Mobile Health (mHealth) in Sierra Leone: A Critical Realist Study

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PhD Declaration

I, Patrick Joseph Wall, hereby declare that this thesis has not been submitted as an exercise for a degree at this or any other University, and that the work described within is entirely my own except where otherwise stated.

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Date: October 2020

Executive Summary

The number of mobile health (mHealth) implementations around the world, particularly in developing countries, has been increasing dramatically. However, the design, implementation and adoption of mHealth in such environments is beset with wide-ranging challenges and many such projects have been unable to sustain or demonstrate any significant impact at scale. This is because any mHealth implementation in a developing country environment is bound to be shaped by a variety of ethical, social, cultural, political, environmental, ideological, and technological factors.

This PhD research examines an ongoing mHealth initiative in Bonthe District, Sierra Leone. The research questions ask why the mHealth project evolved the way it did, and what were the mechanisms that determined the outcome. A research framework that relies on critical realism and Margaret Archer's morphogenetic approach is leveraged to hypothesize generative mechanisms which provide an answer to the research question. Critical realism is used as the philosophical approach as it addresses many of the concerns associated with the interpretivist and positivist approaches that have dominated the ICT4D field for many years. A further research question examines how such a critical realist-based research framework can be applied to this case in practice.

Such a critical realist-based philosophical approach has the potential to inform how this particular mHealth case has evolved in a variety of different social, cultural, and political contexts. This approach can also bring many other advantages to the research including its ontological realism combined with epistemological relativism; its iterative, pluralist, and reflexive methodology; and its emancipatory values. In addition, critical realism brings with it a variety of generic values including exposure of context, a contingent causality that reflects real-world experiences, support for use of theoretical frames, legitimisation of different stakeholder views, and reduction of research bias.

A total of 5 generative mechanisms are hypothesized. These include the communications and technological infrastructure built around the mHealth project - in particular the technology, people and monitoring and reporting structures; the motivation and attitude of the CHWs including the altruistic nature of the CHWs and the manner in which they use the mHealth technology to complete their work; the actions of two separate mHealth project champions who are part of the mHealth management team in Sierra Leone; the mHealth infrastructure in its entirety; and the financial and non-financial incentives given to the CHWs and part of the recently introduced CHW national policy.

It is proposed that these generative mechanisms have dictated why this mHealth project evolved in the way that it did. Although these mechanisms are always contingent on conditions and causal structures, they are particularly relevant in this case. This is despite the assertion that it cannot be claimed any of the hypothesized mechanisms identified are the best ones to explain this case, or indeed, that the hypothesized mechanisms even exist. Despite this however, the research framework developed for this research has the potential to be able to identify the best possible explanation of a situation that is consistent with the data provided in the same situation.

All of this means that there is potential to contribute to improving this particular mHealth case, and by extension the entire public health system in Sierra Leone. There are many benefits to be gained from being able to provide explanation of this type for why mHealth implementations have evolved in a certain way. This knowledge has the potential to stop problems before they start and also to do more of what is needed to make mHealth projects work successfully. This gives researchers and mHealth implementers the potential to have great impact, which may mean that many of the world's poorest and most disadvantaged people can benefit from improved mHealth and public health systems.

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I would also like to make special mention of the CHWs in Sierra Leone who work tirelessly on this mHealth project, usually in very challenging and resource-constrained conditions. The work you do saves many lives and makes your communities better places to live. Thank you very much for taking the time to participate in this research. I hope I have done you justice in some small way.

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“Ever Tried. Ever Failed. No matter. Try again. Fail again. Fail better.”

Samuel Beckett, Worstward Ho (1983)

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List of Abbreviations

4D	For development
7-11/ttC	Timed and targeted counselling
ADAPT	ADAPT Centre, Trinity College Dublin
ADP	Area development programme
AI4D	Artificial intelligence for development
AIM-Health	Access to Infant and Maternal Health Programme
CDC	Centre for Disease Control
CGH	Centre for Global Health, Trinity College Dublin
CHC	Community Health Centre
CHP	Community Health Post
CHW	Community Health Worker
CR	Critical Realism
CEP	Cultural Emergent Properties
CVA	Citizens Voice and Action
D4D	Data for development
DFID	Department for International Development (UK)
DHMT	District Health Management Team
DHS	District Health Sister
DMO	District Medical Officer
E4D	Ethics for development
eGovernment	Electronic government
eHealth	Electronic health
EJISDC	Electronic Journal of Information Systems in Developing Countries
HIS	Health information systems
HMIS	Health management information system
IACR	International Association of Critical Realism
ICT	Information and communications technology
ICTD	Information and communications technology for development
ICT4D	Information and communications technology for development
ICT4E	Information and communications technology for education
ICT4H	Information and communications technology for health
ICT4HD	ICT for human development
IFIP	International Federation of Information Processing
IFIP WG 9.4	International Federation of Information Processing, Working Group 9.4 on the Social Implications of Computers in Developing Countries
INDIGO	International Doctoral School in Global Health
IS	Information systems
ITD	Information Technology for Development journal
ITID	Information Technology and International Development Journal
IS-in-DCs	Information systems in developing countries
LMIC	Low and middle-income country

