governance, symbols, aesthetic values, technology, and language, among others (Andreatta & Ferraro, 2012, p. 34). Within cultural systems, social structure is composed of people and their interaction (e.g., relationships, roles, expectations). Extending this concept, we view culture as a set of socially accepted practices and values. Well-laid down and agreed-upon practices define how things

are done locally and shape different peoples' views. For example, the Scandinavians' Thing and the African Ubuntu are well-known cultural practices that have been recognized in PD literature.

In Scandinavian countries, there is the traditional pre-Christian practice of community participation: Thing. The basic meaning of Thing is a "meeting place", which in turn refers to the governing assembly of people in the community (Wildte, 1928). This in turn can be considered as a local participation practice. Today, Thing is still used for the national parliaments managing sociopolitical issues, for instance, Folketing in Denmark and Storting in Norway. Authors like Björgvinsson et al. (2010) and Ehn (2008) take insight from the Thing concept when discussing how to build bonds between dispersed groups, communities, and competencies while conducting PD in a community. Although the authors discuss very interesting implications of Things for PD practice, they haven't explored the very basic aspects or elements of culture such as social structure of the community and its role.

In Southern Africa, Ubuntu is best translated as "collective personhood", referring to the relational nature of being: "I am because we are" (Winschiers-Theophilus et al., 2010). The situational dynamics of social interaction and different societal values were used as aspects of culture. The Ubuntu concept is intentionally used as a philosophy for understanding cultural practice, values, and social relationships. The authors suggest that long-term immersion in the field and effective reciprocal knowledge exchange are essential to understanding local cultural practices.

In adapting PD to the Ethiopian context, we have found an interesting insight about different kinds of sociocultural practices. Ethiopian rural community culture is based on tightly related people where community leaders are regarded as influential spokespersons and act as gatekeepers for outside visitors. Community leaders are therefore considered as of the primary information sources for residents. Community social interconnections are used as rules of reciprocity when working together cooperatively. The cooperation might be formal or informal. In sociocultural cooperation practices, there are also close social ties where people expect their friends to look out for their well-being, which gives more emphasis to collective benefit than prioritizing personal goals. Sociocultural cooperation practices are the community's norms and values that facilitate collective actions for mutual benefit. Specifically, informal social association provides social and economic services to local communities. Various kinds of formal and informal sociocultural associations and cooperation such as Edir, Wenfel and Geda have been practiced (Zewge, Dittrich, & Bekele, 2015).

With respect to Edir, the informal and traditional associations have existed for a long time. For instance, Aredo's (1993) study show that Edir was established in Ethiopia in 1948 with contributions of 0.005 USD per member. His result also indicates that Edir has socioeconomic importance like informal insurance for the community. Currently, Edir functions are not only limited to the provision of core services but is also involved in community development programs such as schools and road construction. Edir is not only characterized by cultural participation practice but also as an organized community-based institution. We observed Edir to be a well-structured community organization that is established and managed by interested collective members. The Edir structure has common tangible and intangible resources such as meeting places and finances, as well as the moral commitment of individuals to collective action. Community-oriented services normally are articulated following the government administration chain, through DAs and FTC. However, mobilizing people through the government administration chain and services is not always as effective as other sociocultural participation practices. Even the local government administrators align their schedule with the Edir's schedule when they want to have a discussion with community members.

Jigi/Wenfel is another self–help participation practices where people cooperate in farming activities. They facilitate socialization processes and harmonious relations, and promote the spirit of working together to produce mutual benefits. The community people take this self–help participation practice as having important value not only for collective work, but also to enhance a sense of common purpose and social solidarity. Economic value is also founded on cooperation practices. We can see the application of sociocultural participation concepts and principles in participatory development work. The modern form of cooperatives were first introduced in Ethiopia in 1960, but it was re-established during the Ethiopian socialist government period (1974-1991) to assist in the implementation of the government's policy (Emana, 2009). Currently, the local farmers' cooperative in collaboration with government bodies provides agricultural inputs such as improved seed, pesticides, and fertilizers to small-scale farmers. This means the concept of participation, be it in community development or self-help, is part of the local community practices.

Geda System is also practiced and known for its indigenous democratic sociopolitical system among the Oromo people. Geda assemblies and power transfer ceremonies take place at cultural spaces, by a sycamore tree (locally named as Oda). Geda guides the life course of individuals and regulates political, economic, social, and religious activities of the community (Dewo, 2008, p. 168). Geda functions as a system of cooperation, social integration, and

enforcement of moral conduct and principles. The governing agencies of the Oromiya Regional Government of Ethiopia derive from the traditional institutions of the Geda egalitarian philosophy and communal solidarity. Recently, given the fact that the Geda system has been practiced as the indigenous democratic system ever since, the United Nations Education, Science, and Cultural Organization (UNESCO) has described it as an Intangible World Heritage (UNESCO, 2016).

In addition to the aforementioned sociocultural participation practices, the community members, who were part of PD project discussed here, often emphasized the issue of belonging (togetherness) through thanksgiving and traditional coffee ceremony events. For instance, every formal meeting or collaborative work starts with thanksgiving by three elders (see Chapter 6, Section 6.1.2). As thanksgiving practice has historical roots in religion, its main intention is to ask their god to bless the upcoming meeting agenda and psychologically prepare participants for commonality. Above all, thanksgiving prayer gives more messages to participants to ask, Why are we here now? The coffee ceremony is also another cultural practice that invites people to discuss issues openly. In our case, the coffee service was used to establish socialization and group harmony during workshop activities. These in turn can help share tacit knowledge among the participants in very implicit and informal ways. This can also make the designer-researchers to be considered as members of the community rather than just a visitor. Specifically, after the users perceived that I was interested in their social life and community interest, it gave rise to dialogue and friendship with them.

Community practices such as the social groups and their interaction, socialization activities, the beliefs and values they hold, self-help cooperative practices, etc., are all part of community culture. Specifically, cooperative practices can offer much more elaborate notions about why, how, and under what conditions people do things together. For a community-based PD researcher, he/she must be able to recognize the elements of these social infrastructures and practices. The community social infrastructures are not only used to construct social relations but also coordinated actions among local members of the community. For example, the concepts of Edir and Wenfel encompass a system of shared meanings that surrounds individuals in social structures through their experiences and relationships. This in turn incorporates value systems in their genuine participation. For instance, in Wenfel and Edir, people's participation is targeted toward self-help or work to be done. In the Geda system, the motivation is to resolve sociopolitical issues. Such value systems not only influence the concept and practices of PD, but also the necessity of establishing reciprocity when engaging local people in design activities. In each of the sociocultural participation practices, the existence of

a local coordinator and an implicit or explicit social structure are an opportunity for joint action. Thus, prior to a PD in a new cultural environment, the elements of the local culture and the very basic idea of participation (meaning) need to be investigated.

Up until now, we have been discussing various aspects of local culture. We further continue discussing how PD activities were actually adapted to the cultural participation practices in the next two subsections. The main discussion covers democratic decisions, the role of local actors, and community participation in design.

7.1.2 Democratic design process through negotiating responsibility

Given the fact that there are vast inequalities in accessing digital information, particularly in developing countries, several designer-researchers have been motivated to bring improvement to intended beneficiaries. However, the background process such as preparations, establishing collaboration, and negotiations depend on the cultural practices and roles and influence of local people. For instance, Dearden (2012) emphasizes how decisions about community development-oriented initiatives are taken and how local people influence those decisions. Here, we discuss how we democratically share responsibility and address the political (power) issues in collaboration with key community people.

The democratic perspective of PD underlines that people who are affected by design should have a say and influence the decision-making process (Kraft & Bansler, 1994). In particular, the experience of the earlier Scandinavian PD "collective resource approach" shows that workers and their unions were encouraged to critically challenge ICT proposals and projects in terms of their own concerns (Bansler, 1989; Ehn, 1989). To do so, the participants first learned about the design and the likely impact on jobs and working conditions. The collaborations between researchers and workers were intended to build knowledge about the relations between technology and work, formulate their goals, and develop strategies in their interests. The overall idea of projects at that time, such as "Utopia", was democratization of the design through complementary ideas of designing tools and environments.

Participatory structures per se do not guarantee an answer to the question of what is politically and ethically legitimate and desirable (Dittrich 2003; Gartner & Wagner, 1996). Each key actor needs to define the problem area and the rationale for various kinds of interventions. Sharing of participants' ideas with designer-researcher knowledge is an exercise of the democratic process (Chiara, Jefferson, & Franzato, 2014; Steen, 2011). Furthermore, the role of the PD researcher is required to be changed from a facilitator to designing a social process and facilitating knowledge transfer. For example, Dittrich, Eriksén, and Wessels

(2014) in three projects reported different roles of the researchers: as mediating a PD process, designing constituency, and leading the exploration and design processes.

A recent study shows a shift from political and workplace democracy to democratic ways of social innovation (Björgvinsson, Ehn, & Hillgren, 2010). The authors' argue for democratic design as an exploration and organization of milieus for innovation through open and public participation. The authors are interested in how designers act in a public space that permits heterogeneity of perspectives to engage in alignments of their conflicting matters of concern. When bringing social issues together, a number of areas of conflict arise between participating groups. It is precisely these areas of conflict that the authors cite as being the essence of "democratizing innovation".

In contemporary ICT for developmental research, the issue related to politically and ethically legitimating of designer-researcher roles has been highlighted (Dearden, 2012). As development is fundamentally about social change, the author recommends that the researcher change the social and power relationships between people and institutions. Dearden and Rizvi (2008b) further reported that a development project that was proposed outside the community raised issues with respect to local benefits and the cultivation of local agency. Based on community-based intervention, scholars from Africa state that rural communities are built on intricate kinship relations whose links are not necessarily transparent to outsiders (Bidwell, Reitmaier, Siya, & Dlutu, 2013; Winschiers-Theophilus et al., 2012). The authors suggest that long-term immersion in the field, effective reciprocal knowledge exchange, and continuing partnerships with communities are essential elements to overcome power differences.

Community empowerment and knowledge transfer is also recommended as a means of democratic participation (Cleaver, 1999; Dearden & Rizvi, 2008). The authors further state that skills and power relations might be developed through ongoing engagement. Cleaver (1999) recommends a transformative approach through democratic participation that is associated with building capacity and empowerment. Community people acquire more power over their lives because they engage in problem-solving and decision-making activities that promote their self-consciousness.

Experience from our community-based design case has also disclosed power issues and the means to address them. As the ICT project initiator (researcher) is the one who initiates contact with the community and conducts the ICT-based intervention, the resources for designing a technological intervention is implicitly assumed to come from a project initiator. This in turn captures a higher position of power dominance, which adds a layer of embedded

cultural power between community members and the researcher. During the early activity of my research work, people were expecting some kind of incentive like a daily allowance for participation. Some of the people were also perceiving that I was collecting my own research data but not for the community's advantage.

In addressing this issue, I had to conduct a range of activities with different roles as facilitator (leader), as change agent, as problem-solver, observer, catalyst, and teacher. I was involved in establishing multiple social relationships and assisting community members in their personal matters. This was done purposefully to build trust and understand community members through multiple bonds. In doing so, we promoted openness and feelings of ownership that motivated members to invest time and energy in our PD activities. This reminds me of the claim stated by Mkabela (2005): "An African-centric research project depends on a holistic relationship between researchers and community members". Again, the Wenfel worldview and my established relationships helped me to identify trusted community leaders.

Trusted local community leaders provide much detailed information about local culture. Considering how the local FTC service works, discussing with community leaders, engaging community youths, and engaging with community social activities were all part of establishing personal relationships. To this end, the local community leaders were found as experienced in managing the local community meetings and community activities. They are gatekeepers of the community who complemented my social and cultural understanding of the context. As we discussed in Chapter 6, Section 6.3.3, the community leaders had an important role in advocating project outcomes and awareness creation, mobilizing participants to attend the workshops, and handling sociopolitical issues. Initially, I was mostly dependent on the development agent (DA) for local coordination by basing my station at the Farmer Training Center (FTC). However, I was forced to shift from FTC to another nearby place where villagers often meet each other. This in turn brought other local actors such as Edir leaders into the picture. I found Edir leaders to be the most influential and trusted individuals compared with DA and other community leaders.

Our case also showed how competing allegiances could become problematic for the overall design process. The conflict between community leaders and Edir leaders nearly resulted in the failure of the project. Although I was involved and attempted to find a solution, the best solutions came from the local people. In fact, community administration is different from Edir administration with different roles and powers. Specifically, the Edir structure has specific local rules for governing and sustaining shared members' resources, which is well

matched to local needs and conditions. We observed that the Edir structure and its core values make it a legitimate community-based institution to look after community interests. Edir structure and principles by their nature advocate for collective benefits and disregard individual interest. If I am to reflect at a broader level, the Edir's human power, good culture of cooperative practices, and shared objective resemble the Scandinavian trade union practices.

Lessons from the early Scandinavian project, designing for empowerment (Ehn, 1993; Gregory, 2003) has made useful contributions to community-based PD. This is because when exploring ICT for community advantage, people not only have to learn about it, but they also have to decide how it should be used. This in turn requires a democratic process of empowering and capacity building, as most people are not familiar with technological options. We found that community leaders, model farmers, and development agents are information gatekeepers. They act as role models by adopting new ideas and encouraging the rest of the community. To reach a larger number of people, communicating through an Edir judge works better than approaching people individually.

We must be able to identify the different key local actors and be able to relate the local political structure and institutional form. To do so, we need to understand how it works and how influence is distributed. We might influence the existing political arrangement as we encourage the formation of a project committee (participants), which in turn creates new political complexity. As a community-based researcher who is expected to play different roles like designer, facilitator, change agent, teacher, and designer-researcher, may often engage in politics. So he/she must be aware and investigate how to democratize and anchor the design process in the community. I argue that being open and reflective about one's political agenda helps to redefine the roles and accountability of the designer-researcher and the local key actors. For example, the designer-researcher can reflect on how roles, influence, and people's capabilities are distributed at particular points in a project, and then he/she can explicitly choose how to organize design process over time.

In general, in this section, I took "democratizing design" to focus on the role of the designer-researcher and key local actors in the community. In the next section, I will continue discussing the third implication of "cultural participation practice" for adapting PD activities (e.g., participation, design, and techniques).

7.1.3 Community meetings and infrastructuring

As PD moves from the workplace into more open community contexts, it brings different design challenges than those found in the former setting. Scholars such as Dalsgaard (2010),

Karasti (2014), and Sabiescu and Memarovic (2013) pointed out some of the issues and difficulties in organizing design activities in a community context. Some of these issues need to identify boundaries of "what is to be designed" and by whom, which can become unclear; handling heterogeneous stakeholders' motivations; interpersonal associations are largely voluntary and driven by intrinsic rewards than by extrinsic factors such as pay. To this end, the forms of people's participation around a shared object of concern have been matters of concern. Providing opportunities for local people to define methods and create boundaries enables us to explore different forms of participation. It requires a reflective attitude on the part of the researcher. In light of this, our discussion is positioned in cultural and collective decision-making practices and how people get involved in design at different stages.

In fact, in PD literature, researchers extended user participation and design through notation of infrastructuring. Recently, Karasti (2014) present a comprehensive review of the literature and reflects on infrastructuring in PD. Here, infrastructuring is viewed as "the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, and a process that might include participants (end-users) not present during the initial design"(Björgvinsson, Ehn, & Hillgren 2010; see also Dantec & DiSalvo, 2013; DiSalvo, Clement, & Pipek, 2012; Ehn, 2008). From a practical viewpoint, infrastructuring is a process of mediating as well as matchmaking among various actors, interests, and activities (Hillgren, Seravalli, & Emilson, 2011).

DiSalvo et al.(2012) argue that a dual understanding of the relation between infrastructuring and the public needs to be maintained. The authors define the public as communities and argue for organizing groups of people around shared issues for collective action. Scholars like Ehn and his collaborators (Björgvinsson et al., 2010, 2012; Ehn, 2008) extend the focus of participation in design by applying the Thing concept. The authors note strategies for infrastructuring and framing participation in "design things". Initially, Ehn (2008) introduced the concept of infrastructuring things as a way of designing participation around public controversial issues. Bjögvinsson et al. (2012) consider infrastructuring as a means to enable design towards ongoing, open-ended and long-term commitments by diverse participants. It also attempts to enable fluid processes of allocating resources and alignment of actors. In a similar study, Björgvinsson et al., (2010) state that the public can be established through exposing and articulating conditions through shared action. The authors consciously applied the Thing concept to set out "Malmö Living Labs" as a type of participatory space, which can inspire user involvement and motivation by providing venues for communication, negotiation, and prototypical practices in the design process. Here, the focus of *thinging* and

infrastructuring activities were on how a designer may facilitate co-designed space with particular people by arranging material resources to set these people free for social innovation.

Winschiers-Theophilus et al. (2012) adapt the values and logic of rural Southern African societies' concepts of participation in design. By drawing on the concept of Ubuntu, the author placed people's interactions at the heart of each design meeting. In order to sustain community collaboration (participation), the authors recommended that a significant amount of time be devoted to speaking and listening activities. They also argue for designer-researchers to embrace the experience of '*being participated'* rather than actively organizing according to their definitions of participation.

In our case, people's participation and infrastructuring activities went beyond a horizontal string of activities with the same set of actors. Infrastructuring activities for long-term ICT-based intervention require establishing people around issues such as access, ownership, and usage. For a community to take action around a shared social condition, one of the most important key issues is finding active bonds and collaborative practices. A central part of infrastructuring activities in my project focused on organizing locally trusted groups towards the formation of common resources and their administration. Establishing and maintaining the social and technical arrangement enabled PD practice to take place. To this end, I was intensively collaborating and negotiating based on the community social structure. For instance, Edir does not only represent a "cultural participation practice" but also an established assembly of people, a community-based informal institution that is in fact a part of the larger community.

We came to closely interact with the local Edir leader on the one hand, and community leaders on the other hand. In the community meeting, issue of mutual concern and interest are discussed. A call for a meeting usually goes out when the leader hears of issues from community members. Every month, all the members gather at their own common meeting place. This community-gathering practice is one of their main knowledge-sharing and participatory decision-making methods. We found the community collective decision-making and participation practice as established and socially arranged in terms of resources. Thus, using homegrown participation practices was useful for selecting who should be part of change process, but not as distinguishing factors.

Working in a collective community, the process of selecting participants to represent community leaders takes social situations into account in order to sure that the community endorses the participants. This is because they select the individual considering the community members who can represent others and strengthen community interest as a whole. In the early

design activity, we approached almost one-third of the community members to collect information on contextual and environmental factors. That way, we also introduced the project to the whole community. Following this, introductory discussions were held at the community level. My discussions with community members and in-person dialogue created the basis for individual members to play a consultative role. A representative of 23 people were involved as participants throughout the design time (see Chapter 6, Section 6.1.2).

We then have been cooperating through different modes of actions, participatory experiments, and research interventions. As the community people were not skilled with respect to technology, what intermediaries and mediators for collaborative design were part of the infrastructuring activities? In fact, tools and techniques have been at the heart of the discourse of PD (Brandt, Binder, & Sanders, 2012). Investigating a string of design representations such as technology probes, scenario building, local metaphors, paper prototypes, and demonstrating multimedia demos provided powerful mediators. Through such tools, people were empowered to realize their reality and their priorities. As I discussed in Section 7.1.2, my role as facilitator contributed through understanding how future technology might be understood, designed, and used. Our "*Design thinging*" oscillated between design practice and social process (collective decision-making). The background negotiation strategies, people's participation, and design activities evolved through negotiation, which was not planned before (see Chapter 6, Sections 6.2- 6.4).

The community-meeting place served to federate different individuals to systemically address interdependent local issues. For example, some of the participants in the design workshop recommended that their youth get computer training. To this end, other infrastructuring activities such as establishing a community knowledge center (CKC), finding computers and trainers, and organizing trainees (community youths) took several months and negotiating with key actors. Several local actors such the Edir leader, community leader, kebele chairperson, development agent, community youth, and Adama Science and Technology University were involved. The arrangement of these resources by itself brought another "*form of public*" to be formed. For example, some of the community members were coming to the CKC to watch videos stored in the local computer center. Youth also scheduled themselves for shared responsibilities such as cleaning the CKC room every week. The Edir judge, "CKC room key holder", and guard articulated their attachments to common issues that were triggered by their shared responsibilities.

This shift occurred in part because the community incorporated the CKC as part of their

common resources. Fortunately, it also created an opportunity to address other design issues. For example, the community human infrastructure was found to be a valuable self-help teaching method to improve peoples' technological literacy (see Section 7.2). Behind all these activities, the community social structure and culture of participation practices were implicitly or explicitly applied for revising PD or infrastructuring activities. Like the adoption of infrastructuring (Björgvinsson et al., 2010, 2012; Ehn, 2008), our case shows the need to continuously take note of the social and material arrangements that in turn enabled the PD to take place.

The collective decision-making through community meetings can be translated into a "*collaborative research method*." User participation surveying, interviewing, focus group discussion, or experience-sharing sessions are different from framing users' participation in mutual learning. First, responsibilities between the various actors must be established. Second, we acknowledge users as co-designers rather than considering them as sources of knowledge. Third, the physical association and places for conversation are crucial for building relationships. In this regard, the community meeting is an arena in which information about community affairs is subjected to rational debate and discussion. The research process is open to inspection by the community and used to form public opinions. Ways of articulating issues in the community meetings has much to offer for PD research efforts in the process of interpretation or analysis of knowledge. Such a multiplicity of roles and actors push the boundaries of research and challenge how research agendas are set. Thus, exploring people's expertise in interpretation and knowledge creation will let us move beyond the isolated reflective practitioner (researcher) towards collaborative, reflective communities, which we term as a "*collaborative research method*."

These reflective communities can be seen as social structures that enable the local community to share knowledge for collaborative problem investigation and learning. This provides the means for scholars to understand better and respond to possible relationships between collective action and design. In other word, such a collaborative research method is one of the ways we can pragmatically research infrastructuring. This in turn provides a base to better understand the connections and leverage between ICT and development. The lessons learned from the three sections (7.1.1-7.1.3) were found as essential empirical ground to learn that the impact of technological solutions is emergent and dependent upon its social context. To this end, in Section 7.4, we further continue discussing the need for a shift both in focus and perspective of ICT4D design intervention. We highlight the overall link between community-based ICT initiative along with tangible and intangible benefits to target

beneficiaries. Specifically, we present comprehensive explanations of design processes and what to include at the operational level while addressing local needs and issues.

7.2 Appropriateness of Technological Alternatives

In this section, we reflect on our experience from the collaborative design outcomes and results obtained from deployment. The potential for ICT in agricultural is numerous but not all technologies are suitable, desirable, or feasible for their potential beneficiaries. For instance, ICT such as mobile phones, computers, telecenters, and the Internet (web) have been used in rural communities. Technology may be theoretically usable, yet it may be expensive to support with local resources. Based on our case study (grassroots-level participation, which is discussed in Section 7.1) and other sources, we highlight aspects such as peer-to-peer information dissemination and usability when designing, introducing, and scaling-up ICT for agricultural projects. This in turn enables us to bridge the gap between what is known in the academic community and what is possible and useful in context.

7.2.1 Multipurpose and peer-to-peer information dissemination tool

Traditionally, community people have their own trusted social sources of information. As a collective community, individuals rely on social groups to make up for lack of resources of information, including new knowledge. The community people who occupy a prominent position such as such as DA, model farmers, and community leaders like the Edir committee are among the main sources for other community people. Here, what really matters is that it is not only obtaining information but also the possibility (means) for an individual to disseminate such information to the rest of the community (Walsham, 2013). We reflect on aligning technological solutions based on multipurpose functionality and community communication practices.

In the literature, as we pointed out in our systematic mapping study, several kinds of technological options and information dissemination channels have been tried to reach rural farmers. The type of channel (medium) is an important consideration if people in rural communities are to take advantage of ICT-based information services. For example, the notion of public access to ICT brought the telecenter movement throughout the world. However, a number of telecenters fell into disuse due to several factors such as lack of assistance, awareness, skills, language barriers, weak ICT infrastructure, and inadequate service delivery (Amariles et al., 2007; Srinivasan, 2007; Tandi, 2010). A web portal with a telecenter as an access point can provide compressive and in-depth information, but Internet connection is still

expensive and the reachability of the information for rural farmers is very low compared to mobile phone-based information services.

With the growth of mobile phone coverage over the past decade, voice and/or interactive voice response (IVR), audio-visual and SMS based information dissemination have been tried. For instance, interactive audio-visual and/or interactive voice response (IVR) in India have been designed for local farmers to ask questions and/or browse others' responses on a range of agricultural topics (Dearden, Matthews, & Rizvi, 2011; Dearden & Rizvi, 2009). Similarly, an interactive voice forum for asking questions and browsing others' questions and responses on agricultural topics was also reported (Agarwal, Kumar, Nanavati, & Rajput, 2010; Patel, Chittamuru, Jain, Dave, & Parikh, 2010). Specifically, Patel et al. (2012) demonstrate that farmers' follow-up of agriculture tips is higher in peer-to-peer communication compared to tips given by university agricultural scientists. The interactive voice application or IVR is relatively good for addressing language and illiteracy problems, but navigation and searching user-generated content is tricky.

The "Digital Green" project had been tried to share video-based agricultural information and agriculture best practices using TV, DVD, and personal computers (Gandhi et al., 2009). As I discussed in Chapter 2, the "Digital Green" approach has begun implementation in Ethiopia. However, this approach has limitations at both the technology and process levels, including the high cost of devices and digital resources, problems in reaching wider people, and it is not at all interactive when farmers want to share information and events compared with mobile phone.

Belachew's (2010) study based on national government initiatives such as school-net and woreda-net show that even if there is an infrastructure, it is underutilized because of lack of skills, lack of organizational commitment, and unavailability of digital content. All the aforementioned issues indicate that technological alternatives for rural people require taking several issues into consideration. Technology might be feasible, but the community cannot afford it. Technology might be feasible and affordable, but might be unusable by the community due to the lack of skills to use it.

As we discussed in Chapter 6, Section 6.3.2, three different design ideas were discussed. First, a farmers' shop center, to establish farmers' information shopping center at the near by town where farmers can ask for help while they go marketing. Second, FTC- based service – Strengthen the FTC; however, inaccessibility of electricity at FTC made it problematic. Third, community-owned information center, an information center established at the center of the

local village where people usually gathered for meetings. As we discussed in Section 7.1, community people have a strong traditional information-sharing approach, as well as trusted relationships among themselves. We promote ICT for agriculture as the continuation of such traditional practices. Thus, the third option was found to be a hub for awareness creation sessions, capacity building and accessing information.

In light of the above, two types of technological alternatives, low-end and high-tech mobile-based solutions, were designed. The low-end solution was appropriated to support bidirectional and group SMS over mobile phones. This is labeled as social media with SMS communication channel: *SM@SMS*. This technological solution is also in line with the local ICT infrastructure and mobile penetration. As of July 2017, 85% of the Ethiopian geographic area has been covered by 2G mobile service, and about 51% is covered by 3G (GSMA, 2017). Of the 23 workshop participants, 19 own a mobile phone. Regarding smartphone accessibility, among the 19 cell phone owners, only three model farmers own smartphones. Taking the current trend and expecting to reach most of the rural community, we explore the possibility of high-tech (smartphone) based solution, m-CIH, along similar lines.

The affordability of technological solutions is another issue that was taken into account. The Ethiopian charges for telecommunication services are even higher than in Denmark (see Table 2). The current cost of a monthly Internet package of 10GB is 19.69USD in Denmark, but the same data package costs 43.73USD (more than double) in Ethiopia. As most of the ICT initiatives are driven top-down and technocentric (Dodson et al., 2012; Wikipedia, 2017), the local telecommunication services charge by itself raises the affordability issue. In our case, as we discussed in chapter two, the pre-study results show that most of the respondents spent 0.91-1.8 USD per month for sharing agriculture-related information or social issues and other via calling. The Ethiopian tariff for sending a single message costs 0.02 USD, and sending 600 bulk SMS messages costs 1.8 USD per month. We also replaced a 90USD monthly SMS-Gateway subscription fee (Ethiopian telecommunication service) using a mobile phone as SMS-Gateway. To this end, a monthly SMS package is relatively the cheapest, which made an affordable channel to build a social media that does not require Internet support.

Not only the community's technological options but also the scope of the information service needed in support should be considered. Based on our initial assumption and the study results, agricultural marketing information was taken as the most important information. Such information is often needed most during harvest time, which usually goes for 2-3 months out of twelve seasonal agriculture months. The collaborative problem investigation (Chapter 6,

Section 6.2) shows that agriculture marketing information service alone is not the desired need of smallholder farmers. Rather, the scope of the community information need was far larger. These include not only crop and agricultural inputs but also animal health and social activity information.

Both *SM@SMS* and *m-CIH* technological alternatives support bottom-up knowledge sharing. People in the local community are considered not only receivers of information, but also content providers. Such solutions support community strengthening social groups (peer-to-peer), which allow them to be informed of events as they happen. At the same time, content could be disseminated to the social group for wider access through the existing strong social ties. Stories of successes and failures in agriculture practices can help farmers to learn from others' experiences and assist in developing better connections. Experts can use the solutions to disseminate useful information in situations such as pest or disease outbreaks among their peers. Furthermore, DAs, NGOs, visiting researchers, etc. often collect information from the community for reporting to others or for their consumption. As far as the information is useful, this technological alternative can support sharing knowledge with the community groups for collective development action.

Pilot results of the use of a low-tech solution further demonstrate the usefulness of multipurpose information dissemination to work with existing service providers. The evaluation results from the pilot trial went from July-October 2016, and a total of distinct 96 messages were disseminated among and/or between the three social groups (farmer, model farmer, and development agent). Out of 96 messages, 38 were related to agriculture. The low-tech solution was not designed to replace traditional extension methods but to supplement the DA to function more effectively. As discussed in Chapter 2, based on the preliminary survey, the proportion of DAs to the farming community is 1:700. As a result, one development agent is expected to provide agricultural advice for 700 farmers, which is a bit difficult to cover, as farming communities often live in scattered settlements. Interestingly, development agents (DAs) were found as the main users of the system, as they provided farmers with crop disease, best practice, and information on upcoming meetings. Although I was expecting SS@SMS to be used most for agriculture purposes, 17 messages were received as social events related text such as greetings and good wishes for "spiritual anniversary day". Most of these messages were informational and the DA was one of the actors who had most frequently sent messages. The community information needs are season-dependent, and most of them are informal compared to organization-based information sharing practices.

Finally, we understood that instead of designing full-fledged functionalities of agriculture information services, it is better to keep it simple. A tendency that attempts to design all the information those farmers possibly need could lead to complexity and higher costs. A better approach is to start by providing limited information with the intention to upgrade and scale up services over time. The multipurpose and peer-to peer alternatives are in line with community communication practices. Here, we argue that the aforementioned lesson exemplifies the results of collaborative problem analysis and design that enable us to bridge the gap between what is known in academic studies from what is useful in context.

7.2.2 Extending usability concept and evaluation procedure

Usability includes defining attributes to involve potential users in simulating activities and processes that will be performed on the actual technological solution. This in turn might require evaluation through quantitative measurement or qualitative feedback whether usability goals have been met. The individual-level evaluation could be done as a formal laboratory test or collection of satisfaction data through survey. However, the limitation of usability concepts and focusing usability evaluation at the individual level brings up issues about universality. Specifically, given the fact that most rural communities lack both educational and technological literacy(see Section 2.5), we are required to redefine and address usability goals according to the rural context and needs.

Based on ISO-9241-11 standard, usability is defined in terms of Usefulness, Learnability, Efficiency, Error rates, Satisfaction or likability in a particular context of use (Bevan, Carter, & Harker, 2015). Such a usability definition focuses on what level can target users achieve specified goals in a specified context of use (technological solution). DiSalvo et al. (2012) argue that the conventional usability evaluation process contrasts with conventional norms of formal learning that implies a unidirectional flow of knowledge. Scholars like Winschiers-Theophilus and Fendler (2007), based on their work with Namibian user groups, state that standard usability evaluation encompasses a twofold bias. First, the definition of usability according to Western standards and secondly, the usability evaluation method that aim to test an already biased objective. In a similar manner Teka, Dittrich, Kifle, Ardito, and Lanzilotti (2017) explore usability evaluation in software organizations in Ethiopia. The authors reported that less ICT skills, lack of trained professionals, and lack of awareness are still unique challenges to conducting usability evaluation. A study by Bruijn, Nyamnjoh, and Brinkman (2009) demonstrated the two positive reasons for widespread use of cell phones in developing countries. First, the cell phone is simple to use and learn. Second, it is trainability where an

individual can experiment with public phones and share families' phone before acquiring it. Our case also disclosed two important usability insights at the concept and evaluation level.

First, extending the usability concept from individual attributes to a usability attribute related to group (community) users. ICT4D requires changes through interaction and collective action. Incorporating a communal perspective enables us to better understand usability through social opportunities. This is because collective action is the process of doing something together, and it is an inherent element of rural community practice (as we discussed in 7.1). As a collective community, people are more dependent on their community to realize their capabilities. For example, during the early study time we were defining and assuming usability as individual access to "agriculture market information". But we later understood that empowerment and collective (social) capability building were found most essential to make ICT useful to the community. Furthermore, increasing social interaction can promote acceptance and address usability issues for the wider community. Thus, we need to redefine the very basic concept of usability in conjunction with the intended user (beneficiaries) and cultural context. This in turn quickens the process by which ICT intervention is appropriated to the community needs and practices and establishes collective local ownership (see 7.3).

Second**,** extending usability evaluation procedure**,** quantitative usability ("time and errors"), and evaluation based on standard usability evaluation does not fit with community people. As we discussed in Chapter 6 (Section 6.5), our user experience shows that some of them first want to observe others before they start trying; others wanted to discuss in a group. Some want to get enough training before they start using it. For instance, Edir Judge preferred his son to try it before him. As a reason, he said "I bought a laptop for him to study the computer, so I found this is very interesting and easy for to him to do it". One of the 8th-grade students was also selected as the best trainee in the community computer training and was very confident in performing what he was asked to do.

Similarly, a subjective usability evaluation tool (see Appendix C) also brings biased results. As the community-based PD researcher, I was engaging in a range of activities with different roles as facilitator (leader), as change agent, problem-solver, observer, catalyst, and teacher. In due course I purposefully built trust and friendships. Following this, while I asked subjective questions to evaluate our work, the answer might become biased and give mostly positive feedback rather than pointing out limitations. Our experience and understanding show that both the summative and formative usability evaluation demanded extending its scope from a single evaluation to long-term based usability evaluation.

We considered (social) human infrastructure as an opportunity. First, every family has at least one son or a daughter who can read and write. Second, as the community is a collective society, there is a strong social connection among members, which is an opportunity for the community people to get support and to start using a newly designed technology. To this end, the initial formative evaluation was performed in the CKC at both farmer and youth levels through an educational approach (see Section 7.2.3). The youth at the center were found to be a human infrastructure that facilitates self-help skill development and training for other community members. Third, the DA is usually approaching many farmers in the community, as his duty is teaching farmers about best agriculture practices.

With respect to the formative evaluation of m-CIH, the culture-oriented and domain-specific nearby pictures are understandable and can be used for designing user interfaces for illiterate people. As we discussed in Section 6.4.2, people even with low literacy can memorize text as visual patterns and recognize them, which we commonly expect to be difficult to interpret. For example, they easily identified and classified the types of fertilizers, Urea and Dap, by looking at the written text on a fertilizer bag.

In general, to further support usability evaluation in context, alternative evaluations and local issues such as "why things were done" and "how it fits in the broader context" is required. Strengthening awareness of community towards their-use-in practice could be complemented through long-term capacity building and activity-based pilot evaluation. This is because providing short-term training or demonstrating exemplary case and then start conducting usability evaluation may not address issues at use time. One farmer reflected on his experience how he became motivated to buy his phone. He said," Initially I thought mobile phone was designed for an educated person, and purchasing price and monthly airtime fee was high. However, I became inspired after a year when I saw some of the people who started using it". Adopting a developmental view of capacity building in which community people develop skills and capabilities through the course of long-term human infrastructure is useful.

7.2.3 Functional education and promotion from the outset

The technological solution requires both educational and technical literacy, which are both lacking among a majority of the rural population. Almost 75% of people in Africa are non-users of digital information, and 38% of adults are still illiterate (Pasquier, 2014). These numbers become worse when we consider the Ethiopian context. According to the Human Development Index, only 49.1% of the population aged 15 and older are can both read and write (UNDP, 2016). The overall rank of Ethiopia is found at the lower level, 74 out of 188

countries. Our survey results from 110 interviewed farmers also showed that 39% of the respondents had not received formal education (or illiterate). About 33% of the respondents attended primary school, but among all respondents who attended formal education, only 50% of them have the capability of only reading and writing out of the two local languages of Amharic or Oromigna, but not both.

In our case, the result of a process, exposure to its outcomes, and awareness of its future use are essential for addressing functional education and promotion. Currently, new knowledge about agriculture extension and technologies has been exchanged through functional rather than formal learning. The development agent (DA) usually trains a group of model farmers in the hope that such farmers come in contact with other farmers. DAs are expected to approach many farmers in the community, as his duty is teaching farmers about best agriculture practices. The rural community in general has a low level of perception of the relevance of the ICT project. Thus, the community members have to learn both how to use it, and decide on how it should be used as a community service. A promotion of ICT service is essential for a wider community of people to know that what is available and possible. This in turn demands empowerment strategies beyond skill enhancement.

As we discussed in Section 7.1.3, infrastructuring activities such as establishing a community knowledge center (CKC), arranging "self-help teaching" for community youths, was established at the outset of the study. The arrangement of these resources by itself brought another "*form of public*" to be formed. For example, some of the community members were coming to the CKC to watch videos stored in the local computer center. Due to overwhelming interest by the youth in ICT, other community people can leverage the use of technological solutions. They can help wider rural communities to interpret ICT in terms of local needs, and ultimately this enables community people to get functional education and awareness.

Summary: I recap this section by reflecting that only availability of technological options such as access to ICT infrastructures and a low-cost device cannot solve the significant challenges of information access at the community level. The availability of ICT infrastructure access is not valuable to them without associated digital content that is relevant to local populations. Similarly, without appropriate and timely data, a community's decision-making on agriculture business cannot be improved. Farming communities need various kinds of timely information across the agriculture seasons. Although access to information can be provided in relatively affordable, usable, and feasible ways, this alone is not sufficient for the rural people to practice information dissemination. Thus, technological solutions should focus

more on strengthening social communication and information dissemination among or between key actors.

We understood technological solution and phenomena as mutually reconfiguring ensembles of social and technological entities in a specific context. We underline community-based PD as a sociotechnical approach where human experience and social agency are the primary focus. Here, community-based PD is fundamentally geared towards designing technological alternatives for actual use. Again, based on our discussion in Chapter 4, the pragmatic epistemological approach was followed for understanding how we can learn and generate knowledge through action-and-design-based intervention. Finally, the lesson learned from 7.2.1-3 was used to organize our thoughts to propose a comprehensive sociotechnical approach (see Section 7.4). Before we discuss this approach in detail, let us first deliberate on community ownership for self-help capacity building and adoption of technological solutions. Organizing human infrastructure in turn requires establishing shared responsibility for public access. The next section is devoted to the process of establishing community ownership.

7.3 Establishing local project ownership

This section presents our insights into how local ownership was built up both at the process and product levels. Our lessons from Sections 7.1 and 7.2 indicate that when community people participate in the design process, they develop a sense of owning the envisioned technological solution. This in turn quickens the process by which it is appropriated to community needs and practices. It is essential that local operational issues are resolved from the outset to build the competence of the local ownership and gain their support. Thus, we need to give due attention to establishing relations between a community's participation and the development of a sense of ownership. Community involvement is not likely to foster the expected sense of ownership when top-down directives undermine community decision-making practices. Before discussing and reflecting on the impact of ownership on ICT4D initiative, let us define it as a construct.

Psychological ownership as defined by Pierce, Kostova, and Dirks (2003) refers to people's feelings of possession of a variety of material and immaterial things. Developing the feeling of immaterial ownership may include people's ideas and worldviews. By extending this concept, we view ownership as community behavior about ICT project objectives, design process, and transferring the final results to the community services. Here, one can differentiate individual technological ownership from social ownership. Individual technological ownership occurs when technology becomes simple and accessible, whereas social ownership happens

when technology becomes a tool for social and economic advantage. People who have not taken the opportunity to reach a close relation with ICT, due to historical reasons or lack of education, require specific support. Thus, ownership is the learning process that leads people to have control of ICT uses in keeping with their own context. To this end, we discuss our lessons and reflections related to reciprocity and communal resource and administration.

7.3.1 Reciprocity and Incentive structures

As an ICT4D researcher, it is important to acknowledge the fact that both researcher and the community people (participants) need to gain benefits from research outputs. This is because they are expected to address both local problems and research problems together with the community people. Engaging community members in collaborative design means that people have to prioritize their time. In an ICT4D project, there is still discussion on suitable ways of compensating study participants for their input such as paying a daily allowance to reach a better future through the technological alternative.

In the literature, lack of incentives (compensation) for participation was stated as one of the reasons for failure of development-related research projects (Winschiers-Theophilus et al., 2015; Marais, 2011; Walton & Heeks, 2011; Tongia & Subrahmanian, 2006). The authors state that the use of financial incentives encourages people in participation and establishing reciprocity. This seems to work with the process approach where community people perform what the ICT4D researcher tells them to do. However, for the community people to take an interest in a particular reason (e.g., community need) and then become activists, a better understanding of community motivation and incentive structure is required. Rather than relying only on a common strategy of materially rewarding informants, scholars like Kapuire, Winschiers-Theophilus, and Blake (2015) suggest that harmony and humanness should be focused on as primary values in community-based interactions.

In our case, as we discussed in Section 6.2.3, during the early activity of our work people were expecting some kind of offer like daily allowance. Some of the people were also perceiving that I was collecting my own research data but not for the community's advantage. We discussed with intermediary and local people to understand what methods would be appropriate ways of compensating people. Some of the people criticized the reciprocity of the project by pointing out their previous experience with other researchers: "We have been asked by different researchers before but the result of the research project have not yet been seen in the community." It was therefore important to form a trustworthy relationship with community representatives to establish a collaborating strategy that leads to a win-win outcome. As we

discussed in Section 7.1.1, again, the wenfel worldview was adapted. That means that the local community promised to attend meetings regularly and discuss with their neighbors to articulate their perspectives and needs; in return, I agreed on the project results and related outcomes to bring value to the community people.

In light of the above agreement, I was accomplishing tasks that were beyond the planned project activities. For example, I was involved in establishing multiple social networks and assisting community members in their personal matters, community youth among others. This was done purposefully to build trust and understanding with community members through multiple bonds. In doing so, I promoted openness and the feeling of ownership that motivates members to invest time and energy in design activities. In response to their request for community children to get ICT training, obtaining ten used computers and five trainers from ASTU also improved reciprocity. Although establishing the community knowledge center is beyond the initial purpose of the study, it became a shared resource. This in turn was considered as a form of compensation for participation. This reminds me of the claim stated by Mkabela (2005): “an African-centric research project depends on a holistic relationship between researchers and community members”.

Furthermore, at the center of building reciprocity, the prospect of a better future through the technological alternative was deemed as an incentive for community people. As we discussed in Section 7.2, designing and deploying technological alternatives was based on community need and practice. Specifically, once the community is convinced and becomes part of the co-design process, ICT4D efforts can cut down on the cost of an intervention. In our case, for instance, community people contributed money to construct a house for the community knowledge center. This, in turn, is created for ICT4D initiatives to transfer ownership to the community people.

7.3.2 Communal resources and administration

Beyond establishing trust with local key actors and becoming trusted by the community, the other most important question is what type of social arrangement might be recognized as legitimate representatives of community interests, and who should be consulted. The fundamental concepts of establishing responsibility and community ownership can be derived from appointed or emergent participation. In the case of the former, some community people must be identified or explicitly assigned a role of supporter for the ICT4D project. In this strategy, community people and ICT4D researcher work together to achieve the goals that they agree upon. However, a rural community is not a unit entity, but composed of several social

groups each with their own local leaders. It is difficult to resolve these issues without making some decisions about the moral legitimacy and scope of authority of these social groups. An emergent standpoint requires community people to take an interest by exploring opportunity and previous experience, or demonstrating existing technologies as a catalyst. In doing so, ICT-based projects can benefit by enabling reciprocal exchanges of knowledge between local communities and designer-researchers. Towards the formation of communal resource and administration, we need to explore social and structural capabilities to define community interests.

ICT4D projects have been facing the problem of transferring ownership to the community during and/or after the project lifecycle (Rega, Fino, La, & Moro, 2013; Winschiers-Theophilus, Zaman, & Yeo, 2015). For many ICT4D projects, local intermediaries such as NGOs have been treated as key gatekeepers (Ho, Smyth, Kam, & Dearden, 2009; Ssozi-Mugarura, Blake, & Rivett, 2016). NGOs or local government administration could be used as intermediaries, but still they are not part of the community. Scholars like Winschiers-Theophilus et al. (2015) state that the researcher and community members should build a strong and clear understanding for joint project ownership. In an e-Choupal project in India, extreme importance was given to identifying and choosing a trusted local person or operator (Kumar, 2004). To do so, the researchers made multiple visits to a village and used selection criteria including standing in the village, trust in the community, and farming experience, among others.

In our case, the understanding of community motivation and the agency of local actors were crucial to our understanding of the ownership. Just as a designer-researcher must develop a deeper appreciation of the communities he/she hopes to assist, rural communities need opportunities to develop an appreciation of technologies. Thus, negotiating a strategy that convinces community members of the worth of the project and lets them play a role in some specific activities was part of the PD process. As discussed in Section 7.1.2, community (gere) leaders played a pivotal role in the establishment of this project for local interests. Their cooperation was indispensable in mobilizing the participants for the meeting and facilitating group discussions. However, with respect to the responsibility of ownership, Edir Judge was found as the most preferred leader. Edir is not only characterized as a cultural participation practice but also as an organized community-based institution. We found Edir to be a well-structured community organization, which is established and managed by the interested and collective members. Edir structure has common tangible and intangible resources such as meeting places, finances, and the moral commitment of individuals to collective action among others. We observed that Edir's structure and core values make it a legitimate community-

based institution to look after their own interests. If I am to reflect on a broader level, the Edir's human power, cooperation, and shared objective resemble the Scandinavian trade union.

The process of establishing the community knowledge center disclosed many social and political issues that had strong connections to the concept of community (collective) ownership. Improving perception of technological opportunities may lead people to see them as an end. However, establishing local ownership demands appropriately managing political and social issues as they arise during the research process. In our case, transferring ownership came over time and was highly influenced by personal conflicts of interest. At the beginning, the exercise of ownership followed the existing community power structure (community leaders). To practically implement collective ownership and administration, we shifted responsibility from community leaders to Edir leaders. However, this process was not ended without creating tensions from both sides, as we discussed in Section 6.3.3. Similarly, DAs had been enthusiastic from the beginning and showed interest for handling technological solution. However, we faced practical problems with establishing the community knowledge center at FTC. First, there was no electricity in the Farmer Training Center (FTC) where the official office of the DA was placed. Second, DAs are actually living about 12 kilometers away from the FTC (community). Finally, DAs were accounted to work on providing support or advice towards adopting the technological solution for a larger use but not as the main owner of the CKC. This is because the sociopolitical structure and administration in Edir is different from the way FTC has been administered. Finally, we handed over the CKC and its administration in the hands of the community that was led by Edir committee.

The community-based PD not only allowed community people to offer input on crucial matters but also fostered ownership. Neglecting to involve local people in local administration of ICT intervention implies that local people's requirements are overlooked. The lack of local people's involvement also meant their views and opinions are not incorporated into the design, hence affecting the process of establishing local ownership. Thus, the ICT4D researcher needs to engage in dialogue and review different community roles in determining which social groups should own the final project outcomes. Negotiating their local needs, sharing control of the design process at the same time, exposing an intermediate outcome, and awareness of its future use, assisted in identifying trusted social groups for the collective ownership. To this end, we understood that the feeling of perceived usefulness was one of the important driving forces for people to acquire ownership and commitment. This is also in line with Cleaver's (1999) argument that a participatory approach to development could inform building capacity, empowerment, and local ownership.

Finally, our summary and generalization links the lesson from community ownership to long-term partnership. ICT4D researchers need to engage in dialogue and review different community roles in determining which social groups should own the project outcomes. Starting with community individuals, followed by community-level local groups and eventually reaching the majority of society can lead to a concrete characterization of the rural community. An important point here is to consider ways of ascertaining community accountability from the start of the project, and work beyond simply providing training. Thus, we need to look more closely at how we engage local people in the design process and questioning our approaches and methods. Furthermore, the collaborations between ICT4D researchers and community people need to address questions that lead local people to express and understand their individual roles, responsibilities, and expectations. Here, community-based ICT4D designer-researchers should not only focus on technology as a final solution or outcome but also need to use several artifacts to build people's awareness and inspiration.

Towards establishing local ownership, opportunities and resources were taken into account. First, we focused on local community structure and the trusted human networks in which people are engaged. In this case, Edir was found to be a trusted community social group, which finally took the responsibility of ownership. Second, we considered existing ICT infrastructure, accessible and affordable technology (e.g., mobile phones), and affordable means of accessing digital information (see Section 2.4). We designed technological alternatives, which is a multipurpose and peer-to-peer information dissemination tool (see Section 7.2). It also supports relevant content and services, which can support social activities of the community to be produced and shared by individuals within the community. Third, human resources, or the available skills and capabilities of the local people to utilize the designed technological solutions, were addressed by taking advantage of the human infrastructure and social groups, and lessons from 7.1 and 7.2 were activities carried out for human capital. In doing so, we attempted to address the twin risks of ICT4D failure: "failure in designing technologies" and "failure of ownership" (Dearden & Rizvi, 2015).

7. 4 Conceptualizing the link between ICT and development

In this section, we discuss how and under what circumstances ICT embedded in social practices and processes moves the community towards local development. The previous three sections (7.1-7.3) were focused on people's participation and opportunities, technological alternatives, and establishing ownership. The technical solution is not seen as "a single technical entity" but as a part of the sociotechnical processes that emerge over time from ongoing sociocultural practice and collaboration. Now, we further continue discussion of the overall link between ICT and tangible and intangible aspects of development. My interpretation of development stands on the following points or questions. Development requires change, which in turn raises a question of "Why is there a need of change?" "What aspects of things should change?" "Who are the target people? And "What to put at the operational level?"

Based on the development perspective, which is presented in Section 3.1, we develop an alternative conceptualization of capability approach. According to Sen (1999), the capability approach views development by introducing human choices in the first place. It also stresses the capacity of people to define their own development priorities. We see ICT as an opportunity to establish access to information, promote local knowledge sharing, and foster empowerment. ICT provides possibilities (choices), but to match people's capability with possibilities, we need to embed both the social and technical design processes into the concrete social situation. PD is a way to design ICT and at the same time develop people's capability so that ICT becomes an opportunity.

In light of the above, we first present the contemporary ICT4D challenges in Section 7.4.1. In Section 7.4.2, we discuss concepts and ways for understanding ICT4D issues in a holistic manner. Systems thinking and the "values perspective" of the early Scandinavian PD, the collective resource approach (CRA), is discussed. Specially, the two core values of PD, "democratic value" and "pragmatic value", are used to support my argument. Finally, in Section 7.4.3, an approach that elaborates the link between ICT and development is discussed. My move from empirical data to theoretical statement corresponds with 'abductive reasoning'[9]. In abductive reasoning, pre-understanding of a context influences understanding of a certain phenomenon that in turn requires a set of observations to find a most likely explanation.

[9] https://en.wikipedia.org/wiki/Abductive_reasoning

7.4.1 ICT4D challenges

Although a growing effort is underway to provide ICT services to disadvantaged people, it seems common to read that ICT initiatives fail to meet their expectations. What are the challenges and how are they discussed? Here, several ICT4D researchers claim, including myself, briefly discuss their challenges. These challenges or remedies are by no means exhaustive but it provides a relatively comprehensive picture of the ICT4D challenges. For the sake of discussion, the challenges (claims) are presented in terms of three themes: a) challenges related to contextual conditions; b) challenges related to design approaches or processes; and c) challenges related to aspects of development.

7.4.1.1 Challenges related to contextual conditions

Context is often used as a term that refers to where and when technologies are developed, implemented, and used. Investigations and descriptions of context are constructive activities for multiple accounts to be understandable (Hayes & Westrup, 2012). Understanding ICT4D contextual issues and acquiring knowledge about phenomena enhanced our study and design practices. Several researchers mentioned their claims and contextual issues that affect the ICT intervention.

The very lack of or weak ICT infrastructure for connectivity is the first common issue in most developing countries (Pimienta, 2009; Walton & Heeks, 2011). For people to make use of ICT, local barriers such as financial resources, skills, social resources (knowledge, motivation, and trust) must be addressed (Duncombe, 2007; Siyao, 2012). Misinterpretation of soft constructs such as culture, social, institutional, and political issues are reported as failure factors (Abbott & Kashefi, 2016; Best & Kumar, 2008; Marais, 2011; Reijswoud, 2009). Identifying relevant contextual phenomena and actual local needs is largely unknown before conducting an ICT4D project (Bon & Akkermans, 2016). Other scholars like Winschiers-Theophilus et al. (2010) emphasize adhering to the sociocultural norms of the context. Similarly, Dearden and his colleague underscore the side effects of skewed power relationships between development actors and intended beneficiaries (Dearden & Rizvi, 2008; Dearden & Tucker, 2016). Also, when it comes to solutions, contextual factors are highlighted. For local community people to make their own choices and leverage local knowledge and knowledge acquired from external sources, the significance of local capacity building is highlighted (Dearden, Light, Kanagwa, & Rai, 2010; Marais, 2011; Walton & Heeks, 2011).

7.4.1.2 Challenges related to design approach and process

Here, design approach refers to a hierarchical approach (top-down) or a grassroots

(bottom-up) approach. Several scholars claim limitations of the externally driven and top-down approach as it fails to understand the real needs of people and is inadequate in gathering and defining requirements (Dodson et al., 2012; Hamel, 2010; Pitula & Radhakrishnan, 2011; Tongia & Subrahmanian, 2006). Even if the villagers' input is solicited, their social status, limited literacy, and lack of exposure to ICT act as barriers to their full participation when using conventional requirement elicitation approaches (Pitula & Radhakrishnan, 2011). Determining what is relevant and applicable is often established by external experts to comply with agendas of funding agencies, and elaborated in a top-down manner (Kleine & Unwin, 2009; Pitula & Radhakrishnan, 2011). Goals of donor agencies are typically more high-level and generic, but the goals of end-users are often much more specific (Bon et al., 2016). This is further driven by technology-centeredness, with a lack of co-designing technological solutions with the intended beneficiary (e.g., community people).

If community development is a primary objective, the needs of the community have to be given higher priority than a technology-centric response (Dodson et al., 2012; Gichamba et al., 2016; Hamel, 2010; Knoche et al., 2011; Zewge & Dittrich, 2017). For example, access to information through the Internet alone is insufficient; instead, ICT need to support active knowledge-sharing among local beneficiaries. Scholars like Walsham (2017) claim that ICT4D researchers should not consider themselves as "experts" bringing top-down solutions to beneficiaries. Rather, "we should see ourselves as co-contributors with everyone else, since all people throughout the world have views about the impact of ICT in their particular context". However, effective user participation, establishing partnership with local organizations, and building relationships with local governments are still affecting our understanding of local contexts (Knoche, Rao, & Huang, 2011; Maail 2011; Toyama, 2011; Walton & Heeks, 2011). Strong local people participation reduces the twin risks of "failure of ownership", a lack of local commitment to sustain technology interventions, and the delivery of technologies that are not appropriate (Dearden & Rizvi, 2015).

7.4.1.3 Challenges related to "aspects of development"

Different development perspectives and dimensions of development have been proposed for ICT4D researchers to derive objectives of ICT innovation (as discussed in Chapter 3, Section 3.1). For example, the economic growth perspective is founded in the concept that developing countries can reach the same level of development as advanced countries by imitating the latter (Hettne, 2009). The notion of "human development" draws on the capability approach (Sen, 1999) where development is seen as people's freedom to "lead lives that they value". A key development concept here is people's well being, which refers to a person's

functioning, what he/she can do and agency achievement of what a person values (Hamel, 2010; UNDP, 2016). Human development underpins the millennium development goals (UNDP, 2003) and sustainable development goals (World Bank, 2016).

Despite the above development perspective, linking ICT to development is still an arguable issue, particularly the processes it necessitates. After decades of ICT4D research, several researchers are asking for clarity in "What is meant by development" and practically linking ICT with development (Andersson & Hatakka, 2013; Heeks, 2006, 2010; Islam & Grönlund, 2012; Thapa & Sæbø 2014; Walsham, 2017, 2013). In fact, economical empowerments, social cohesion or communication (access to information), and the rights of individuals to access digital information are among the most commonly cited dimensions of development (Zewge & Dittrich, 2017). The theories for development are dynamic, with new objectives and approaches continually emerging. For example, economic developmental outcomes do not result from the diffusion of ICT alone. Instead, issues associated with the economic growth benefits of ICT need wider government intervention such as regulation and structural reforms. The core assumption of millennium development goals and sustainable development goals is that ICT can bring development specifically to marginalized people such as rural farmers in developing countries. Although this hypothesis has noble intentions, it is often difficult to demonstrate in practical terms beyond policy issues.

Donor agencies, academic communities, and development practitioners have used the human development (HD) perspective extensively (Hamel, 2010; Oxoby, 2009; UNDP, 2016). The Human Developments Index (HDI) is a composite of statistical indicators based on life expectancy, education, and per capita income. However, HDI does not include essential subjective and intangible development outcomes. Similarly, the ICT Development Index (IDI) defined by International Telecommunication Unit (ITU, 2016) has eleven indicators to assess ICT impacts. These indicators are used to assess the impact of access to ICT on economic development. Access can be collected easily using a survey study or it is readily available in survey data sets. However, development as we understand it goes beyond mere statistical indicators. Telecommunication systems are predictable prerequisites for ICT4D initiatives, which should be addressed at the country level. Both HDI and IDI indicators are used to view development from the top.

Sen's (1999) capability approach provides an overall development perspective for social development, but it lacks an explanation of collective capability and process from ICT interventions to achievement. For example, during the early study activity, we were assuming

that individual access to "agriculture market information" was considered development. However, we understood that empowerment and community capacity building such as self-help teaching and peer-to-peer communication were ways towards reaching development outcomes. It is my understanding that the theoretical challenge to the ICT4D researcher regarding development is not the choice between the different development perspectives, but rather the difficulty of adequately grounding the theory of development to specify a sociotechnical design process.

We have described several issues related to context, ICT, and development. We also understood that there are important similarities among ICT-based interventions, regardless of their purpose and scale. At the same time, we see ICT as one tool among several, but not as a panacea for the immediate improvement of community problems. That means ICT intervention requires multilevel actions with several intermediate and interdependent outputs. Furthermore, ICT4D issues are interdependent and cannot be understood in isolation. In the next section, we discuss the theoretical underpinnings of the systems and values perspective of participatory design as a way forward.

7.4.2 Systems thinking and PD values perspective

Before discussion of ways of linking ICT and development, we first recap the two theoretical underpinnings. The first one is the systems thinking and the second is the values perspective of the early Scandinavian PD: collective resource approach (CRA). Specifically, the two-core values perspective of PD, "democratizing design" and "pragmatic value in design", are used to support my argument.

Systems Thinking: As discussed in Chapter 4, this is a way of understanding real-life scenarios that are often ill defined and highly dependent on human activities (Checkland 1994,1998). The basis of systems thinking is that "the world is complex and appears different to each observer." It provides a language to describe and analyze the area of concern through concepts such as systems boundary, structure and relationships, and inputs and outputs (Jackson 2003, 2010; Sherwood, 2002; Stowell, 2009). That means, the situation is described in all its richness and abstract systems' multidimensionality. In practice, systems idea could mean enabling the observer to view situations of interest in its formulating perspectives and that learning about it can only be done from within and by being a part of the situation. Thus, a conceptual distinction is made between systems emerging properties and what it does: constituent activities and relationships. To this end, multiple perceptions are exploited to learn about and eventually improve a problematic situation.

The PD values perspective: The early Scandinavian PD approach, the collective resource approach (CRA) was an innovative participatory approach to design and implement technologies in a workplace (Kraft & Bansler, 1992). It emphasizes not only technology and systems design, but also change for and improvement of people, organizations, and practices. To this end, groups of workers and their organizations were supported in developing their understandings of technology and alternative ways of designing (Ehn, 1988; Floyd et al., 1989; Kensing & Blomberg, 1998; Kraft & Bansler, 1992). The organized workforce challenged proposals and projects regarding their concerns. In the design process, the use process was also conceptualized to include design aspects such as technology, use values, work organization, and skill requirements (Floyd et al., 1989). Empowerment through practical learning and the creation of local ownership through participative processes were also the central issues (Braa & Hedberg, 2002).

We can see the essential concepts and design processes that characterize collaborative work in early Scandinavian PD. As we have also discussed earlier, politics, people, context, method, and product are the five interrelated aspects of PD. Behind this, the two core underlining value viewpoints of PD are the democratic view and pragmatic view (Bjerknes & Bratteteig, 1995; Greenbaum, 1993; Halskov & Brodersen, 2015; Kyng, 2010). The democracy view refers to the social and rational idea of democracy as a value that leads to the legitimate decision process, whereas the pragmatic perspective underscores the importance of people's knowledge to designing improved outcomes, or "design for improvement". This is founded on the belief that PD designer-researcher and target people do not share similar worldviews (experience) about the problem context. However, they can understand each other's experiences and dilemmas through collaboration. The democratic and pragmatic PD values are leading to better technology. PD to do better technology always carries an element of emancipation, as it presents technology as something to be designed (Dittrich 2003).

Here, our main message and our argument is that the systems thinking and the Scandinavian PD values perspective enable us to ground the link between ICT and development. As we discussed in Section 7.4.1, ICT4D issues are multiple and interdependent. They are systemic issues, which cannot be understood in isolation but they are interconnected and interdependent. Based on the above discussion and lesson from our PD encounters (section 7.1-7.3), seven ICT4D design issues are framed. We present our argument in terms of what, how, and why of ICT4D issues. Part of our argument includes collaboration and participation, understanding context and need, empowerment and capability building, sociocultural issues and opportunities (see Section 7.1), ownership (see Section 7.3), and technological alternatives

(see Section 7.2) and impact dimension. For the sake of understandability, plausible explanations about the how as well as why (the glue between them) are discussed in the next section.

7.4.3 Evolving sociotechnical issues and interventions in ICT4D

Based on our lessons from Section 7.4.1 and our PD encounters, we are arguing for a shift both in focus and perspective of ICT4D design intervention. It is fundamental to think that the impact of technological solutions is emergent and dependent upon its social context. Above all, the relationship between ICT initiatives and development goals is complex and often indirect. The foundational issues that need a deeper consideration in ICT4D are: a) The way we identify contextual issues and involve the target community as actors; b) the way we think about technological alternatives; c) the ways we think about development that ICT is expected to bring to the local community.

An inductive step has been made from empirical statements to theoretical statements. The resulting theoretical statement explains concerns to account for actions while designing community-based technological alternatives. This conceptual framework can be thought of as an approach that describes what ICT4D issues is discussed above, how (the relationships between issues) and why (influences between them) (see Figure 37). As background, we refer to “the role of theory”, which was discussed in Section 7.4.2. Specifically, systems thinking is sensitive for the designer to understand context from multiple perspectives. The two PD values provide concrete ways to address a wicked design problem in a democratic and pragmatic manner, which in turn leads to improved appropriating technological alternatives.

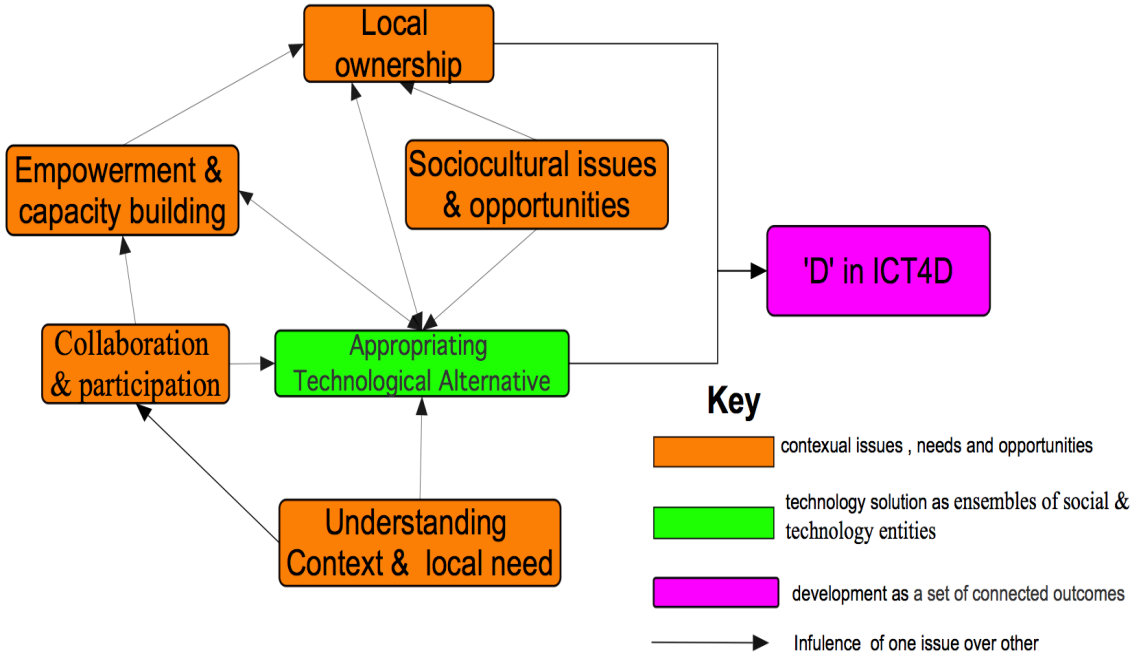

Figure 37: Conceptualization of ICT4D in design intervention

The discussion follows are also labeled with three different colors as shown in Figure 37. Furthermore, the argument also follows based on issues and results to be considered during "exploration and design" as well as "pilot and use". We start the discussion and argument from "understanding context and local need" followed by the others.

Understanding context and local needs: ICT4D researchers and development practitioners use context to describe conditions and processes in the explanation of phenomena. Context may be international, country, organization, regional, neighborhood (society), or individual (Gomez et al., 2012). Investigation of context is a constructive activity, which requires bringing and holding multiple descriptions to form a picture. Some limitations of the ICT4D initiative to bring impact for an intended community already indicates that it is a wicked problem (Pitula, 2010; Tongia & Subrahmanian, 2006). As we discussed in Section 7.4.2, scholars like Sherwood (2002) state that systems thinking is the art and lens that enable us to make sense of problem situations in a wider context as he put it: *"*Seeing the forest for the trees*"*. Thus, it is problematic to assume easily identifiable, agreed-on goals like in the case of top-down and technology-centric development given that there are multiple values, beliefs, and interests of local people in context.

In response to this, the following questions could support our systems thinking to see the full picture of the problem context (see Table 18, number one). What are the needs and

aspirations of local people? What are the environmental and infrastructural challenges to ICT-based solutions? What are the characteristics of local people's ability, opportunity, and motivation in relation to information, communication, and knowledge-sharing? What is the level of local people's perception of disseminating information and advice using ICT? As we discussed in Chapter 2, we first analyzed the agriculture sections at three levels: national, organizational, and community. Collecting stories from local stakeholders and investigating government policy helped us to discover the complexities of the process and what aspects to consider. We zoomed in and considered the rural community as a relevant context for further systemic investigation. This in turn requires establishing relationships with the community for both collaboration and accommodation of different worldviews of particular changes.

Collaboration and participation: Embracing PD values for ICT4D require building trust and working relationships within the rural community. In fact, we began building common ground about the contextual issues and practices using ethnographic field studies prior to conducting the design workshops. Here, we first focused on closer engagement with the local people to understand cultural nuances and establish local collaboration. Different groups of people such as community leaders, Edir leaders, community youths, Kebele administrators, DAs, Woreda agriculture extension officers, and university staffs were engaged. The other and unique collaboration between ASTU and community also came up through my deep-rooted relationship with the community and personal commitment. The basic idea came up after some of the community people were asking for computer training for their children. In fact, the origination of PD as a design approach was derived from people (as collectives) to engage designers in their practice (Binder et al., 2011). To this end, the following initial questions could help us to identify key local stakeholders and benefactors over time. What are local stakeholders' expectations and worldviews about technological options? What should be the extent and influence of each of stakeholder's participation? How can we establish local formal and/or informal local institutions as co-collaborators?

Here, we argue that establishing collaboration as mentioned above exemplifies a basic prerequisite for ICT4D researcher to be guided by PD values. To this end, collaboration between community people and the ICT4D researcher, including local universities, must be in the interests of both sides helping both parties to push ahead with research-based technological design. This in turn provides a theoretical and methodological basis for designing and adapting technological solutions to relevant local contexts and needs. Furthermore, the way we established collaboration with the community, social group (Edir) and local universities would respond to one of the ICT4D issues: "many ICT programs also fail to develop local partnerships

with existing community-based organizations working in their project area" (Gigler, 2011; Knoche et al., 2011; Maail, 2011; Toyama, 2011; Walton & Heeks, 2011).

Sociocultural issue and opportunities: Every design situation presents a unique blend of participants' identities, agendas, and roles in their context (Hakken & Maté, 2014; Winschiers-Theophilus et al., 2012). This is because the context of the people, environment, people attitudes, and their interaction with each other influence PD process and outcomes. Specifically, local people's participation is one of the cornerstone issues for any PD activity, which in turn requires culture-oriented interaction and negotiation. Adapting PD practices and concepts to this context demands understanding, interpreting, and responding to the local sociocultural values and practice.

In our case, as we discussed in Section 7.1, culture was an opportunity for adapting participation and a means for negotiating the design process. One of the grassroots level collaboration, which is unique in ICT4D literature, is the value of the community social group (e.g., Edir's social structure, resources, and administration). A rural community consists of many different informal institutions, political groupings, and ethnic and social groups, each having different goals and agendas. Thus, prior to a PD in a new cultural environment, the elements of the local culture and the very basic idea of participation (meaning) need to be investigated. To this end, the following initial guiding questions are useful (see Table 18): What are local culture elements such as values, social solidarity, and self-help cooperative practice, social structure, and socialization activities? What is the degree of difficulty and strength of establishing community social groups for joint activities? How are the local political context, power dynamics, and relationships within the community structured? How can we develop a trusting relationship with the community?

Empowerment and capacity building: Rural communities in general have a low level of perception about the relevance of the ICT project. Scholars like Mutenda, Mpazanje, and Chigona (2011) state that a community will not participate in ICT initiatives if individuals cannot see the relevance of the project. The community member has to learn both how to use it and decide on how it should be used as a community service. Thus, a significant time was allocated to discussion with some of the community leaders before the committee became part of the collaborative work. Identifying local model farmers and working with them expanded awareness of the project at the community level. Arrangements were made to enable community members to participate in the design process using the local language, conducting meetings near where they lived, and coordinating workshop meetings with facilitators. The

first visible common understanding showed when the participants watched some ICT initiative demos from other African countries. This awareness creation workshop (demonstration) improved user capacity, which later ended with establishing the local community knowledge center.

The democratic values of PD underline an empowering process leading to empowered outcomes. For instance, Ehn's (1993) design-empowering strategies such as skill enhancement for people to gain confidence in their abilities to overcome constraints were identified in the research process. In our case, empowerment strategies demand going beyond skill enhancement (awareness creation) to the issues of establishing responsibility and a collective resource pool. In this process, information becomes a "resource". For instance, in terms of opportunities for local ICT capacity building, arranging "self-help teaching" for community youths was established at the outset of the study, but remain a property of the study for the remaining design activities and outcomes (see Figure 37). Furthermore, Participatory Communication (PC) in which the community youth were given basic ICT training and they were informed to tell their fathers about their impression and lessons learned.

Our community empowering and infrastructuring activities exemplify and extend in three directions: *i)* preparing the stages for community people as a co-designer; *ii)* developing "being-participated", whereby the designer-researcher becomes a member of the community to some extent (Winschiers-Theophilus et al., 2010); and *iii)* creating opportunities for community members to develop capacity and capability, which responds to Dearden et al.'s (2010) claim: "If we aim to design ICT4D, the approach that we adopt must be sensitized to how they empower local people to progress their own visions of the kind of social development, and the form of ICT that they want". We might trigger a point for investigating issues related to empowerment and capacity building. What means and ends are used to build awareness about the benefits of ICT projects in general? What are expected local skills and knowledge to be developed over time? Are communication resources such as technologies, and operational costs available and affordable? How can we establish a local human infrastructure for delivering self-help training and support?

Local ownership: Empowerment and awareness creation should go beyond skill enhancement to issues of responsibility and project ownership. One of the critical and contextual issues in ICT projects is to what degree the process of designing ICT has led to the gradual transfer of "ownership" to the local community. More importantly, a sense of ownership is a process that requires building a shared vision over time. As we discussed in

Sections 6.4.2.3 and 7.3, we initially assumed that the community knowledge center would be placed in the kebele administration, but that did not work. And then we shifted to the sociocultural group (Edir), but the committee was not prepared to take ownership. There were several local issues such as membership, operational cost, lack of perceiving short-term impact of technological solutions, and additional burden for administration. The dialogue went into several stages such as negotiating with elders (locally called "shimagle") and discussion at the community meeting (assembly). Finally, it worked out not only through my effort but also most importantly through the efforts of local actors. In the early study, the designer-researcher should not be focused only on design skills but also on his ability to create conditions that encourage a collaborative design process and active reflection (Merkel et al., 2004). Again, empowerment and capacity building were found as prerequisites to cultivate local ownership; see Figure 37. The following question can be used as an initial checklist to further support our investigation. What type of local responsibility is established at different stages of the project? What kind of local institutionalization means and preconditions are needed for local people to take the lead role and the responsibility in the project? How can we understand users' attitudes and perceived usefulness toward the overall project goals or outcomes?

Behind all these activities, the community social structure and culture of participation practices were implicitly or explicitly applied to infrastructuring activities. Specifically, the application of communal resources and administration practices were useful concepts for establishing systemic ownership. The community knowledge center became part of the local resource and the community rules, procedures and administrative practices. These elements cannot be imported from the outside but must be cultured and strengthened locally together with community people. ICT intervention focuses not only on introducing ICT solution for the community service, but also designing a local strategy for people to see how they might learn about and address their emerging needs. This in turn facilitates further consideration of negotiation, needs, and discourses about different issues of technological solutions and local development.

Appropriating Technological Alternative: As we discussed in Sections 7.2 and 7.4.2, technology might be feasible and affordable, but might be unusable by the community due to lack of skills. Even if it is usable, it may not be relevant to the community's needs due to lack of localized and timely information. Furthermore, technology might be feasible, but the community cannot afford it. Here, technological alternative also stands to represent that people in the local community are considered not only receivers of information but also content providers, in contrast with information dissemination from one single center. This in turn

strengthens their peer-to-peer communication so that content could be disseminated to the local social group for wider access. We view technological solution and phenomenon as mutually reconfiguring ensembles of social and technology entities. It is also difficult to understand either technological solutions or context as independent entities.

In early studies, both work context and technology were subject to evolutionary design (Dittrich, Eriksén, & Wessels, 2014;Dittrich, Eriksén, & Hansson, 2002; Floyd, Mehl, Reisin, Schmidt, & Wolf, 1989; Grønbaek, Kyng, & Mogensen, 1997; Kyng, 1998).The authors suggest action-oriented and "systemic process of learning" (inquiry) to improve the problematic situation. As we mentioned in Chapter 4, our standpoint ICT4D is a pragmatic paradigm where knowledge making is a process of interaction among people, practices, and artifacts. Thus, the relevant social and technical issues have significant implications for theory and practice. From a practical perspective, it facilitates detailed design activities. From the theoretical point of view, it guides completeness of issues in ICT intervention towards tangible or intangible development outcomes. Again, the following questions are used to highlight basic issues. What is the level of ease of ICT tool in the eyes of end users? What is the level of the intended context of use compared with daily community social practices? How can local community members be part of the source of information and become involved in generating it?

From Sections 6.2-6.4 and 7.1.3, our infrastructuring activities were oscillating between social and technical issues and processes. Specifically, a*)* the explicit discussions of design intentions; *b)* clarification of values embedded in design strategies*; c)* conceptualization of design in relation to social practices; d) continuous reflection-in-action illustrating our community-based PD. Again, based on the pragmatic values of PD, we understand design through a process of creating and developing PD techniques to share experiences about existing situations and envisioning the future as mentioned by Brandt, Binder, and Sanders, (2012), Dearden and Rizvi (2008), and Ehn (1993). In our case, PD techniques were extensively used to bridge the worlds between the designer–researcher and community people. For example, the local PD concepts and local techniques such as odd tree, house, agriculture seasonal metaphors, and technological probe were all part of the investigation (adaption) and design processes. Specifically technological probe, multimedia presentations, and prototypes were used to lead ordinary community people to understanding. Most importantly, the conceptualization of technology as a social resource expanded collaboration in design (see Section 7.3). As can be seen in Figure 37, the intermediate outputs such as awareness and inspiration (as an

empowerment), and local opportunities were continuously refining local needs and negotiations to be intertwined within the design process.

We created circumstances for a local community to be a co-designer by conducting design activities at the community meetings and practices. Here, I was acting as facilitator, helping users to realize their needs, and acting as designer, researcher, and "agent of development." The community meeting and design workshop enabled action to occur and change to happen. The level of change depends on many factors such as the perceived value of ICT and establishing the community knowledge center. Based on the democratic value of PD, the designed technological solutions were an "empowering outcome" because it contributed to people better understanding the benefits of ICT intervention and local ownership.

"D in ICT4D": We found difficulty viewing "development" as a simple package of individual factors such as economic earnings, accessibility of information, ICT infrastructure and devices (mobile phone), etc. Development is instead related to a set of empowering processes and empowered outcomes. In fact, the capability approach provides a multi-level process of development (Sen, 1999). It focuses on individual ideas of capability and opportunities. However, real-world problems and addressing development in the local context is much more complicated than what we typically expect in an ICT4D project. For instance, stories from the field demonstrate that owning mobile phones often could not help them, although their capability and opportunities are in place. Here was one story told by one of the community members from our study area:

> *" .....last summer, we were informed that the price of the crops was better in a nearby town (Assella), then after a week's preparation we packed our onions and potatoes to sell there. Unfortunately, the local trader (middleman) followed in our footsteps to make the final price even cheaper".*

This indicates that addressing social-economic developing goals require a careful investigation of the broader social context such as establishing a local institution, building collective capability, and knowing about government policy, among others. To explore what aspects of development to consider at the local level, the following questions need to be addressed: How can ICT help people to achieve what they consider to be valuable? What is the intangible expected benefits actually taking place at the end of the project activity? What kind of local institutional means and preconditions are need for local people to take the lead role and the responsibility for the project?

We focus on the informational power of ICT, and benefit comes when social ownership of ICT and outputs are locally appropriated. The democratic perspective of early Scandinavian PD was rooted to ultimately bring improvement to the workplace and to people's lives. Similarly, "development" requires actions and changes through interaction and collaboration. Negotiation is a continuous planning process that itself is a goal as well as objective of development. It was the empowerment of collective social and human capability that led to ownership of the community knowledge center. That means adding a collective capability to Sen's individual capability gives a better understanding of how ICT can lead to community development. As depicted in Figure 37, we attempt to address the local meaning of development through a systemic approach with several intermediary (intangible and tangible) outputs. These intangible and tangible outputs include trust building, empowerment and capacity building, and establishing a community knowledge center.

The real ICT4D initiative can impact to rural lives when current people's know-how is improved and when the community adapts technologies into their own social and cultural practices. This in turn requires long-term and continuous improvements to the system services and supports. Thus, strengthening people's informational and human capabilities both during design and after deployment is required. Our case shows that it is difficult for ICT4D researchers to observe and report real development outcomes over the course of a few months' pilot study. Outcomes come through ongoing process of ICT use rather than from product or short-term deployment of ICT. In fact, we expected to continuously work on ICT awareness creation and capacity building beyond the traditional training methods. Facilitating the wider community to join the digital communication system and let them practice for some time requires continuous follow-up. An increase in take-up and use of an ICT by the community is a proxy for capability and meaningful impact to come.

Finally, my generalization to this section, "conceptualizing the link between ICT and development", relates to some of ICT4D researchers' previous claims. According to studies by Gigler (2015), Harris (2015), and Dearden and Tucker (2016), contemporary ICT4D studies are often inclined to influencing academic research practice and policy but less inclined toward activities that would make an impact on local people. Similarly, scholars like Gomez and Pather (2012) argue for a fundamental shift in the current ICT4D, both at the theoretical and methodological level through detailed exploration. Our community-based PD and the systemic approach respond to this debate. As presented in Figure 37, understanding what are the issues, how issues are interrelated, and why one issue influences others are key for defining ICT

intervention. In doing so, we cannot only see values that implicate in design process as evaluation criteria, but that are also used for theorizing from ICT4D design practices.

Moreover, this conceptual framework (approach) can serve as an opening path for ICT intervention from its initial stage of needs assessment up until enhancement of human and social capabilities. We hope that the above conceptual framework would extend the motivations and priorities of PD values into ICT4D design practices and support in defining local Aspects of developement. Furthermore, based on our empirical studies and the argument above, we develop an initial checklist for systematizing method and what to take into account (see Table 18*).* The table describes the issues of ICT initiatives to be considered at various levels and scopes, be they tangible or intangible outputs and outcomes, both in the design activity and piloting (use) activity. It also helps to see how the technological solution might come into being and what kinds of empirical data should be collected.

Table 18: Issues in ICT4D initiatives and design dimensions

1. Understanding Contextual need	
A	What are the needs and aspirations of local people?
B	What the characteristics of local people ability, opportunity, and motivation in relation to information, communication, and knowledge sharing?
C	What the level of local people perception of supplying information and advice using ICTs?
D	What are the environmental, and infrastructural challenges and opportunities toward ICT based solution
2. Collaboration and participation	
A	What are local stakeholders expectation and worldviews about technological options?
B	What kind of incentives need to be aligned to stakeholder and end-user
C	What are the extent and influence of each of stakeholder participation
D	How can we establish local formal and/or informal local institution as a co-partner
3. Sociocultural issues and opportunities	
A	What is the degree and strength of establishing community social network through joint activities?
B	What are local culture elements such as, values, social solidarity, and mutuality of feelings, norms, social structure and socialization activities?
C	How is the local political context, power dynamics and relationships within the community structure?
D	How can we developing trusted relationship with the community
4. Capability and capacity building	
A	What means and ends are used to build awareness creations about the benefits of project ICT in general?
B	What are expected local skills and knowledge to be developed over time?
C	Are communications resources such as content, technologies, operational cost are available and affordable ?
D	How can we establish an appropriate local human infrastructure for delivering training and support service?
5. Local ownership	
A	What types of expected ownership is assumed to be establshied by local stakeholders at different stages of the project?
B	What kind of local institutionalization means and pre-condition is need for local people to take the lead role and the responsibility in the project ?
C	Understand users' attitudes and perceived usefulness toward the overall project goals or outcome?
6 Designing Technological Appropriatenes	
A	What is the level simplness of ICT tool in the eyes of end-users?
B	What is the level of the intended context of use compared with daily community social practices?
C	How local community member can be part of the source of information and involve in generating it
7. "D in ICT4D" :Impact dimensions	
A	How can ICT help people to achieve what they consider to be valuable?
B	What are the intangible expected benefit actually taking places at the end of the project phase?
C	What is the level of users use pattern of information and knowledge?

8. CONCLUSION and RECOMMENDATIONS

The recent proliferation of ICT across the world and developing countries in particular has been creating opportunities for rural communities. ICT is becoming a platform for information dissemination and communication, which in turn calls on the ICT4D researcher to play a significant role at this point in time. Despite widespread use of ICT and the importance of this research field, still there are several constraints to be addressed in making ICT intervention useful for the intended beneficiaries (Dodson et al. 2012; Gitau et al. 2010; Gomez, et al., 2012; Tongia & Subrahmanian, 2006).

This study was concerned with comprehensive explanations of design process towards local development goals. In light of this, a flexible and reflective research strategy was applied to generate knowledge while addressing real-world problems. Being inspired by Scandinavian PD tradition and literature, and motivated by problem areas in the rural community, I described the journey of my study in eight chapters. Chapters 5 and 6 present the core empirical research concepts and participatory design with the rural community. Much of the research on PD approaches in literature has limited experience within developing countries, particularly in rural community settings. Understanding sociocultural issues and investigating different forms of opportunities leads us to appropriate design in a new way. The results and our reflection are discussed in detail in Chapter 7. The following three subsections summarize what PD and ICT4D research mean in the community context.

8.1 The implications of the results for PD and ICT4D research

This section summarizes concepts, processes, and results mentioned throughout this thesis towards addressing the research question. *How can community-based ICT intervention be designed in a socially complex rural context with people who have little or no technology experience?* As a starting point for discussing the implications of my study, let me first refer to the current trends and gaps in PD and ICT4D research. In ICT4D literature, the majority of research is concentrated on understanding the factors and impact of ICT initiatives. This is dominated by survey analysis without synthesis data through the design process (Gomez, 2013; Sein et al., 2016; Zewge & Dittrich, 2017). Within the PD community, there is so much experience and focus on processes of user participation, but often the designing computational alternatives and impact of project outcomes have been neglected (Balka, 2010; Halskov & Brodersen, 2015; Korsgaard, Nylandsted, & Bødker, 2016). This study lay between PD and

ICT4D research. We indicate the implications in four themes: PD in a context, technological alternative, ownership, and ICT4D issues and concerns.

PD research in context

Local collaboration and collective decision-making practices like the Ethiopian case, *Wenfel, Debo, Edir,* and *Geda* worldview can serve as a strategic point to adapt PD processes to a local context. Here, we contribute a conceptual base to articulate why familiarizing PD concepts and design practices are so important for PD research and approaches. These practices not only facilitate the identification of problems that need to be addressed, but also foster in-depth collaboration to develop a co-design attitude. It also helps to understand how community and social dimensions can be taken to contextualize global development goals in the local context. The grounding of PD research in specific PD practices is necessary to continuously indicate what PD can or should be (Dittrich, Eriksén, & Wessels, 2014).

Co-designing with community people helps to adjust and negotiate design processes based on the community's worldview. This in turn is influenced by the culture and social values of the community. The community-based design inspires us to rethink our design practices and roles. Based on the aforementioned cultural practices, we reconsider our role and see ourselves as co-designing a "common resource pool" in collaboration with various community people. Such infrastructuring activity becomes necessary when research output, local capacity building, and social development goals like ICT4D are expected to converge during the project activity.

As a community-based researcher who is expected to work in different roles like designer, facilitator, change agent, teacher, and designer-researcher may often engage in politics. So he/she must be aware and investigate how to democratize and anchor the design process in the community. We suggest that being open and reflective about one's political agenda helps to redefine the roles and accountability of designer-researcher and the local key actors. For example, the designer-researcher can reflect on how roles, influence, and capability are shared at particular moments in a project, and then he/she can explicitly choose how to organize design processes over time.

As a generalization to our community-based PD encounter, when collaboration design approach is the subject of research, the elements of the local culture and the very basic idea of participation need to be investigated. For community people to take action around the shared social conditions, one of the most important issues is finding active bonds and local participation practices. For instance, the community meeting is an arena in which information about community affairs is subjected to rational debate and discussion. The research process is

open to the community and is used to form public opinions. Thus, the ways of articulating issues in the community meeting has much to offer for PD research efforts in the process of interpretation or analysis of knowledge. Such a multiplicity of roles and actors pushes the boundaries of PD research agendas and challenges.

The ICT4D issues and multilevel actions

In the ICT4D research domain, it is essential to be aware that access to technology should not only consider availability of ICT infrastructure and devices, but also their affordability and tangible or intangible benefits to the intended beneficiaries. Furthermore, it is important to realize that new technology may take time for uptake by the larger community or people may not immediately shift from the more traditional forms of communication, knowledge-sharing, and collective action that evolved within a given community. Thus, technology should not attempt to replace or bring new ways of communication; rather, it should complement and be integrated into communities' social practices. In doing so, we support relevant content and services that can help the social activities of the community to be produced and shared by individuals within the community. In a rural community, it is most likely that we are engaging with inexperienced groups both in terms of education and technology. In response to this, exploring local social groups brings an opportunity for better learning through shared access. Again, the available skills and capabilities of the local people to utilize the designed technological alternative can be addressed by strengthening the human infrastructure found in most African collective cultures.

The local intermediaries, or community leaders, are gatekeepers in order to establish reciprocity between the designer-researcher and the community. Communities can be engaged through knowledgeable and trusted individuals. The community-based design is a basis for continuous engagement with the local people to understand their context, their needs, and aspects of their environment. It is not enough to only examine culture, social groups, and ethnicity of the local context and involving them in the discussion without incorporating their responsibility. It is important for the researcher to examine and win the confidence of community members and build a trusted relationship throughout the design process. Here, a tangible and physically observable demonstration of the project outcome is very important to create awareness and engagement throughout the design activity and beyond. Their involvement can be visible through empowerment and by considering local sociocultural groups and power relationships. In dealing with ownership issues, local opportunities, capabilities, and the types of resources available need to be taken into account. Again, social

groups, together with local community structures, and trusted human networks in which people are engaged are already established in the rural community.

With respect to "D in ICT4D", it is difficult to expect impact based on the academic definition of development goals. This is because first, it is tough to gauge the success of an ICT4D project in the limited period and with the limited funding available for a Ph.D. student. Second, even if the success of the usability and usefulness of technological alternatives fulfills the community's needs, the quantifiable impact may not be visible in the short term. We see development from multiple perspectives where an ICT4D project is an effort of collective change. Development interventions need to be guided and facilitated within the community, not by devising purely technical "solutions" from the outside. The reconfiguration of a network of people and practices guides continuous interaction and success or failure is critically dependent on mobilizing these people.

We present a comprehensive conceptual framework that illustrates infrastructuring activities. ICT4D issues are multiple and interdependent and cannot be understood in isolation. In our case, people's participation and infrastructuring activities went beyond a horizontal string of activities with the same set of actors. We shift our focus and perspective of a design process that oscillates between social and technical issues in collaboration with several key actors. Specifically, our ICT intervention and infrastructuring activities are characterized by (i) conceptualization of design in relation to social practices; (ii) embedded values in design strategies*;* and (iii) continuous reflection-in-action. Most importantly, technological solutions and phenomenon are considered as mutually reconfiguring ensembles of social and technology entities. This provided us a holistic lens to consider several social-technical issues in a systemic and participatory manner. This in turn simplifies to adequately ground the conceptualizing or theory of development to specify ICT-based intervention and design activity.

It is my understanding that the theoretical challenge of ICT4D researchers regarding development is not a choice between the different development perspectives, but the difficulty of adequately grounding a theory of development to specify the sociotechnical design process. Here, we argue that the glue connecting ICT4D research and community problems is infrastructuring. Such an open innovation process enables us to prioritize community problems and alternative solutions or services. Finally, our suggestions and generalizations contribute to further clarifying the epistemological basis for exploring ICT4D practices and how we theorize from our design intervention. Here, the main argument is the importance of a research design

that promotes the direct engagement of the researcher with an action-design-research approach to a situation.

8.2 Limitations of the study

This study was philosophically grounded in a pragmatist worldview with participatory design, action research and design science research as the strategy of inquiry. Mixed methods, qualitative and quantitative, were used as data collection techniques for the empirical findings of the study. At the same time, the effect of the following three issues needs to be considered.

First, *effect of having multiple roles*, the action research and principles of participatory design offer researchers the opportunity to gather firsthand data from participants in their specific situation and investigate the intervention. Due to the collaborative nature of the research activities, sometimes the process was out of my control. At the same time, I had been working as a community problem-solver, researcher, and designer, which created complexity in the research process. Due to a dynamic shifting of roles, demarcating roles as researcher position and as agent of development, could also lead in subjectivity of some of the results.

Second, *managing timeline*, balancing regular traveling to the rural community and my school engagements (e.g., courses, conferences, reading, writing) was also difficult. Although the research was longitudinal, I was restricted by the time limitation to terminate my field study. When I see journey back, most of the time wasted in negotiating the social process. Establishing local responsibility not for daily allow but to build. This is because working as a community problem-solver takes so much time at the expense of other research activities.

Third, *as a proponent of pragmatist* reality was constantly renegotiated and reinterpreted to solve local problem and the research issues at hand. Both my active engagement and the design process were influenced by a series of choices that I made along the way. Thus, other researchers should be aware of the fact that effect of researcher multiple role, and the contextually of the research process.

8.3 A case for an interdisciplinary approach

Our lesson from this study and experience from the community project led to a few general recommendations as follows.

- **Difficulty in identifying research area**: As my personal background is the computing field, software engineering and computer science, one of the greatest challenges that I faced doing my PD and/or ICT4D research was the idea of combining applied research theory and design practice. The tension lies in finding the line that separates the research and

practices. Where does research end and practice start, or vice versa? In fact, this dilemma was not unique only to me but also has been common among graduate students in ICT4D across the world. As a PD and ICT4D researcher in a rural community context, one must keep a clear idea of his/her motivation in doing ICT4D research and his/her expectations of the target community.

- ***Mainstreaming ICT4D research domain***: Although this research field focuses on developing countries' problems, mainstreaming the ICT4D curriculum as a discipline and investigation field is still very rare to see in universities across African nations. ICT4D research is an interdisciplinary research field; for example, a researcher from the computing stream needs to view ICT4D research not only in terms of technical issues, but also the human, sociocultural, and environmental issues surrounding it. Specifically, researchers from computing and agriculture have to develop an interdisciplinary research area to support efficient implementation of ICT in the agricultural sector.
- ***A Common Framework of Agricultural Knowledge System***: A cooperative and focused effort across different stakeholders and groups such as agriculture expansion offices, NGOs, local agriculture extension offices, universities, research institutions, and national governments should be linked to a common agricultural knowledge and information sharing system. The coordinated effort could facilitate addressing the rural community problems and make ICT solutions of relevance to agriculture sector users, particularly rural farmers. This is because obtaining recent information or digital content is one of the difficult challenges for the local community, even though they have available phones to communicate.

8.4 Future work

As a continuation of this dissertation work, I want to refine and explore in detail the ontological, epistemological, and methodological dimensions of community-based PD. Our lessons and understanding and Ubuntu in general, inspired me to learn about other variations of these types. The collective sociocultural decision-making can be translated into a collaborative research method. Thus, exploring and facilitating people's involvement in interpretation and knowledge creation will move beyond the current isolated reflective designer-researcher towards reflective communities, the "collaborative research method" as discussed in 7.1.3. Thus, how such research rigorously describes its own ontology, epistemology and methodology supplements the existing PD and ICT4D research approaches.

Reference

Abbott, P., & Kashefi, A. (2016). The Influence of Intangible ("Soft") constructs on the outcome of community ICT Initiatives in Ghana: A Gap Archetype Analysis. *Electronic Journal of Information Systems in Developing Countries*, *77*(3), 1–22.

Ackoff, R. L. (1994). Systems thinking and thinking systems. *System Dynamics Review (Wiley)*, *10*(2/3), 175–188.

Agrawal, R., Atray, M., & Sattiraju, K. (2013). Exploring suitable interfaces for agriculture based smartphone apps in India. In ACM International Conference Proceeding Series (pp. 280–285).

Agarwal, S., Kumar, A., Nanavati, A., & Rajput, N. (2010). User-Generated Content Creation and Dissemination in Rural Areas. Information Technologies and International Development, 6(2), 21–37.

Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics (United Kingdom)*, *47*(S1), 35–48.

Alam, Q., Yusuf, M., & Coghill, K. (2010). Village Phone Program, Commodification Of Mobile Phone Set And Empowerment Of Women. *The Journal of Community Informatics*, *6*(1), 1–9.

Alliance for Affordable Internet(A4AI). (2017). Affordability Report. Retrieved July 13, 2017, from http://a4ai.org/affordability-report/

Alturki, A., Bandara, W., & Gable, G. (2012). Design Science Research and the Core of Information Systems. *Design Science Research in Information Systems. Advances in Theory and Practice*, *7286*, 309–327.

Amariles, F., Paz, O., Russell, N., & Johnson, N. (2007). The impacts of community telecenters in rural Colombia. *The Journal of Community Informatics*, *2*(3), 1–14.

Andersson, A., & Hatakka, M. (2013). What are we doing? - theories used in ICT4D research. In *Proceedings of the 12th International Conference on Social Implications of Computers in Developing Countries, Jamaica*.

Andreatta, S., & Ferraro, G. (2012). Elements of Culture: An Applied Perspective. Wadsworth Cengage Learning.

Aredo, D. (1993). *Informal and semi-formal financial sectors in Ethiopia: a study of the iqqub, iddir, and savings and credit co-operatives*. *Growth Lakeland* (Vol. 3).

Ashley, C., & Carney, D. (1999). *Sustainable livelihoods: Lessons from early experience* (Vol. 7). Department for International Development London.

Avgerou, C. (2003). The link between ICT and economic growth in the discourse of development (Vol. 126, pp. 373–386).

Avgerou, C. (2004). IT as an institutional actor in developing countries. *The Digital Challenge: Information Technology in the Development Context*, 46–62.

Avgerou, C. (2008). Information systems in developing countries: a critical research review. *Journal of Information Technology*, *23*(3), 133–146.

Avgerou, C. (2010). Discourses on ICT and Development. *Information Technologies & International Development*, *6*(3), 1–18.

Avison, D., & Fitzgerald, G. (2006). *Methodologies for Developing Information Systems : A historical perspective. The Past and Future of Information Systems: 1976–2006 and Beyond. Springer US*.

Aykin, N. (2006). Usability and internationalization of information technology. Lawrence Erlbaum Associates.

Balka, E. (2010). Broadening Discussion About Participatory Design A response to Kyng, *22*(1), 77–84.

Balka, E., & Wagner, I. (2008). Steps toward a typology for health informatics. *Proceedings of the ACM 2008 Conference on Computer Supported Cooperative Work*, 515–524.

Bansler, J. (1989). Trade unions and alternative technology in Scandinavia. *New Technology, Work and Employment*, *4*(2), 92–99.

Baskerville, R. (1999). Investigating information systems with action research. *Communications of AIS*, *2*(3), 4.

Baskerville, R. L., & Myers, M. D. (2015). Design ethnography in information systems. Information Systems Journal, 25(1), 23–46.

Baumol, W. J., & Blinder, A. S. (2011). Economics Principles and Policy. 11th Ed. United Stated of America. Cengage Lea.

Baumüller, Heike. 2012. Facilitating Agricultural Technology Adoption among the Poor: The Role of Service Delivery through Mobile Phones.

Belachew, M. (2010). E-government initiatives in Ethiopia. In *Proceedings of the 4th International Conference on Theory and Practice of Electronic Governance* (pp. 49–54).

Bergold, J., & Stefan, E. (2012). Participatory Research Methods : A Methodological Approach in Motion. *ESIS - Leibniz-Institute for the Social Sciences , Center for Historical Social*, *37*(4), 191–222.

Bernard, T., Makhija, S., Orkin, K., Seyoum, A., & Spielman, D. (2016). *Video-based agricultural extension: Analysis of a pilot project in Ethiopia*. *Washington, D.C.: International Food Policy Research Institute (IFPRI)*. Retrieved from http://www.ifpri.org/publication/video-based-agricultural-extension-analysis-pilot-project-ethiopia

Best, M. L., & Kumar, R. (2008). Sustainability Failures of Rural Telecenters:Challenges from the Sustainable Access in Rural India (SARI). *Information Technologies & International Development*, *4*(4), 31–45.

Bevan, N., Carter, J., & Harker, S. (2015). ISO 9241-11 revised: What have we learnt about usability since 1998?

Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), *9169*, 143–151.
Bidwell, N., Reitmaier, T., Siya, M., & Dlutu, B. (2013). Timely relations in rural africa. In *IFIP Working Group 9.4 12th International Conference on Social Implications of Computers in Developing Countries* (pp. 92–106).
Bilandzic, M., & Venable, J. (2011). Towards Participatory Action Design Research: Adapting Action Research and Design Science Research Methods for Urban Informatics. *The Journal of Community Informatics*, *7*(3), 1–17.
Binder, T., Michelis, G., Pelle Ehn, G., Jacucci, & Per Linde, I. W. (2011). *Design Things*. MIT press.
Bjerknes, G., & Bratteteig, T. (1995). User participation and democracy: A discussion of Scandinavian research on system development. *Scandinavian Journal of Information Systems*, *7*(1), 73–98.
Bjögvinsson, E., Ehn, P., & Hillgren, P.-A. (2012). Design Things and Design Thinking: Contemporary Participatory Design Challenges. *Design Issues*, *28*(3), 101–116. https://doi.org/10.1162/DESI_a_00165
Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2010). Participatory design and "democratizing innovation." In *Proceedings of the 11th Biennial Participatory Design Conference* (pp. 41–50).
Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2012). Design things and design thinking: Contemporary participatory design challenges. *Design Issues*, *28*(3), 101–116.
Blake, E. (2010). Software Engineering in Developing Communities. *CHASE '10 Proceedings of the 2010 ICSE Workshop on Cooperative and Human Aspects of Software Engineering*, 1–4.
Blommestein, Nele, Stijn Van, Lucie Lamoureux, Katherine Morrow, and Frans Neuman. 2006. ICTs for Agricultural Livelihoods. Impact and Lessons Learned from IICD Supported Activities. Ministry for Development Cooperation(IICD) of the Netherlands.
Bødker, K., Kensing, F., & Simonsen, J. (2004). *Participatory IT design: designing for business and workplace realities*. MIT press.
Bødker, S. (2000). Scenarios in user-centred design—setting the stage for reflection and action. *Interacting with Computers*, *13*(1), 61–75.
Boehm, B. (2006). A View of 20th and 21st Century Software Engineering. In *Proceedings of the 28th International Conference on Software Engineering SE - ICSE '06* (pp. 12–29).
Bon, A., Akkermans, H., & Gordijn, J. (2016). Developing ICT Services in a Low-Resource Development Context. Complex Systems Informatics and Modeling Quarterly-CSIMQ, (9), 84–109.
Braa, J., & Hedberg, C. (2002). The struggle for district-based health information systems in South Africa. *Information Society*, *18*(2), 113–127.
Brandt, E., Binder, T., & Sanders, E. (2012). Tools and techniques: Ways to engage telling, making and enacting. In *Routledge international handbook of participatory design. Routledge, New York* (pp. 145–181).
Bratteteig, T., Bødker, K., Dittrich, Y., Mogensen, P. H., & Simonsen, J. (2012). *Organising principles and general guidelines for Participatory Design Projects*. *Routledge international handbook of participatory design*.
Bratteteig, T., & Wagner, I. (2014). Design decisions and the sharing of power in PD. In *Proceedings of the 13th Participatory Design Conference(PDC2014), Volume 2*.
Bratteteig, T., & Wagner, I. (2016). What is a participatory design result? In *Proceedings of the 14th Participatory Design Conference: Full papers-Volume 1* (pp. 141–150).
Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology Using thematic analysis in psychology, (January), 37–41.
Brewer, E., Demmer, M., Du, B., Ho, M., Kam, M., Nedevschi, S., … Surana, S. (2005). The case for technology in developing regions. *Computer*, *38*(6), 25–38.
Brown, A., & Grant, G. (2010). Highlighting the Duality of the ICT and Development Research Agenda. *Information Technology for Development*, *16*(2), 96–111.
Bruijn, M., Nyamnjoh, F., & Brinkman, I. (2009). *Mobile phones: the new talking drums of everyday Africa*. *Review of African Political Economy* (Vol. 37).
Cáceres, R. B. (2012). Traders at Fairs in Rural Peru. *Information Technologies and International Development*, *8*(3), 35–52.
Camara, B., Nocera, J., & Dunckley, P. (2008). Exploring the Problem Domain : A Socio-Technical ICT Design for the Developing World. In *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008* (pp. 155–158).
Camara, S. B., Oyugi, C., Abdelnour-Nocera, J., & Smith, A. (2010). Augmenting usability: Cultural elicitation in HCI. *IFIP Advances in Information and Communication Technology*, *316*, 46–56.
Cavaye, A. L. M. (1995). User participation in system development revisited. *Information & Management*, *28*(5), 311–323.
Chambers, R. (2002). *Participatory Workshop: A Sourcebook of 21 Set of Ideas & Activities*.
Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper (Vol. 296).
Checkland, P. (2000). Soft Systems Methodology : A Thirty Year Retrospective a, *58*, 11–58.
Checkland, P., & Haynes, M. (1994). Varieties of systems thinking The case of soft systems methodology, s*ystem*

Dynamics Review, *10*(2–3), 189–197.
Checkland, P., & Holwell, S. (1998). Action research: its nature and validity. *Systemic Practice and Action Research*, *11*(1), 9–21.
Chepken, C., Mugwanya, R., Blake, E., & Marsden, G. (2012). ICTD interventions: Trends over the last decade. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development, ICTD'12, March 12–15 2012, Atlanta, GA, USA* (pp. 241–248).
Chetty, M., Tucker, W. D., & Blake, E. H. (2003). Developing locally relevant applications for rural areas. Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT) (pp. 1–5).
Chiara, D., Jefferson, A., & Franzato, C. (2014). The influence of local powers on participatory design processes in marginalized conflict areas. Proceedings of the 13th Participatory Design Conference on Research Papers - PDC '14, 131–139
Clarke, A. (1991). Social worlds/arenas theory as organizational theory. *Social Organizationa and Social Process. Essays in Honor of Anselm Strauss*. 119–158.
Cleaver, F. (1999). Paradoxes of Participation: Questioning Particpatory Approaches to Development. *Journal of International Development*, *11*, 597–612.
Clement, A., & Besselaar, P. (1993). A retrospective look at PD projects. *Communications of the ACM*, *36*(6), 29–37.
Cole, R., Purao, S., Rossi, M., & Sein, M. K. (2005). Being Proactive: Where Action Research meets Design Research. In *ICIS 2005 Proceedings* (pp. 1–21).
Cooper, A., Reinmann, R., & Cronin, D. (2007). *About Face 3.0: The essentials of interaction design*. *Information Visualization*.
Creswell, J. (2013). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (4th ed.). SAGE Publications Ltd.
Creswell, J. (2007). Qualitative enquiry & research design, choosing among five approaches (2nd ed.). SAGE Publications , London New Delhi.
CSA. (2007). *Ethiopia - Population and Housing Census of 2007*. https://doi.org/ETH_2007 _HC_v01_M
Dalsgaard, P. (2010). Challenges of participation in large-scale public projects. *Proceedings of the 11th Biennial Participatory Design Conference on - PDC '10*, 21.
Damodaran, L. (1996). User involvement in the systems design process-a practical guide for users. *Behaviour & Information Technology*, *15*(6), 363–377
Dantec, C., & DiSalvo, C. (2013). Infrastructuring and the formation of publics in participatory design. *Social Studies of Science*, *43*(2), 241–264.
Davison, R., Martinsons, M., & Kock, N. (2004). Principles of canonical action research. *Information Systems Journal*, *14*(1), 65–86.
Dearden, A., & Rizvi, H. (2008). Participatory design and participatory development: a comparative review. *PDC'08 Conference, Indiana, USA*.
Dearden, A., & Rizvi, H. (2009). A deeply embedded sociotechnical strategy for designing ICT for development. International Journal of Sociotechnology and Knowledge Development, 1(4), 57–70.
Dearden, A., Light, A., Kanagwa, B., & Rai, I. (2010). Technical ICT research for Development? Getting from research to practice. In *The Workshop" Mobile HCI and Technical ICTD: A Methodological Perspective", at the Mobile HCI 2010 Conference, Portugal*.
Dearden, A., Matthews, P., & Rizvi, H. (2011). Kheti: Mobile multimedia in an agricultural co-operative. Personal and Ubiquitous Computing, 15(6), 597–607.
Dearden, A. (2012). See no evil?: ethics in an interventionist ICTD. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development, ICTD'12, March 12–15 2012, Atlanta, GA, USA* (Vol. 9, pp. 1–17).
Dearden, A., & Rizvi, H. (2015). ICT4D and Participatory Design. In The International Encyclopedia of Digital Communication and Society. JohnWiley & Sons, Inc.
Dearden, A., & Tucker, W. (2016). Moving ICTD research beyond bungee jumping: practical case studies and recommendations. *IEEE Technology and Society Magazine*, 36–43.
Dewo, T. (2008). The Concept Of Peace In The Oromo Gadaa System: Its Mechanisms and Moral Dimension. *Journal of Oromo Studies*, *15*(1), 159–184.
Dewey, J. (2007). The development of American pragmatism. Scientiae Studia, 5(2), 227–243.
DFID. (1999). *Sustainable Livelihoods Guidance Sheets*. *Context*. https://doi.org/10.1002/smj
Dias, W. P. S. (2008). Philosophical underpinning for systems thinking. Interdisciplinary Science Reviews, 33(3), 202–213.
DiSalvo, C. (2009). Design and the Construction of Publics. *Design Issues*, *25*(1), 48–63.
DiSalvo, C., Clement, A., & Pipek, V. (2012). Participatory design for, with, and by communities. *International Handbook of Participatory Design. Simonsen, Jesper and Toni Robertson (Eds). Oxford: Routledge.(2012)*, 182–209.

Dissanayeke, U. (2014). Mobile based information communication interactions among major agriculture stakeholders : SRI-LANKAN exprienace. *Electronic Journal of Information Systems in Developing Countries*, *60*(1), 1–12.
Dittrich, Y., Eriksén, S., & Hansson, C. (2002). PD in the wild; Evolving practices of design in use. In *Proceedings of the Participatory Design Conference, PDC02* (pp. 124–134). Palo Alto.
Dittrich, Y., Eriksén, S., & Wessels, B. (2014). Why the specific is crucial for participatory design research. Scandinavian Journal of Information Systems, 26(1), 29–56.
Dittrich, Yvonne, Kari Rönkkö, Jeanette Eriksson, Christina Hansson, and Olle Lindeberg. 2007. "Cooperative Method Development." *Empirical Software Engineering* 13(3):231–60.
Drake, Patrick Mirembe, Bernard Obaa, and Peter Ebanyat. 2016. "Developing and Piloting a Multi-Channel ICT-Enabled Model to Enhance University Engagement with Smallholder Farming Communities in Uganda." International Journal of Agricultural Extension and Rural Development 1(1):13–21.
Dodson, L., Sterling, R., & Bennett, J. (2013). Minding the Gaps : Cultural , Technical and Gender-Based Barriers to Mobile Use in Oral-Language Berber Communities in Morocco. In Proceedings of the Sixth International Conference on Information and Communication Technologies and Development.
Doerfinger, J., & Dearden, A. (2013). Evolving a Software Development Methodology for Commercial ICTD Projects. *Information Technologies and International Development*, *9*(3), 43–60.
Duncombe, R. (2007). Using the Livelihoods Framework to Analyze ICT Applications for. *Information Technologies and International Development*, *3*(3), 81–100.
Easterbrook, S. (2014). From Computational Thinking to Systems Thinking: A conceptual toolkit for sustainability computing. *Proceedings of the 2014 Conference ICT for Sustainability*, 24–27.
EATA. (2016). *The Ethiopian Agriculture Transforamtion Agency(EATA): Annual Report 2015-16*. Retrieved from https://www.transpower.co.nz/sites/default/files/news-articles/attachments/Transpower Annual Report 15-16 %28print final%29.pdf
Easterbrook, S., Singer, J., Storey, M.-A., & Damian, D. (2008). Selecting Empirical Methods for Software Engineering Research. In Guide to Advanced Empirical Software Engineering (pp. 285–311).
ECX. (2017). Ethiopia Commodity Exchange(ECX). Retrieved May 7, 2017, from http://www.ecx.com.et/
Ehn, P. (1988). *Work-Oriented Design of Computer Artifacts*.
Ehn, P. (1989). Scandinavian Design: On Participation and Skill. *Usability: Turning Technologies into Tools*.
Ehn, P. (1993). Scandinavian design: On participation and skill. In *Participatory design: Principles and practices* (pp. 41–77).
Ehn, P. (2008). Participation in design things. *Conference on Participatory Design*, 92–101.
Elovaara, P., Igira, F. T., & Mörtberg, C. (2006). Whose participation? whose knowledge?: exploring PD in Tanzania-Zanzibar and Sweden. *PDC '06: Proceedings of the Ninth Conference on Participatory Design*, 105–114.
Emana, B. (2009). *Cooperatives: a path to economic and social empowerment in Ethiopia*. ILO.
Emmanuel, E., & Hippolyte, M. (2010). A User Interface For Micro-Entrepreneurs In A Rural Community. Electronic Journal of Information Systems in Developing Countries, 43(2), 1–19.
EthioTelecom. (2017). Mobile Internet Package-ethiotelecom. Retrieved February 12, 2017, from http://www.ethiotelecom.et/?q=mobileinternetpackageoffer
Franklin, U. (2005). THE REAL WORLD OF TECHNOLOGY. House of Anansi Press Inc.
FDRE. (2016a). *Federal Democratic Republic of Ethiopia(FDRE): The National Information and Communication Technology Policy and Strategy*. Retrieved from http://www.mcit.gov.et/documents/1268465/1282796/ICT+Policy_final.pdf/b54ea006-0c42-4085-81f1-9c2a8937a110
FDRE. (2016b). *The Federal Democratic Republic of Ethiopia (FDRE)-Growth and Transformation Plan II (2015-2020)* (Vol. I). Retrieved from http://dagethiopia.org/new/images/DAG_DOCS/GTP2_English_Translation_Final_June_21_2016.pdf
Floyd, C., & Gryczan, G. (1992). STEPS a Methodological Framework for Cooperative Software Development with Users. In *Proc. East-West International Conference on Human Computer Interaction*.
Floyd, C., Mehl, W., Reisin, F., Schmidt, G., & Wolf, G. (1989). Out of Scandinavia : Alternative Approaches to Software Design and System Development. Human Computer Interaction, 4(4), 253–350.
Floyd, C., Reisin, F.-M., & Schmidt, G. (1989). STEPS to software development with users. In European Software Engineering Conference (pp. 48–64).
Foth, M., & Axup, J. (2006). Participatory design and action research: Identical twins or synergetic pair? In *Participatory Design Conference PDC Trento Italy* (pp. 93–96).
Freedom-House. (2017). Freedom in the World : Country Scores. Retrieved January 20, 2017, from https://freedomhouse.org/report/fiw-2017-table-country-scores
Futterman, N. F., & Shuman, R. S. (2010). AppLab Question Box : A Live Voice Information Service in Rural Uganda. In *International Conference on Information and Communication Technologies and Development*.
Gandhi, R., Veeraraghavan, R., Toyama, K., & Ramprasad, V. (2009). Digital Green : Participatory Video and

Mediated Instruction for Agricultural. *Information Technologies and International Development*, *5*(1), 1–15.
Gartner, J., & Wagner, I. (1996). Mapping Actors and Agendas: Political Frameworks of Systems Design and Participation. *Human–Computer Interaction*, *11*(3), 187–214.
Garudachar, S. (2010). E-Agro initiative of Ekutir and Grameen-Intel JV social business. *The Journal of Community Informatics*, *6*(2), 1–7.
Gates, M. (2010). Accelerating Ethiopian Agriculture Development for Growth , Food Security , and Equity.
Gebremedhin, B., Hoekstra, D., & Tegegne, A. (2006). *Commercialization of Ethiopian agriculture : extension service from input supplier to knowledge broker and facilitator Commercialization of Ethiopian agriculture : Extension service from input*.
Gibbs, J. L. (2009). Culture as kaleidoscope. *Proceeding of the 2009 International Workshop on Intercultural Collaboration - IWIC '09*.
Gichamba, A., Waiganjo, P., Orwa, D., Wario, R., & Ngari, B. (2016). Prototyping mAgriculture Applications among Smallholder Farmers, 1–7.
Gigler, B.-S. (2011). *Informational Capabilities - The Missing Link for the Impact of ICT on Development*. *E-Transform Knowledge Platform*.
Gigler, B.-S. (2015). *Development as Freedom in a Digital Age: Experiences from the Rural Poor in Bolivia*. World Bank Publications.
Gitau, S., Plantinga, P., & Diga, K. (2010). ICTD Research by Africans: Origins, Interests and Impact. In *Fourth International Conference on Information and Communication Technologies and Development (ICTD 2010)*.
Godjo, T. (2010). Scenarios to foster user participation in the design of small scale agricultural and food processing equipment in sub-Saharan Africa countries. *Proceedings of the 11th Biennial Participatory Design Conference on - PDC'10*.
Gollakota, K., Pick, J. B., & Sathyapriya, P. (2012). Using technology to alleviate poverty : use and acceptance of telecenters in rural India. Information Technology for Development, 18(3), 185–208
Pick, James, Kamala Gollakota, and Manju Singh. 2013. "Technology for Development: Understanding Influences on Use of Rural Telecenters in India." Information Technology for Development 20(4):296–323.
Gomez, R. (2013). The changing field of ICT4D: growth and maturation of the field, 2000-2010. *Electronic Journal of Information Systems in Developing Countries*, *58*(1), 1–21.
Gomez, R., & Day, S. (2013). research questions , paradigms and methods in ict for development : content analysis of selected ictd literature , 2000-2010 research questions , paradigms and methods in ICT for development : content analysis of selected ictd literature. In *Proceedings of the 12th International Conference on Social Implications of Computers in Developing Countries* (pp. 301–316).
Gomez, R., Luis, B., & Silfvast, B. (2012). The Changing Field of ICTD: Content Analysis of Research Published in Selected Journals and Conferences, 2000-2010. In *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development, ICTD'12,* (pp. 65–74).
Gomez, R., & Pather, S. (2012). ICT evaluation: Are we asking the right questions? Electronic Journal of Information Systems in Developing Countries, 50(5), 1–14.
Goswami, R. (2010). Telesupport Experiment for Agricultural Information Management in West Bengal, India. *The Journal of Community Informatics*, *6*(2), 1–9.
Green, M. (2010). Making Development Agents: Participation as Boundary Object in International Development. *Journal of Development Studies*, *46*(7), 1240–1263.
Greenbaum, J. (1993). PD a personal statement. *Communications of the ACM*, *36*(6), 47.
Gregor, S. (2006). The nature of theory in Information Systems. *MIS Quarterly: Management Information Systems*, *30*(3), 611–642.
Gregg, D., Kulkarni, U., & Vinzé, A. (2001). Understanding the Philosophical Underpinnings of Software Engineering Research in Information Systems. Information Systems Frontiers, 3(2), 169–183.
Gregory, J. (2003). Scandinavian Approaches to Participatory Design. *International Journal of Engaging Education*, *19*(1), 62–74.
Grønbaek, K., Kyng, M., & Mogensen, P. (1997). Toward a Cooperative Experimental System Development Approach. 201–238.
Grunfeld, H. (2014). ICT for sustainable development: an example from Cambodia. *The Journal of Community Informatics*, *10*(2), 1–12.
GSMA. (2017). Mobile Economy in Sub-Saharan Africa. Retrieved November 8, 2017, from https://www.gsma.com/mobileeconomy/sub-saharan-africa-2017/
Hakken, D., & Maté, P. (2014). The culture question in participatory design. In *Proceedings of the 13th Participatory Design Conference* (Vol. volume 2, pp. 87–91).
Halskov, K., & Brodersen, N. (2015). The diversity of participatory design research practice at PDC 2002–2012. *International Journal of Human-Computer Studies*, *74*, 81–92.
Hamel, J. (2010). ICT4D and the human development and capabilities approach: the potentials of information and communication technology. *Human Development Research Paper*, (37), 1–78.

Haq, M. (1995). Reflections on human development: Mahbub Ul Haq. oxford university Press.
Harris, R. W. (2015). How ICT4D Research Fails the Poor. *Information Technology for Development*, *1102*, 1–16.
Harris, C., & Achora, J. (2018). Designing ICT for Agriculture (ICT4A) Innovations for Small-holder Farmers : The Case of Uganda. In Proceedings of the XIX International Conference on Human Computer Interaction. ACM.
Hayes, G. R. (2011). The relationship of action research to human-computer interaction. *ACM Transactions on Computer-Human Interaction*, *18*(3), 1–20.
Hayes, N., & Westrup, C. (2012). Context and the processes of ICT for development. *Information and Organization*, *22*(1), 23–36.
Heeks, R. (2006). Theorizing ICT4D Research. *Information Technologies and International Development*, *3*(3), 1–4.
Heeks, R. (2008). ICT4D 2.0: The Next Phase of Applying ICT for International Development. *IEEE Computer Society*, *41*(6), 26–33.
Heeks, Richard, and Laura Kanashiro. 2009. "Telecentres in Mountain Regions - A Peruvian Case Study of the Impact of Information and Communication Technologies on Remoteness and Exclusion." Journal of Mountain Science 6(4):320–30.
Heeks, R. (2009). *The ICT4D 2.0 manifesto: Where next for ICTs and international development?* No. 42. *Development Informatics, Working Paper Series*.
Heeks, R. (2010a). An ICT4D Journal Ranking Table. *Information Technologies and International Development*, *6*(4), 71–75.
Heeks, R. (2010b). Do information and communication technologies (ICTs) contribute to development? *Journal of International Development*, *22*(5), 625–640.
Heeks, R., & Molla, A. (2008). Compendium on impact assessment of ICT-for-development projects. *Manchester: IDRC*.
Hettne, B. (2009). *Thinking about development.* Zed Books Ltd.
Hevner, A., March, S., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105.
Hevner, A. R. (2007). A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems, 19(2), 87–92.
Hillgren, P. A., Seravalli, A., & Emilson, A. (2011). Prototyping and infrastructuring in design for social innovation. CoDesign, 7(3–4), 169–183.
Ho, M., Smyth, T., Kam, M., & Dearden, A. (2009). Human-Computer Interaction for Development : The Past , Present , and Future. Information Technologies and International Development, 5(4), 1–18.
Hofstede, G. (2011). Dimensionalizing Cultures : The Hofstede Model in Context. *Online Readings in Psychology and Culture*, *2*(1), 1–26.
Iadah, N., Ibrahim, H., Mat, Z., Zahurin, A., Zulkhairi, D., Ghazali, O., … Abu, M. (2012). Information Needs of Rural Communities. *The Journal of Community Informatics*, *9*(1), 1–6.
IndexMundi. (2016). World demographics profile 2016. Retrieved from http://www.indexmundi.com/world/demographics_profile.html
International_Livestock_Research_Institute. (2005). Livestock Information Network Knowledge System (Project Funded by USAID). Retrieved May 2, 2016, from http://www.lmistz.net/Pages/Public/Home.aspx
Islam, S., & Grönlund, Å. (2007). Agriculture Market Information E-Service in Bangladesh: A Stakeholder-Oriented Case Analysis. In International Conference on Electronic Government. Berlin, Springer.
Islam, M. S., & AlAwadhi, S. (2008). Sustainable Rural IS Implementation Process for Developing Countries: Agriculture Market Information Services (AMIS) in Bangladesh. In *International Conference on M4D Mobile Communication Technology for Development*.
Islam, M. S., & Grönlund, Å. (2012). Applying design science approach in ICT4D research: Mobile phone based agriculture market information service (AMIS) in Bangladesh. In *Communications in Computer and Information Science* (Vol. 286 CCIS, pp. 132–143).
ITU. (2016). The ICT Development Index. Retrieved April 6, 2017, from http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2015/methodology.aspx
ITU. (2017). Global ICT Development Index. Retrieved November 23, 2017, from http://www.itu.int/net4/ITU-D/idi/2017/index.html#idi2017economycard-tab&ETH
Jabar, M., Sidi, F., Selamat, M., Azim, A., Ghani, A., & Ibrahim, H. (2009). An Investigation into Methods and Concepts of Qualitative Research in Information System Research. *Computer and Information Science*, *2*(4), 47–54.
Jackson, M. (2003). *Systems thinking: Creative holism for managers*. Wiley Chichester.
Jackson, M. (2010). Reflections on the Development and Contribution of Critical Systems Thinking and Practice. *Systems Research and Behavioral Science*, *27*, 133–139.
Järvinen, P. (2007). Action research is similar to design science. *Quality & Quantity*, *41*(1), 37–54.
Johansson, L. (2014). Telecentre For Community Development Evaluation Of The Tunjang Telecentre, Malaysia.

The Journal of Community Informatics, *6*(2), 1–16.
Jungk, R., & Müllert, N. (1987). Future Workshops: How to create desirable futures. 1987. *London: Institute for Social Inventions*.
Kameswari, V. L. V., Kishore, D., & Gupta, V. (2011). ICT for agricultural extension: a study in the Indian himalayan region. *Electronic Journal of Information Systems in Developing Countries*, *48*(3), 1–12.
Karasti, H. (2014). Infrastructuring in participatory design. In *Proceedings of the 13th Participatory Design Conference on Research Papers - PDC '14* (pp. 141–150).
Karasti, H., & Baker, K. (2008). Community Design – Growing One ' s Own Information. In *Proceedings of the Tenth Anniversary Conference on Participatory Design,PDC2008* (pp. 220–223). Indiana University.
Karasti, H., & Syrjänen, A.-L. (2004). Artful infrastructuring in two cases of community PD. In *Proceedings of the eighth conference on Participatory design Artful integration: interweaving media, materials and practices - PDC 04* (Vol. 1, p. 20).
Kapuire, G. K., Winschiers-Theophilus, H., & Blake, E. (2015). An insider perspective on community gains: A subjective account of a Namibian rural communities perception of a long-term participatory design project. International Journal of Human Computer Studies, 74, 124–143.
Kensing, F., & Blomberg, J. (1998). Participatory Design : Issues and Concerns. *Computer Supported Cooperative Work*, *7*(1993), 167–185.
Kensing, F., Simonsen, J., & Bodker, K. (1998). MUST: A Method for Participatory Design. *Human-Computer Interaction*, *13*(2), 167–198.
Kersten, G., Kersten, M., & Rakowski, W. (2002). Software and culture: Beyond the internationalization of the interface. *Journal of Global Information Management*, *10*(4), 86–101.
Kitchenham, B., & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. Keele University and Durham University Joint Report : Evidence-Based Software Engineering (EBSE) Technical Report 2007-001.
Klein, H. H. K., & Myers, M. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, *23*(1), 67–93.
Kleine, D., & Unwin, T. (2009). Technological revolution, evolution and new dependencies: What's new about ICT4D? *Third World Quarterly*, *30*(5), 1045–1067.
Knoche, H., Rao, S., & Huang, J. (2011). Human-Centered Design for Development. *International Journal of Mobile Human Computer Interaction*, *3*(3), 1–13.
Korsgaard, H., Nylandsted, C., & Bødker, S. (2016). Computational alternatives in participatory design - Putting the T back in Socio-Technical research. In *Participatory Design Conference, PDC2016*.
Kraft, P., & Bansler, J. (1992). The collective resource approach: the Scandinavian experience. In *Proceedings of Participalory design Confernce , In PDC'92* (Vol. 6, pp. 71–84).
Kraft, P., & Bansler, J. (1994). The collective resource approach: the Scandinavian experience. *Scandinavian Journal of Information Systems*, *6*(1), 71–84.
Kumar, R. (2004). eChoupals: A Study on the Financial Sustainability of Village Internet Centers in Rural Madhya Pradesh. *Information Technologies and International Development*, *2*(1), 45–73.
Kyng, M. (1998). Users and Computers-A Contextual Approach to Design of Computer Artifacts. *Scandinavian Journal of Information Systems*, *10*(1&2), 7–44.
Kyng, M. (2010). Bridging the Gap Between Politics and Techniques: On the next practices of participatory design. *Scandinavian Journal of Information Systems*, *22*(1), 49–68.
Lalji, Z., & Good, J. (2008). Designing new technologies for illiterate populations: A study in mobile phone interface design. Interacting with Computers, 20(6), 574–586.
Lalji, Z., & Good, J. (2008). Designing new technologies for illiterate populations: A study in mobile phone interface design. Interacting with Computers, 20(6), 574–586.
Lee, A., & Baskerville, R. (2003). Generalizing Generalizability in Information Systems Research. Information Systems Research, 14(3).
Lloret-Climent, M. (2002). Direct and indirect causality in living systems. Kybernetes, 31(3/4), 485–495.
Lumsden, J. (2008). *Handbook of research on user interface design and evaluation for mobile technology* (Vol. 1). IGI global.
Maail, A. G. (2011). User Participation and the Success of Development of ICT4D project: A Critical Review. In *Proceedings of the 4th Annual Workshop. ICT IN GLOBAL DEVELOPMENT. Pre-ICIS Meeting*.
Mabelebele, J. (2006). Ideological objectives underpinning imbizo as a model of communication and governance. *Communicare: Journal for Communication Sciences in Southern Africa*, *25*(2), 103–125.
Marais, M. (2011). An analysis of the factors affecting the sustainability of ICT4D initiatives. *ICT for Development: People, Policy and Practice. IDIA2011 Conference Proceedings*, 100–120.
McNiff, J., & Whitehead, J. (2006). All you need to know about action research. SAGE Publications Ltd.
McGinley, T., & Nakata, K. (2012). A participatory design approach to the wicked problem of designing sustainable communities. In The TSBE EngD Conference.
Medhi-Thies, I., Ferreira, P., Gupta, N., O'Neill, J., & Cutrell, E. (2014). KrishiPustak: A Social Networking System

for Low-Literate Farmers. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computin*.
Mennett, J., & Bennett, M. (2003). an Integrative Approaches to Global and Domstic Diversity. Handbook of intercultural training.
Merkel, C., Xiao, L., Farooq, U., & Ganoe, C. (2004). Participatory design in community computing contexts: Tales from the field. In *Participatory Design Conference 2004,* (pp. 1–10).
Merritt, S. (2012). Lessons and opportunities in ICT4D. *XRDS: Crossroads, The ACM Magazine for Students*, *19*(2), 46.
Merritt, S., & Stolterman, E. (2012). Cultural hybridity in participatory design. *Proceedings of PDC 2012*, 73–76.
Mifsud, J. (2012). Paper Prototyping as A Usability Testing Technique. Retrieved from https://usabilitygeek.com/paper-prototyping-as-a-usability-testing-technique/
Mkabela, Q. (2005). Using the Afrocentric Method in Researching Indigenous African Culture. The Qualitative Report, 10(1), 178–189.
Moens, N. P., Broerse, J., Gast, L., & Bunders, J. (2010). A Constructive Technology Assessment Approach to ICT Planning in Developing Countries: Evaluating the First Phase, the Roundtable Workshop. *Information Technology for Development*, *16*(1), 34–61.
Muller, M. (2002). Participatory design: the third space in HCI. In *The Human Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications. Mahwah, NJ, Lawrence Erlbaum,* (Vol. 4235, pp. 1051–1068).
Mutenda, T., Mpazanje, F., & Chigona, W. (2011). Community Participation in ICT4D Projects : Where Are We Getting It Wrong ? In *Proceedings of ReSNES'2011* (pp. 1–13).
Muthiah, G., Prashant, S., Umadikar, J., & Karthikeyan, K. (2013). An exploratory sudy of mobile multimedia agricultural advisory system: challenges and lessons from TAMIL NADU, INDIA. *Electronic Journal of Information Systems in Developing Countries*, *56*(5), 1–14.
Myers, M., & Tan, F. (2002). Beyond Models of National Culture in Information Systems Research. Journal of Global Information Management, 10(2), 24–32.
Nguyen, N., Graham, D., Ross, H., Maani, K., & Bosch, O. (2012). Educating Systems Thinking for Sustainability: Experience with a Developing Country. *Systems Research and Behavioral Science*, *29*(1), 14–29.
Niehaves, B. (2007). On Epistemological Pluralism in Design Science. Scandinavian Journal of Information Systems, 19(2), 93–104.
Oates, B. (2006). Researching information systems and computing. SAGE Publications , London New Delhi.
Oxoby, R. (2009). Understanding social inclusion, social cohesion, and social capital. *International Journal of Social Economics*, *36*(12), 1133–1152.
Papas, N., O'Keefe, R., & Seltsikas, P. (2012). The action research vs design science debate: reflections from an intervention in eGovernment. *European Journal of Information Systems*, *21*(2), 147–159.
Parmar, V. (2009). A Multidisciplinary Approach to A Multidisciplinary Approach to ICT Development. *Information Technologies and International Development*, *5*(4), 89–96.
Pasquier, M. (2014). Reaching illiterate people in the emerging countries: the power of voice based mobile apps. Retrieved April 8, 2017, from http://www.innovationiseverywhere.com/reaching-illiterate-people-emerging-countries-power-voice-based-mobile-apps/
Patel, N., Chittamuru, D., Jain, A., Dave, P., & Parikh, T. (2010). Avaaj otalo: a field study of an interactive voice forum for small farmers in rural india. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 733–742).
Patel, N., Savani, K., Klemmer, S., Parikh, T., Dave, P., & Shah, K. (2012). Power to the Peers : Authority of Source Effects for a Voice-based Agricultural Information Service in Rural India Categories and Subject Descriptors. *Information Technologies and International Development*, *9*(2), 81–93.
Pierce, J. L., Kostova, T., & Dirks, K. T. (2003). The state of psychological ownership: Integrating and extending a century of research. *Review of General Psychology*, *7*(1), 84.
Pimienta, D. (2009). Digital Divide, Social Divide, Paradigmatic Divide. *International Journal of Information Communication Technologies and Human Development*, *1*(1), 33–48.
Pipek, V., & Wulf, V. (2009). Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. *Journal of the Association for Information Systems*, *10*(5), 447–473.
Pitula, K. (2010). *On Requirements Elicitation for Software Projects in Ict for Development*.
Pitula, K., & Dysart-gale, D. (2010). Expanding the Boundaries of HCI : A Case Study in Requirements Engineering for ICT4D. *Information Technologies & International Development*, *6*(1), 78–93.
Pitula, K., & Radhakrishnan, T. (2011). On eliciting requirements from end-users in the ICT4D domain. *Requirements Engineering*, *16*(4), 323–351.
Pieterse, Jan. 2009. Development Theory: Deconstructions/Reconstructions.
Plauché, M., & Nallasamy, U. (2008). Speech Interfaces for Equitable Access to Information Technology. Information Technologies and International Development, 4(1), 69–86.
Puri, S. ., Byrne, E., Leopoldo, J., & Quraishi, Z. (2004). Contextuality of Participation in IS Design : A Developing

Country Perspective. In *Proceedings of the 8th conference on Participatory design PDC 04, Toronto, Canada*.
Rao, S. S. (2009). Role of ICTs in Indian Rural Communities. *The Journal of Community Informatics*, *5*(1), 1–10.
Rega, I., Fino, E., La, R., & Moro, P. A. (2013). Exploring the Meanings of Community Multimedia Centers in Mozambique : A Social Representation Perspective. *Information Technologies and International Development*, *9*(4), 35–54.
Rege, R., & Nagarkar, S. (2010). Krishi-Mitra: case study of a user-centric ICT solution for semi-literate and illiterate farmers in India. In *Proceedings of the international conference on Interaction Design & International Development*.
Reijswoud, V. (2009). Appropriate ICT as a tool to increase effectiveness in ICT4D: theoretical considerations and illustrating cases. *Electronic Journal of Information Systems in Developing Countries*, *38*(9), 1–18.
Robertson, T., Mansfield, T., & Loke, L. (2006). Designing an immersive environment for public use. In *Proceedings of the ninth conference on Participatory design: Expanding boundaries in design-Volume 1*.
Robeyns, I. (2005). The Capability Approach: a theoretical survey. Journal of Human Development, 6(1), 93–117.
Robinson, H., Segal, J., & Sharp, H. (2007). Ethnographically-informed empirical studies of software practice. Information and Software Technology, 49(6), 540–551.
Rodil, K., Winschiers-theophilus, H., Stanley, C., Koch, G., & Rehm, M. (2014). An Approach to User Interface Design with two Indigenous Groups in Namibia. In *Proceedings of OzCHI 2014* (pp. 460–469).
Rosson, M. B., & Carroll, J. M. (2002). Scenario-Based Design. In *Human-Computer Interaction* (pp. 145–162).
Robson, C., & McCartan, K. (2016). Real World Research. Edition. Blackwell Publishing. Malden.
Sabiescu, A., & Memarovic, N. (2013). Participatory design for cultural representation: A cultural transparency perspective. In *IFIP Conference on Human-Computer Interaction. Springer, Berlin, Heidelberg*.
Scheyvens, R., & Storey, D. (2003). Development Fieldwork: A Practical Guide. SAGE Publications Ltd.
Sharp, H., Dittrich, Y., & Souza, C. (2016). The role of ethnographic studies in empirical software engineering. IEEE Transactions on Software Engineering, 42(8), 786–804.
Schmidt, C., Jean, T., Shayne, M., & Azaabanye, A. (2012). Impact of Low-Cost , On-Demand Information Access in a Remote Ghanaian Village. *Information Technologies and International Development*, *8*(2), 85–100.
Schön, A. D. (1983). *The Reflective Practioner*. Basic Books, Inc.
Sein, M. K., Hatakka, M., Thapa, D., & Sæbø, Ø. (2016). What theories do we need to know to conduct ICT4D research? In *Proceedings of SIG GlobDev Ninth Annual Workshop* (pp. 1–19).
Sein, M. K., Henfridsson, O., Rossi, M., & Lindgren, R. (2011). Action Design Research. *MIS Quarterly*, *35*, 37–56.
Sen, A. (1999). Development as Freedom. *Oxford Press*, 1–50.
Sharda, R., & Voß, S. (2007). *INFORMATION SYSTEMS ACTION RESEARCH : An Applied View of Emerging Concepts and Methods*. (N. Kock, Ed.). Boston, MA: Springer US.
Sherwood, D. (2002). *Praise for Seeing the Forest for the Trees*. London: Nicholas Brealey Publishing.
Sibongile, S., & Iyamu, T. (2013). A Guide to Selecting Theory. In *IFIP International Federation for Information Processing* (pp. 525–537).
Simonsen, J., & Hertzum, M. (2012). Sustained Participatory Design: Extending the Iterative Approach. *Design Issues*, *28*(3), 10–21.
Simonsen, J., & Robertson, T. (2012). *Routledge international handbook of participatory design*. Routledge international handbook of participatory design.
Siyao, P. (2012). Barriers in accessing agricultural information in tanzania with a gender perspective : the case s tudy of small- scale sugar cane. *Electronic Journal of Information Systems in Developing Countries*, *51*(6), 1–19.
Srinivasan, J. (2007). The role of trustworthiness in information service usage : The case of Parry information. In *International Conference on Information and Communication Technologies and Development*.
Ssozi-Mugarura, F., Blake, E., & Rivett, U. (2016). Supporting Community Needs for Rural Water Management through Community-Based Co-Design. *Pdc'16*, 91–100.
Steen, M. (2011). Tensions in human-centred design. *CoDesign*, *7*(1), 45–60.
Stillman, Larry. 2013. "Participatory Action Research & Inclusive Information and Knowledge Management for Empowerment." Proceedings of the Sixth International Conference on Information and Communications Technologies and Development Notes - ICTD '13 - volume 2 163–66.
Stowell, F. (2009). Soft systems and research. *Kybernetes*, *38*(6), 879–896.
Sutinen, E., & Tedre, M. (2010). ICT4D: A computer science perspective. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (Vol. 6060 LNCS, pp. 221–231).
Swanson, B., & Rajalahti, R. (2010). Strengthening Agricultural Extension and Advisory Systems: Procedures for Assessing, Transforming, and Evaluating Extension Systems (No. 45).
Tandi, E. (2010). Bridging The Agricultural Knowledge And Information Divide: The Case Of Selected Telecenters And Rural Radio In Tanzania. *Electronic Journal of Information Systems in Developing Countries*, *43*(6), 1–14.

Thapa, D., & Sæbø, Ø. (2014). Exploring the Link between ICT and Development in the Context of Developing Countries: A Literature Review. *The Electronic Journal of Information Systems in Developing Countries*, *64*(1), 1–15.

Thapa, D., & Sein, M. K. (2010). ICT, social capital and development: The case of a Mountain region in Nepal. *Third Annual SIG GlobDeve Workshop*.

Tomitsch, M., Sturm, F., Konzett, M., Bolin, A., Wagner, I., & Grechenig, T. (2010). Stories from the Field : Mobile Phone Usage and its Impact on People ' s Lives in East Africa. In *International Conference on Information and Communication Technologies and Development, ICTD2010*. London.

Tongia, R., & Subrahmanian, E. (2006). Information and Communications Technology for Development (ICT4D) – A Design Challenge? In *International Conference on Information and Communication Technologies and Development* (pp. 243–255).

Toyama, K. (2011). Technology as amplifier in international development. *Proceedings of the 2011 iConference on - iConference '11*, 75–82.

Trompenaars, F., & Hampden-Turner, C. (1997). *Riding the waves of culture*. Nicholas Brealey Publishing Limited.

Truex, D., Holmstrom, J., & Keil, M. (2006). Theorizing in Information Systems Research: A Reflexive Analysis of the Adaptation of Theory in Information. *Journal of the Association for Information Systems*, *7*(12), 797–821.

UN. (2001). *Road map towards the implementation of the United Nations Millennium Declaration Report of the Secretary-General Executive summary*. Retrieved from http://www.un.org/documents/ga/docs/56/a56326.pdf

UN. (2015). Sustainable Development Knowledge Platform. Retrieved March 20, 2017, from https://sustainabledevelopment.un.org/

UNDP. (2016). *Human Development Report 2016*. Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

UNDP-Ethiopia. (2012). *Promoting ICT based agricultural knowledge management*. *Empowering Lives and Resilient Nations*. Retrieved from http://www.undp.org/content/dam/ethiopia/docs/Promoting ICT based agricultural knowledge management to increase production and productivity of smallholder farmers in Ethiopia.pdf

UNESCO. (2016). Gada system, an indigenous democratic socio-political system of the Oromo -Intangible heritage Culture Sector. Retrieved April 9, 2017, from http://www.unesco.org/culture/ich/en/RL/gada-system-an-indigenous-democratic-socio-political-system-of-the-oromo-01164

UNICT. (2003). *Tools for Development : Using Information and Communications Technology to Achieve the Millennium Development Goals*.

United Nations Development Group. (2003). *Indicators for monitoring the Millennium Development Goals* (Vol. 6). Retrieved from http://mdgs.un.org/unsd/mi/wiki/1-9-Proportion-of-population-below-minimum-level-of-dietary-energy-consumption.ashx

Urquhart, C., Liyanage, S., & Kah, M. M. O. (2008). ICTs and poverty reduction: A social capital and knowledge perspective. *Journal of Information Technology*, *23*(3), 203–213.

Van, C. (2006). Information Communication Technologies: Concepts, Methodologies, Tools, and Application. In information science reference (Vol. I).

Veeraraghavan, R., Yasodhar, N., & Toyama, K. (2009). Warana Unwired : Replacing PCs with Mobile Phones. Information Technologies and International Development, 5(1), 81–95.

Vincent, K., & Cull, T. (2013). " Ten Seeds ": How Mobiles Have Contributed to Development in Women-Led Farming Cooperatives in Lesotho. *Information Technologies and International Development*, *9*(1), 37–48.

Ferré, X., Juristo, N., Windl, H., & Constantine, L. (2001). usability engineering Usability Basics for. IEEE Software, 18(1), 22–29.

Wadsworth, Y. (1998). What is Participatory Action Research? Action Research International, Paper 2, 1–23.

Walker, K., Underwood, J., Waema, T., Dunckley, L., Abdelnour-Nocera, J., Luckin, R., … Camara, S. (2008). A resource kit for participatory socio-technical design in rural kenya. *Proceeding of the Twenty-Sixth Annual CHI Conference Extended Abstracts*, 2709–2714.

Walsham, G. (2002). Cross-cultural software production and use: a structurational analysis. *MIS Quarterly*, *26*(4), 359–380.

Walsham, G., & Sahay, S. (2006). Research on information systems in developing countries: Current landscape and future prospects. Information Technology for Development, 12(1), 7–24.

Walsham, G. (2006). Doing interpretive research. *European Journal of Information Systems*, *15*(3), 320–330.

Walsham, G. (2010). ICT for the broader development of india: an analysis of the literature. *Electronic Journal of Information Systems in Developing Countries*, *41*(4), 1–20.

Walsham, G. (2013). Development Informatics in a Changing World : Reflections from ICTD 2010 / 2012. *Information Technologies & International Development*, *9*(1), 49–54.

Walsham, G. (2017). ICT4D research: reflections on history and future agenda. *Information Technology for Development*, *23*(1), 18–41.

Walsham, G., & Sahay, S. (2006). Research on information systems in developing countries: Current landscape and future prospects. *Information Technology for Development*, *12*(1), 7–24.
Walton, M., & Heeks, R. (2011). *Can a Process Approach Improve ICT4D Project Success?* (No. 47). *Development Informatics*.
Wikipedia. (2017, July 19). List of ICT4D organizations. Retrieved February 3, 2017, from https://en.wikipedia.org/wiki/List_of_ICT4D_organizations
Wildte, F. (1928). Scandinavian Thing-steads. *Antiquity*, *2*(7), 328–336.
Winschiers-Theophilus, H. (2006). The Challenges of Participatory Design in an Intercultural Context : Designing for Usability in Namibia, 73–76.
Winschiers-Theophilus, H. (2009). Cultural appropriation of software design and evaluation. In *Handbook of Research on Socio-technical Design and Social Networking Systems* (pp. 699–710). IGI Global.
Winschiers-Theophilus, H., Bidwell, N., & Blake, E. (2012). Community Consensus: Design Beyond Participation. *Design Issues*, *28*(3), 89–100. https://doi.org/10.1162/DESI_a_00164
Winschiers-Theophilus, H., Chivuno-Kuria, S., Kapuire, G. K., Bidwell, N., & Blake, E. (2010). Being participated: a community approach. In *Proceedings particpatory design conference,PDC2010,Sydeny, Australia*.
Winschiers-Theophilus, H., Zaman, T., & Yeo, A. (2015). Reducing "white elephant" ICT4D projects. In *Proceedings of the 7th International Conference on Communities and Technologies - C&T '15* (Vol. 27–30, pp. 99–107). ACM Press.
World Bank. (2000). *ENTERING THE 21st Century world developmnet report*. Retrieved from http://documents.worldbank.org/curated/en/581181468184138461/World-development-report-1999-2000-entering-the-21st-century
World Bank. 2011. ICT in Agriculture : Connecting Smallholders to Knowledge , Networks ,and Institutions. Washington D.C.
World Bank. (2016). *World Development Indicators Highlights: Featuring the Sustainable Development Goals*. https://doi.org/10.1596/978–1-4648–0683–4
WSIS. (2014). WSIS+10 Statement on the Implementation of WSIS Outcomes. Retrieved June 6, 2017, from http://www.itu.int/net/wsis/implementation/2014/forum/inc/doc/outcome/362828V2E.pdf
Wulystan, P., & Andrew, C. (2013). Using information and communication technologies for enhancing the accessibility of agricultural information for improved agricultural production in Tanzania. *Electronic Journal of Information Systems in Developing Countries*, *56*(1), 1–14.
Wyche, S., & Steinfield, C. (2016). Why Don't Farmers Use Cell Phones to Access Market Prices? Technology Affordances and Barriers to Market Information Services Adoption in Rural Kenya. Information Technology for Development, 22(2), 320–333.
Young, P. (2008). Integrating culture in the design of ICTs. *British Journal of Educational Technology*, *39*(1), 6–17.
Zimmerman, J., & Forlizzi, J. (2008). The Role of Design Artifacts in Design Theory Construction. Artifact, 2(1), 41–45.
Zewge, A., & Dittrich, Y. (2017). Systematic mapping study of information technology for development in agriculture (the case of developing countries). *Electronic Journal of Information Systems in Developing Countries*, *82*(2), 1–25.
Zewge, A., Dittrich, Y., & Bekele, R. (2014). Providing Market Information for Ethiopian Farmers: Extending Participatory Design. *Participation for Development*. Retrieved from http://www.itu.dk/people/ydi/final/participation4d_submission_8.pdf
Zewge, A., Dittrich, Y., & Bekele, R. (2015). Adapting participatory design to design information system with rural Ethiopian community. In the proceeding of *AFRICON 2015,* (pp. 1–5).

Appendix A: List of included papers in systematic mapping study

Agarwal, S., Kumar, A., Nanavati, A., & Rajput, N. (2010). User-Generated Content Creation and Dissemination in Rural Areas. Information Technologies and International Development, 6(2), 21–37.
Agrawal, R., Atray, M., & Sattiraju, K. (2013). Exploring suitable interfaces for agriculture based smartphone apps in India. In ACM International Conference Proceeding Series (pp. 280–285).
Alam, Q., Yusuf, M., & Coghill, K. (2010). Village Phone Program, Commodification Of Mobile Phone Set And Empowerment Of Women. The Journal of Community Informatics, 6(1), 1–9.
Amariles, F., Paz, O., Russell, N., & Johnson, N. (2007). The impacts of community telecenters in rural Colombia. The Journal of Community Informatics, 2(3), 1–14.
Bailur, S. (2007). Using Stakeholder Theory to Analyze Telecenter Projects. Information Technologies and International Development, 3(3), 61–80.
Baro, E. E., & Endouware, B. C. (2013). The Effects of Mobile Phone on the Socio-economic Life of the Rural Dwellers in the Niger Delta Region of Nigeria. Information Technology for Development, 19(3), 249–263.
Bello-bravo, J., & Baoua, I. (2012). Animated Videos As A Learning Tool in Developing Nations: A Pilot Study of

Three Animations in Maradi and Surrounding Areas in Niger. Electronic Journal of Information Systems in Developing Countries, 55(6), 1–12.
Blake, A., & Garzon, M. Q. (2012). Boundary objects to guide sustainable technology-supported participatory development for poverty alleviation in the context of digital divides. Electronic Journal of Information Systems in Developing Countries, 51(1), 1–25.
Cáceres, R. B. (2012). Traders at Fairs in Rural Peru. Information Technologies and International Development, 8(3), 35–52.
Cloete, E. (2008). B2B e-Marketplace Adoption in South African. Information Technology for Development, 14(3), 184–196.
Dissanayeke, U. (2014). Mobile based information communication interactions among major agriculture stakeholders : SRI-LANKAN exprienace. Electronic Journal of Information Systems in Developing Countries, 60(1), 1–12.
Dittoh, F., Aart, C. Van, & Boer, V. De. (2013). Voice-Based Marketing for Agricultural Products : A Case Study in Rural Northern Ghana. In International Conference on Information and Communication Technologies and Development (pp. 21–24).
Doerfinger, J., & Dearden, A. (2013). Evolving a Software Development Methodology for Commercial ICTD Projects. Information Technologies and International Development, 9(3), 43–60.
Futterman, N. F., & Shuman, R. S. (2010). AppLab Question Box : A Live Voice Information Service in Rural Uganda. In International Conference on Information and Communication Technologies and Development.
Gandhi, R., Veeraraghavan, R., Toyama, K., & Ramprasad, V. (2009). Digital Green : Participatory Video & Mediated Instruction for Agricultural. Information Technologies & International Development, 5(1), 1–15.
Garudachar, S. (2010). E-Agro initiative of Ekutir and Grameen-Intel JV social business. The Journal of Community Informatics, 6(2), 1–7.
Pick, James, Kamala Gollakota, and Manju Singh. 2013. “Technology for Development: Understanding Influences on Use of Rural Telecenters in India.” Information Technology for Development 20(4):296–323.
Goswami, R. (2010). Telesupport Experiment for Agricultural Information Management in West Bengal, India. The Journal of Community Informatics, 6(2), 1–9.
Grunfeld, H. (2014). ICT for sustainable development: an example from Cambodia. The Journal of Community Informatics, 10(2), 1–12.
Iadah, N., Ibrahim, H., Mat, Z., Zahurin, A., Zulkhairi, D., Ghazali, O., … Abu, M. (2012). Information Needs of Rural Communities. The Journal of Community Informatics, 9(1), 1–6.
Johansson, L. (2010). Telecentre For Community Development Evaluation Of The Tunjang Telecentre, Malaysia. The Journal of Community Informatics, 6(2), 1–16.
Kameswari, V. L. V., Kishore, D., & Gupta, V. (2011). ICT for agricultural extension: a study in the Indian himalayan region. Electronic Journal of Information Systems in Developing Countries, 48(3), 1–12.
Kuriyan, R., Toyama, K., & Ray, I. (2006). Integrating Social Development and Financial Sustainability: The Challenges of Rural Computer Kiosks in Kerala. International Conference on Information and Communication Technologies and Development, 121–130.
Madon, S., Reinhard, N., Roode, D., & Walsham, G. (2009). Digital Inclusion Projects in Developing Countries : Processes of Institutionalization. Information Technology for Development, 15(2), 95–107.
Martin, B. L., & Hall, H. (2011). Mobile Phones and Rural Livelihoods : Diffusion , Uses , and Perceived Impacts Among Farmers in Rural Uganda. Information Technologies and International Development, 7(4), 17–34.
Maunder, A., Marsden, G., Gruijters, D., & Blake, E. (2007). Designing Interactive Systems for the Developing World – Reflections on User- Centred Design. In International Conference on Information and Communication Technologies and Development.
Medhi, I., & Toyama, K. (2007). Full-context videos for first-time, non-literate pc users. International Conference on Information and Communication Technologies and Development.
Moens, N. P., Broerse, J., Gast, L., & Bunders, J. (2010). A Constructive Technology Assessment Approach to ICT Planning in Developing Countries: Evaluating the First Phase, the Roundtable Workshop. Information Technology for Development, 16(1), 34–61.
Mpazanje, F., Sewchurran, K., & Brown, I. (2013). Rethinking Information Systems Projects Using Actor-Network Theory: A Case Of Malawi. Electronic Journal of Information Systems in Developing Countries, 58(7), 1–32.
Muthiah, G., Prashant, S., Umadikar, J., & Karthikeyan, K. (2013). An exploratory sudy of mobile multimedia agricultural advisory system: challenges and lessons from TAMIL NADU, INDIA. Electronic Journal of Information Systems in Developing Countries, 56(5), 1–14.
Parmar, V. (2009). A Multidisciplinary Approach to A Multidisciplinary Approach to ICT Development. Information Technologies and International Development, 5(4), 89–96.
Patel, N., Chittamuru, D., Jain, A., Dave, P., & Parikh, T. (2010). Avaaj otalo: a field study of an interactive voice forum for small farmers in rural india. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 733–742).

Patel, N., Savani, K., Klemmer, S., Parikh, T., Dave, P., & Shah, K. (2012). Power to the Peers: Authority of Source Effects for a Voice-Based Agricultural Information Service in Rural India. Information Technologies and International Development, 9(2), 81–93.
Pick, J. B., Gollakota, K., & Singh, M. (2013). Technology for Development: Understanding Influences on use of Rural Telecenters in India. Information Technology for Development, 20(4), 296–323.
Plauché, M., & Nallasamy, U. (2008). Speech Interfaces for Equitable Access to Information Technology. Information Technologies and International Development, 4(1), 69–86.
Puri, S. K., & Sahay, S. (2007). Role of ICTs in participatory development: An Indian experience. Information Technology for Development, 13(2), 133–160.
Rao, S. S. (2009). Role of ICTs in Indian Rural Communities. The Journal of Community Informatics, 5(1), 1–10.
Reijswoud, V. (2009). Appropriate ICT as a tool to increase effectiveness in ICT4D: theoretical considerations and illustrating cases. Electronic Journal of Information Systems in Developing Countries, 38(9), 1–18.
Sambasivan, N., & Smyth, T. (2010). The human infrastructure of ICTD. In International Conference on Information and Communication Technologies and Development (pp. 1–9). New York, USA: ACM Press.
Schmidt, C., Jean, T., Shayne, M., & Azaabanye, A. (2012). Impact of Low-Cost , On-Demand Information Access in a Remote Ghanaian Village. Information Technologies and International Development, 8(2), 85–100.
Siyao, P. (2012). Barriers in accessing agricultural information in tanzania with a gender perspective : the case s tudy of small- scale sugar cane. Electronic Journal of Information Systems in Developing Countries, 51(6), 1–19.
Srinivasan, J. (2007). The role of trustworthiness in information service usage : The case of Parry information. In International Conference on Information and Communication Technologies and Development.
Tandi, E. (2010). Bridging The Agricultural Knowledge And Information Divide: The Case Of Selected Telecenters And Rural Radio In Tanzania. Electronic Journal of Information Systems in Developing Countries, 43(6), 1–14.
Tomitsch, M., Sturm, F., Konzett, M., Bolin, A., Wagner, I., & Grechenig, T. (2010). Stories from the Field : Mobile Phone Usage and its Impact on People ' s Lives in East Africa. In International Conference on Information and Communication Technologies and Development, ICTD2010. London.
Tongia, R., & Subrahmanian, E. (2006). Information and Communications Technology for Development (ICT4D) – A Design Challenge? In International Conference on Information and Communication Technologies and Development (pp. 243–255).
Veeraraghavan, R. (2009). Warana Unwired : Replacing PCs with Mobile Phones. Information Technologies and International Development, 5(1), 81–95.
Vincent, K., & Cull, T. (2013). " Ten Seeds ": How Mobiles Have Contributed to Development in Women-Led Farming Cooperatives in Lesotho. Information Technologies and International Development, 9(1), 37–48.
Wulystan, P., & Andrew, C. (2013). Using information and communication technologies for enhancing the accessibility of agricultural information for improved agricultural production in Tanzania. Electronic Journal of Information Systems in Developing Countries, 56(1), 1–14.

Appendix B: Survey Questionnaire

Dear All

The purpose of this survey is to investigate the farmers' information needs and hindrances to information accessibility for effective decision making. Kindly spare some time to complete this questionnaire as best as you can. Please be assured that the information that you provide here would be treated with utmost confidentiality.

Address:

Farmer Association(Kebele) Name	Respondent Name	Enumerator Name

Part I: Demographics Characteristics

1. Gender: 1= Male 2= Female
2. Age: 1= below 25 2= 25-34 3= 35-45 4=45-50 5= above 45
3. Formal educational level you attend
   1. Illiterate
   2. Primary
   3. Secondary
   4. Certificate
   5. Diploma and above
   6. Others:_____
4. Marital Status
   1. Single 2. Married 3. Divorced 4. widowed
5. Religion: 1= Orthodox 2= Muslim 3= Protestant 4 Other:_____
6. Specify your language skill by placing **'X'** in the space provided

Language	Understand	Speak	Read	write
Amharic				
Oromigna				
English				
Other: specify_____				

Part II: Crop related issue

7. How long have you been farming?
   1. <=5 years
   2. <= 10 years
   3. <= 15 years
   4. <= 20 years
   5. >= 20 years
8. What is your Size of land under production:
   1. < 1 Timad
   2. <2 Timade
   3. < 3Timad
   4. 4 Timad
   5. > four Timad
9. Rank major crops that you have been cultivating in the last five years

Crop Type	**Rank your major crop (1-7)** where 1 means most cultivated needed .whereas 7- means the lowest
1. Wheat	
2. Bean	
3. Pean	
4. Barely	
5. Maize	
6. Potato	
7. Sorghum	

10. Which of the following information is most important to you? please **rank** them based on your need from highest to lowest (1-7) where 1 means highly needed .whereas 7- means the lowest

Information Type	Rank(1-7)
1. Market information	
2. Input price	
3. Best package of practice	
4. Plant protection	
5. Weather Information	

6. Value addition to farm products	
7. Rick Recovery	

Part III: Access to Marketing information

11. How often do contact the extension service? _____
    1= Never
    2= Once per every 2 weeks
    3= Once per month
    4= Once per 3 months
    5= When I have a problem
12. During the past 12 months, where did you get information about prices of staple?
    1. I did not get the information
    2. Neighboring farmers
    3. Model farmers
    4. DAs
    5. Printed media, like news paper
    6. TV
    7. Radio
    8. Farmers' organizations
    9. *Local Traders*
    10. *Electronics media like:*
        i. email
        ii. internet
        iii. SMS
        iv. IVR
        v. Via Mobile Phone call

    12.1. How often do you look for such market information
    1. Every Week
    2. Every 15 days
    3. Every month
    4. Every 3 month

    12.2. Are you satisfied about the answer you got, if any, with the answer from Q12? 1= Yes 2=No

    12.3. On the average , How many hours do you walk to get this information
    1. Less than 30 minutes
    2. Less than 1 hour
    3. Less than 2 hours
    4. Less than or equal to 3 hours
    5. More than equal 4 hours
13. Where do you sell your crops?
    1. at farm gate
    2. the Village market area
    3. at wereda town
    4. other town/market place
14. Have you ever sold agriculture product before it is finally produced? 1= Yes 2= No
15. What is the Reason for selling the agricultural product before it is finally produced?
    1. needed immediate cash
    2. Cause of any ceremony
    3. Pay for loan
    4. other
16. When do you Know about market price of your crop:
    1. When I sale it
    2. the day before I sale it
    3. the week before I sale it
    4. a month before I sale it
    5. when I have sowed it
    6. Othre:_____-
17. How do you price your commodity when selling?
    1. According to the floor price as announced by the government
    2. Through bargaining
    3. Using the barter system
    4. Others:_____
18. How do you make decision concerning the number of hectares you want to cultivate in any given year
    1. By relying on the agriculture marketing information
    2. Through trail production
    3. From experience
    4. Deeding on the availability of inputs
    5. Other:_____
19. What are your primary sources of information on **national markets**? (Rank 3 most important) Other farmers

National market Source of information	Rank(1-3)
1. Buyers	
2. Central wholesale market	
3. Export/Production Assn	
4. Farmers Union	
5. Shopkeepers	
6. Radio	
7. TV	

20. Are you benefiting from information that is being published by ECX/ Oromiya Marketing agency?

    1= yes 2= No

21. Do you use any intermediary or middleman to sale your crop? 1= yes 2= No

    21.1. What percentage do you have to pay? _____

22. Do you think that having daily price information change your marketing practices? 1= Yes 2 =No

    22.1. If not, why not? _____

23. If possible, would you like to make any changes in the way you sell your crops? 1= yes 2= No

    23.1. If yes, what do you want do? _____

24. What were the two most significant problems you had selling this crop?
    1. High cost of transport to market
    2. Low prices in accessible markets
    3. High market fees/taxes
    4. Poor transportation infrastructure
    5. Not able to meet quality requirements of buyers
    6. Unpredictable prices
    7. Lack of price information
    8. Difficult/unable to find buyer
    9. Farmers' organization not effective at selling commodities
    10. Late or slow payment from buyers
    11. Other_____

25. how do you judge degree of transparency of the current marketing system for buying improved seeds, fertilizers and selling your crop system

    1= It is transparent 3= Not Transparent at all

    2=partially transparent? 4= I don't Know

    25.1. If the answer for **Q25 is "partially transparent"**, mention one major factor? _____

    25.2. If the Answer for **Q25** is ,"**Not Transparent**", Would you be willing to pay service charges of 1 - 5% of cash received from crop sales to finance a real-time price reporting system from DA? 1= Yes 2=No

    25.3. If the answer for **Q25.2** is **yes**, are you willing to contribute to support while some one is doing real-time price reporting? 1= Yes 2 = No

    25.4. If the answer for **Q25 .3** is **yes**, are you willing to share the same information to other similar farmers like you? 1= Yes 2= No

26. What were your Transaction costs paid in the last transaction
    1. transport of produce
    2. Paid for personal transport
    3. commission for agent(broker)
    4. Other:_____

27. How do you judge the cost transporting your crop to the market area

    1. Cheap 2. Tolerable 3. Expensive

28. Please mention your view with respect to major community problem in selling your commodity
    1. ____
    2. ____
    3. ____

Part IV: ICT USE

29. Does your house have electricity? 1= **Yes** **2= No**

30. Do you have an access(own) to :
1. Radio
2. TV;
3. Mobile phones
4. Computer
5. land telephone line
6. I don't have any

31. What type of telephone do you use most?
    1. Fixed line telephone
    2. Mobile telephone
    3. Not using any phone
32. If the answer for **Q 31 is mobile phone**, do you face any problems (like understanding content, the arrangement of menus/interface, etc) with related to mobile phones use? 1=Yes 2= No
33. Do you know how to use the computer? 1=**Yes** **2=No**
34. If the answer to **Q33 is yes**, do you know how to use the Internet (www)? 1=**Yes** **2=No**
35. If the answer for Q34 is Yes, how do you communicate?
    1= Use it by myself 2= Asks attendant to email / browse for me 3= Other:___________ _____
36. On the average how much birr do you spend for your mobile air time per month
    1. Less than 25 Birr
    2. Less than 50 Birr
    3. Less than 75 Birr
    4. Less than100 Birr
    5. More than 100 Birr
37. Have you been using SMS in the past 6 months via your mobile phone? 1= Yes 2=No
38. If the answer to **Q37 is yes**, please put X

Communication type	**1-5**	**6-10**	**>= 10**
1. No. of calls made daily			
2. No of calls received daily			
3. No of SMS sent daily			
4. No of SMS received daily			

39. If the answer for **Q37** is **YES**, how strongly do you **agree** or **disagree** with the following issues of SMS.

SMS related issues	**Degree of agreement**		
	3=Agree,	**2=Neutral**	**1=Disagree**
43.1 Typing on a small keypad is hard			
43.2 I Don't know how to use			
43.3 Time consuming			
43.4 Expensive			
43.5 doesn't support Local language			

40. Constraints that you think are hindering the use of ICT in agriculture. Please putting 'X' on the given space

Constraint Types in using ICT facility	**Level of Constraints**		
	1= Not constraint	**2= Serious constrain**	**3=Very serious constraint**
1. Lack of technical know-how			
2. Lack of communication infrastructure			
3. Inappropriate contents of ICT that don't meet needs of farmers			
4. Erratic and fluctuating power supply			
5. Poor finance			
6. Language problem			
7. ICT is not user friendly			

~~~~~~~~~~~~~~~~~~~~~~~~~~~END~~~~~~~~~~~~~~~~~~~~~~~~
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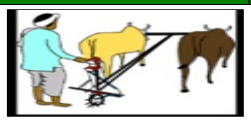
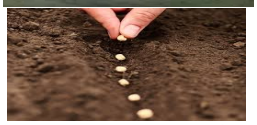
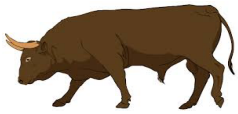
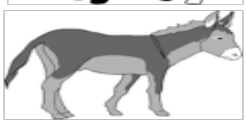
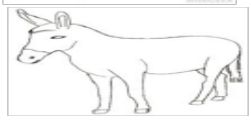
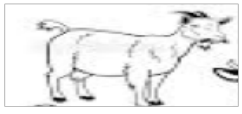
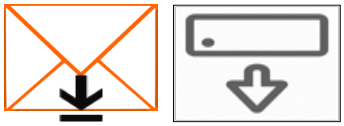
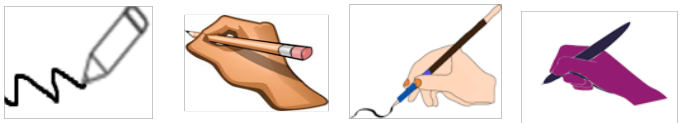
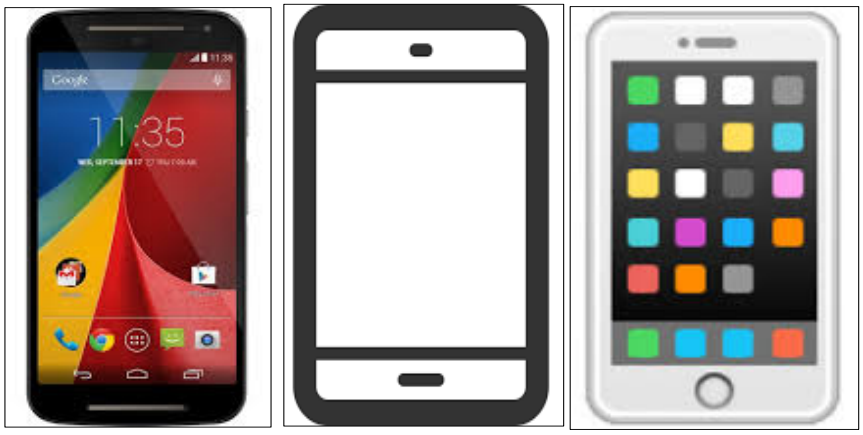
Appendix C: Mapping concepts into near by picture

Appendix A: Concepts and their matching metaphors used to design the UI

		metaphors		
Catagory	**Concepts**	**Aleternative 1**	**Aleternative 1**	**Aleternative 1**
Farming	Plowing			
	Bean			
	Wheat			
	Potato			
	Inset protection			
	Weed protection			
	Fetilizer			
	New Seed(varieties)			
	Market Price			
Animal	Ox			
	Cow			
	Donkey			
	Sheep			
	Goat			

Social events	Birth	
	Death	
	Meeting	
	Marraige	
	sending message : Up load	
	downlaod	
	arrow or direction	
input and output	Hand writting	
	Camera	
	Sound recorder	
	Micraphone	
Mock up	Mobile phone	

Appendix D: Procedure and tasks for usability evaluation

Usability evaluation encompasses prototype evaluation and assesses the evaluation process. The product evaluation main goal is to improve the usability of the developed mobile app and make them easy to use with real users. Whereas, the process evaluation is concerned with defining appropriate tasks, scenario and storyboarding session and let participants to do real tasks. And then observe and recode what the participants do or say for further analysis and reflect on lesson learned.

Usability attributes to measure software systems

Based on the standard ISO 9241, and existing studies on mobile applications the following criterion are selected as usability attributes.

i. **Learnability** focuses on how easily users can finish a task the first time using an application and how quickly users can improve their performance levels (i.e., ease-of-use);

ii. **Effectiveness -** defined as completeness and accuracy with which users achieve certain goals. It can be measured by comparing user performance with required levels.

iii. **Efficiency** is defined as how fast users can accomplish a task while using an application. The difference between efficiency and learnability is that before measuring efficiency, users should have already had some experience of using a mobile application.

iv. **Memorability** refers to the level of ease with which users can recall how to use an application after discontinuing its use for some time. The main idea is to measure how well users can re-establish the skill of using an application;

v. **User satisfaction** and **usefulness** reflects the attitude of users toward using a mobile application;

vi. **Simplicity** is the degree of comfort with which users find a way to accomplish tasks. This attribute is frequently used to assess the quality of menu structures as well as navigation design of mobile applications;

Part I: Formative usability evaluation template

i. **Introductions**—including getting to know each other and users role in the each evaluation process.

ii. **Set Task** (ordered tasks list with name and code): give name and code for each task. On top of this, structure the issues and tasks using affinity diagramming.

iii. **Goal/output**: define the purpose of the workshop, tasks, and identify what each participant expects as an outcome.

iv. **Facilitation techniques –** one of the following method could be used as a facilitation mechanize so as to accomplish a given task

- *Metaphor Brainstorming*- use to generate user interface metaphors, which can serve as organizing concepts using icons or graphical layout
- *Card sorting* -all the icons are drawn on cards, and the users are asked to organize them under predefined categories.
- *Paper prototyping*- the different screens are sketched before the testing. Typical use cases are then created, and the users are requested to try and perform them by interacting with the prototype. Based on where they select, the human-computer changes the interface by introducing whole screens, depending on how the system is intended to react. A person who is chosen to play the human-computer can do this task.
- *Scenario*- once we have the list of tasks for the evaluation, we have to present those tasks to the participants. One way that works well is to give the participant's a very short story scenario that tells participants what we want them to do during the evaluation.

v. **Tasks-** is made up of the steps a user has to perform to accomplish a goal. A task scenario describes what the user is trying to achieve by providing some context and the necessary details to accomplish the goal. Task can also be expressed as a closed one using specific functionalities.

Table1: Sample Tasks and facilitation techniques

task description	Facilitation method (eg. Scenario) description
Evaluate menu structure and arrangements- The whole idea of doing this task is to have a common consensus to classification of menu by different categories, evaluate the understandability and clear interpretation of the used icons by the majority of the users. The menu and submenu structure initially are cataloged into the following format ➢ **Farming:** Market price, seed, fertilizer, weed and insect information ➢ **Social events**: Ider announcement, death, Birth, wedding events ➢ **Domestic animal:** Ox, Donkey, Cow, Sheep	**Metaphor Brainstorming and Card sorting**
Evaluate the human interaction with user interfaces through low-fidelity prototyping and power point slides.	**Paper prototyping**
Assess the understandability of the overall system, if a user can complete a given task once he or she is given whole application structure	**Tree Testing**
Browse information about **New seed** information which is uploaded by different users like research centers	**Scenario:** Assume that you or your community members are looking for recent information about this year new Seed delivery time and others so as to plan the farming activates. You already told that you could get such information from the community data center via mobile phone. Now using this phone to browse such information.
Browse information about **Insect** information which is uploaded by different users	**Scenario:** Assume that you or your community members are looking for recent information about Insect disaster management. You already told that you could get such information from the community data center via mobile phone. Now using this phone to browse such information.
Upload information about seed, market information, fertilizer, weed and insect managing to the data center to be shared with other community members or to get feedback. The message to be uploaded could be Text, Image, Voice or a combination	**Scenario:** Assume that you have a lot of farming information and good practices, which is valuable for other community members if it is shared. As you already know that there is a community data center where you can upload your message to the system and then share it with others. Now you can use this mobile phone or use your phone to do this task.

Part II: Subjective (summative) usability evaluation tool

o	Question	User satisfaction rate		
		Disagree =1	Neutral =2	Agree =3
	Ease of Use			
	Learning to operate this software initially is full of problems			
	It takes too long to learn the software commands			
	The way that system information is presented is clear and understandable			
	Learning how to use system functions is difficult			
	It is relatively easy to move from one part of a task to another			
	It is easy to see at a glance what the options are at each stag			
	Usefulness			
	Using the software improve my information access in my daily lives			
	I found the software as good for farming sector, particularly for farmers			
	Using this software enable farmers to get the information quickly			
	Using the software is a good idea			
	Intention to use			
	I think that I would like to use this system always, if it is online to use			
	I would recommend this software to my colleagues			
	I intend to use frequently in the time ahead			
	I believe that using agriculture system will increase the quality of information access among farmers, DA and woreda Agriculture Office			

Appendix E: Data Extraction Form

Data	Description
Title of an article	A title of each article
Authors Name	The name of each author(s)
Publication venue	Journals and /or Conferences where a papers is published
Year of publication	The time where given papers is published between 2006-
Abstract	An abstract of each paper
Keyword	Keywords of each paper
Research questions	The main research objective of each paper
Main research	Each author's claims and recommendations
Research method	Research process adapted by each study such as
Data collection and	Type of data collected by each study: Qualitative,
Research paradigm	Paradigm standpoint such as Positivism, Interpretativsm,
Theoretical underpinning	A conceptual framework used to guide investigation
Level of analysis	The main Country, Organizational, Community
Technology studied	Personal computer, CD, Mobile phone , and Internet
Discipline	Core disciplines of ICT4D, which include: computer Science, HCI, for development Information system, development

Appendix F: ICT4A initiatives across developing countries

No	Project name	Country	Voice	SMS	Internet (website)	Radio
1	Freedom Phone	Zimbabwe	Voice	SMS	Internet	
2	Farmers' Internet Café	Zambia			Internet	
3	SMS Information Service	Zambia		SMS		
4	Regional Agricultural Trade Information Network (RATIN)	Uganda	Voice		internet	
5	Q and A service Voucher System	Uganda	Voice		Internet	
6	African Farm Radio Research Initatives	Uganda				Radio
7	Agriculture Research and Rural Information Network (ARRIN) Ndere Troupe	Uganda			Internet	
8	Collecting and Exchanging of Local Agricultural Content (CELAC)	Uganda		SMS	Internet	Radio
9	DrumNet (Solution)	Uganda			Internet	
10	Enhancing Access to Agricultural Information using ICT in Apac District (EAAI)	Uganda	Voice	SMS		Radio
11	Agricultural Research Extension Network (ARENET	Uganda			internet	
12	Apps for Africa	Uganda		SMS		
13	CELAC	Uganda		SMS		
14	Esoko	Uganda		SMS		
15	Farmers Information Communication Management (FICOM)	Uganda	Voice	SMS	internet	Radio
16	Infotrade Uganda	Uganda		SMS	internet	
17	Women of Uganda Network (WOUGNET)	Uganda		SMS		
18	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Togo		SMS	internet	
19	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Togo		SMS	internet	Radio
20	Regional Agricultural Trade Information Network (RATIN)	Tanzania	Voice		internet	
21	African Farm Radio Research Initatives	Tanzania				Radio
22	Family Alliance for Development and Cooperation (FADECO)	Tanzania		SMS		Radio
23	Agricultural Sector Development Programme (ASDP)	Tanzania		SMS	Internet	
24	CROMABU (Crops Marketing Bureau) Project	Tanzania			Teleceter	
25	First Mile Project	Tanzania			Internet	
26	Research on Expectations about Agricultural Production (REAP)	Tanzania	Voice			
27	Agricultural Marketing Systems Development Programme (AMSDP)	Tanzania		SMS		
28	Esoko	Tanzania		SMS		
29	Livestock Information Network and Knowledge System (LINKS)	Tanzania		SMS		
30	Vodacom Tanzania	Tanzania		SMS		
31	Regional Agricultural Trade Information Network (RATIN)	Sudan	Voice		internet	
32	Souther arica Develoment Q and A service	South Africa	Voice			
33	Makuleke Project	South Africa		SMS		
34	Regional Agricultural Trade Information Network (RATIN)	Somalia	Voice		internet	
35	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Sierra Leone		SMS	internet	
36	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Senegal		SMS	internet	
37	T2M(Time to Market)	Senegal	Voice	SMS	Internet	
38	Manobi	Senegal		SMS		
39	Trade at Hand	Senegal		SMS		
40	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Senegal		SMS	internet	Radio
41	Xam Marsé	Senegal		SMS	internet	
42	ICT for Improving Agriculture in Rwanda	Rwanda		SMS		
43	Agricultural Commodity Trade Platform	Pakistan	Voice			

No	Project name	Country	Voice	SMS	Internet (website)	Radio
44	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Nigeria		SMS	internet	
45	Agrovision	Nigeria			Internet	
46	Esoko	Nigeria		SMS		
47	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Nigeria		SMS	internet	Radio
48	Informations sur les Marches Agricoles par Cellulaire (IMAC)	Niger		SMS		
49	Système d'Information des Marchés Agricoles (SIMA)	Niger		SMS		
50	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Niger		SMS	internet	Radio
51	Esoko	Mozambique		SMS		
52	Trade at Hand	Mozambique		SMS		
53	Network of Market Information Systems and Traders' Organizations	Mali		SMS	internet	
54	African Farm Radio Research Initatives	Mali				Radio
55	Information Network in Mande	Mali				Radio
56	Jekafo Guelekan System for Farmers in Sikasso	Mali				Radio
57	Fruiléma	Mali	Voice	SMS	Internet	
58	ICT for Shea Butter Producers	Mali			Computer	
59	Sene Kunafoni Bulon	Mali			Internet	
60	Esoko	Mali		SMS		
61	Trade at Hand	Mali		SMS		
62	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Mali		SMS	internet	Radio
63	African Farm Radio Research Initatives	Malawi				Radio
64	Information Services Agricultural Marketing and Information System for Malawi (MIS-Malawi)	Malawi		SMS	internet	Radio
65	Esoko	Madagascar		SMS		
66	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Liberia		SMS	internet	
67	Trade at Hand	Liberia		SMS		
68	Regional Agricultural Trade Information Network (RATIN)	Kenya	Voice		internet	
69	Banana Information Line	Kenya	Voice			
70	National Farmer Inforamtion Service	Kenya	Voice			
71	Millennium Infoamtion center and Community Parilaments	Kenya	Voice	SMS	Internet	
72	Kenya Farmer's Helpline	Kenya	Voice			
73	Infonet Biovision Farmer Information Platform	Kenya				Radio
73	iCow					
73	The Organic Farmer	Kenya			Internet	Radio
73	DrumNet (Solution)	Kenya			Internet	
76	Kenya Agricultural Commodities Exchange (KACE) MIS Project	Kenya	Voice	SMS	internet	
77	Livestock Information Network and Knowledge System (LINKS)	Kenya		SMS		
78	Nokia Life Tools	Indonesia		SMS		
79	IKSL Agri HotLine	India	Voice	SMS		
80	KRIBHCO Kisan Limited	India	Voice	SMS	Internet	
81	Gyandoot	India			Internet	
82	iKisan	India			Internet(Telecester)	
83	Warana	India			Internet	
84	mKrishi	India	Voice	SMS		
85	Nokia Life Tools	India		SMS		

No	Project name	Country	Voice	SMS	Internet (website)	Radio
86	Reuters Market Light	India		SMS		
87	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Guinea		SMS	internet	
88	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Guinea		SMS	internet	Radio
89	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Ghana		SMS	internet	
90	African Farm Radio Research Initatives	Ghana				Radio
91	Eastern Corridor Agro-market Information Centre (ECAMIC)	Ghana	Voice	SMS		
92	E-commerce for Non-traditional Exports	Ghana			Internet	
93	Esoko	Ghana		SMS		
94	E-commerce for women	Ghana			Internet	
95	ICT Support for Agricultural	Ghana		SMS		
96	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Gambia		SMS	internet	
97	Ethiopia Commodity Exchange(ECX)	Ethiopia	Voice	SMS	internet	
98	Livestock Information Network and Knowledge System (LINKS)	Ethiopia		SMS		
99	Virtual extension and research communication network	Egypt			Internet	
100	Regional Agricultural Trade Information Network (RATIN)	Djibouti	Voice		internet	
101	Esoko	Ivory Coast		SMS		
102	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Ivory Coast		SMS	internet	Radio
103	Network of Market InformationSystems and Traders' Organizations of West Africa (MISTOWA)	Ivory Coast		SMS	internet	
104	Allo Ingenier	Cameroon	Voice			
105	Esoko	Cameroon		SMS		
106	Regional Agricultural Trade Information Network (RATIN)	Burundi	Voice		internet	
107	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Burkina Faso		SMS	internet	
108	Miproka	Burkina faso			Internet(Telecester)	
109	Sissili Vala Kori	Burkina faso			Internet	
110	TV Koodo: Market price information using web and national TV	Burkina faso			Internet	TV
111	Esoko	Burkina faso		SMS		
112	Trade at Hand	Burkina faso		SMS		
113	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Burkina faso		SMS	internet	Radio
114	Network of Market Information Systems and Traders' Organizations of West Africa (MISTOWA)	Benin		SMS	internet	
115	Esoko	Benin		SMS		
116	InfoPrix Benin	Benin		SMS		
117	West African Agricultural Market Information System Network (RESIMAO/WAMIS-Net)	Benin		SMS	internet	Radio
118	Agricultural Market Information for Farmers	Bangladish		SMS		
119	Bangalink	Bangladish	Voice			
120	Esoko	Afghanistan		SMS		
121	Regional Agricultural Trade Information Network (RATIN)	Rwanda	Voice		internet	

Source: (**Aker, 2011**; **Baumüller, 2012**; **Qiang, Kuek, Dymond, & Esselaar**, 2011; **WorldBank,** 201

Appendix G: versions of my research methodology

Software Designing Methodology for ICT4D Domain : Participatory Design (PD)

Scenario: Small scale Agriculture Business

Background and motivation

- ✓ Agriculture is the largest livelihoods provider in developing countries
  - ➢ Majority of farmers unsatisfactory due to limited communication facilities
  - ➢ 42% of the Ethiopian GDP
  - ➢ 83% of the Ethiopian labor force
- ✓ The use of ICT as enabler in the area is very limited
- ✓ Interventions at agriculture information service need understanding of:
  - ✓ The physical ICT infrastructure
  - ✓ Organizational setting
  - ✓ The digital information resources
  - ✓ Skills people need to extract and apply knowledge
  - ✓ Social and economic issues

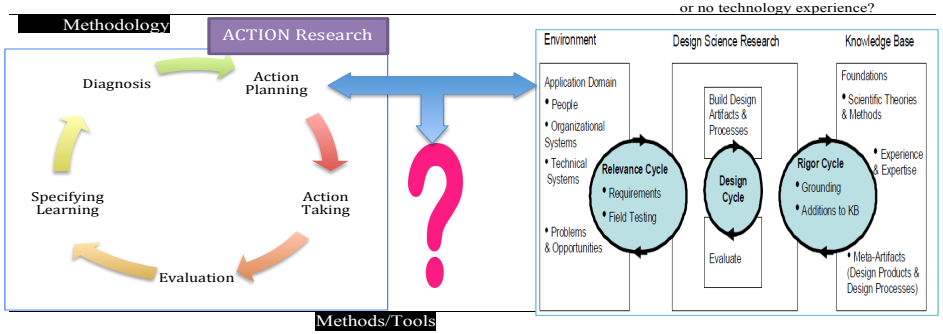
Research Problem

- ✓ ICT4D projects for rural communities differ from conventional software projects in a number of ways.
  - o There is a set of environmental and user constraints specific to ICT4D projects that conventional projects rarely need to address simultaneously.
- ✓ Many farmers in developing country have little or no experience ICT
- ✓ ICT4D research investigates lack of a clear theoretical and methodical stance.
- ✓ Sustainability of ICT project projects remains a central issue that needs further exploration.

Research Questions

- How do we integrate methods of socio-technical analysis with participatory design that interact with specific aspects of social, economic, and cultural contexts for developing countries?
- How can we co-design new technologies with users in participatory design who have little or no technology experience?

Methodology



Methods/Tools

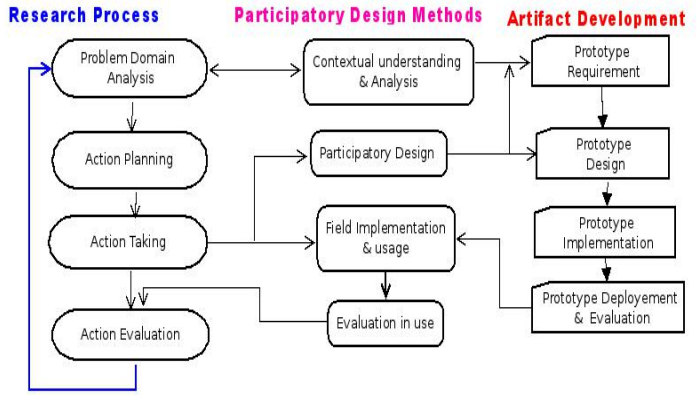
About The Project:

- Information to disseminate: Weekly price information of agriculture produce
- Information to be collected by: Price collector and Peer to peer exchange
- Expected Benefit: Improve Bargaining power of farmers and reduce transaction cost

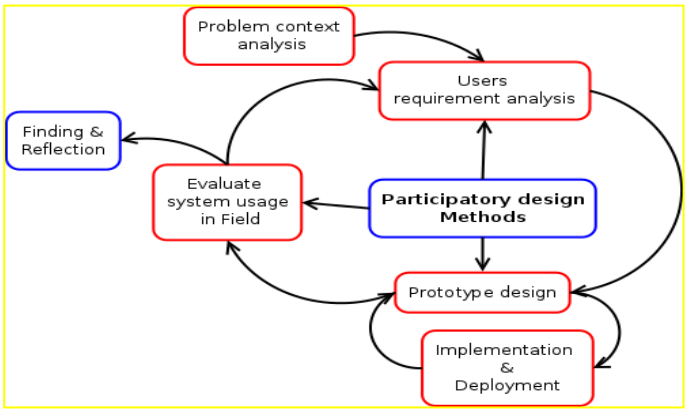
Research Team:

- ✓ Amanuel Zewge: PhD candidate, Adama science and Technology University, Ethiopia azew@itu.dk
- ✓ Yvonne Dittrich (Assoc. prof.), IT university of Copenhagen, ydi@itu.dk
- ✓ Rahel Bekele (Assoc.Prof), Addis Ababa University rahtesf@yahoo.com

PDC2014, Doctorial consortium



Entering into the field: November 2014



PAR for ICT4D: Midway evaluation: Number 2015