M/M	Morphogenetic/morphostatic cycle
M4D	Mobile for development
MA	Morphogenetic approach
mAg	Mobile technology for agriculture
MCH Aide	Maternal and Child Health Aide
MCHP	Maternal and Child Health Post
MDG	Millennium Development Goals
mHealth	Mobile health
MISQ	Management Information Systems Quarterly
MoHS	Ministry of Health and Sanitation (Government of Sierra Leone)
NATCOM	Telecommunications Regulatory Body of Sierra Leone
NWNP	Nepal wireless networking project
NGO	Non-governmental organisation
PEP	Peoples emergent properties
SCSS	School of Computer Science and Statistics, Trinity College Dublin
SDG	Sustainable Development Goals
SEP	Structural emergent properties
SLL	Sierra Leonean Leones (currency of Sierra Leone)
SoMe4D	Social media for development
Tech4Dev	Technology for development
TCD	Trinity College Dublin
UoSL	University of Sierra Leone
Web2forDev	Web 2.0 for development
WHO	World Health Organization
WV	World Vision

Chapter 1: Introduction

1.1 Introduction and Background to the Research

This research examines a mobile health (mHealth) project in Bonthe District, Sierra Leone. The project was introduced as a pilot in 2012 and has sustained through extremely difficult conditions in a severely resource constrained public health system that has been forced to deal with many challenges over the past years. These challenges have included Africa's biggest cholera outbreak in 2012 and the most widespread Ebola virus outbreak in history between May 2014 and March 2016.

This chapter sets the context for this research by commencing with an introduction to the potential of information and communication technology for development (ICT4D) and mHealth in developing countries. A brief introduction to Sierra Leone is then provided, where the many and varied problems faced by the public health systems are outlined. The commitment of the government of Sierra Leone to leverage the potential of ICT4D and mHealth to address some of these problems is also stated. The theoretical framing for the research is then outlined, and the research questions are presented. The significance of the study and details of research outputs are given before the chapter concludes with a discussion of research limitations and problems.

This PhD tells two parallel stories. The first is about ICT4D and mHealth and the huge potential of both in the Global South. The second story is about the mHealth project in Sierra Leone, from its inception to how it sustained to this day through incredibly difficult circumstances. The stories are separate but interconnected in multiple and complex ways. Technology is common to both, but the most important connection is concerned with people and the ethical, social, cultural and political factors that connect the people in the mHealth project to the ICT4D and mHealth technology. It is important to note for the purposes of this research that mHealth is viewed as being a specific sub-field

of ICT4D. This can be seen in figure 1.1 and is explained and justified in more detail in the literature review in Chapter 3.

This means that the research spans a number of different academic fields and sub-fields. The research may be considered to be located primarily within the broader information systems field, and specifically within the sub-fields of ICT4D, M4D and mHealth in developing countries. This research is also located within the field of health informatics and HIS, part of which is located within the more expansive field of global health. The location of the research is represented in figure 1.1 below. The research may therefore be considered to be interdisciplinary. The interdisciplinary nature of this research correlates with the position taken by a variety of scholars (e.g. Naudé 2016, Thapa 2014, Walsham 2012) who suggest that ICT4D should be interdisciplinary, multidisciplinary, and transdisciplinary.

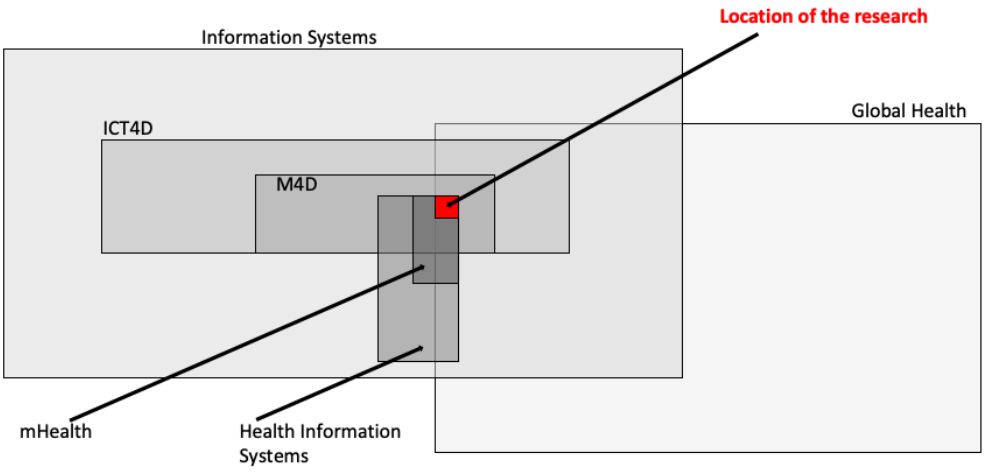

Figure 1.1: Location of the research within the various academic fields and sub-fields

1.1.1 The Potential of ICT4D and mHealth

From the turn of the 21st century, information and communications technology (ICT) has become both ubiquitous and more important across the Global South. This has been accompanied by the development of the relatively new and ever-growing academic field of information and communication

technology for development, commonly abbreviated to ICT4D (Walsham 2017). The field is concerned with ICT-based interventions in developing countries and the use of ICTs for socio-economic and international development (Heeks 2018, Walsham 2017).

Of particular note is the unprecedented and extraordinary spread of mobile phones (Walsham 2017, White 2016) which are now both pervasive and ubiquitous in many developing countries (Heeks 2018, Sahay 2017, Steyn 2013). The claim is that mobile subscriptions are growing at a faster pace than population growth (Karippacheril 2013), and that people in developing countries are more likely to have access to mobile phones than to toilets, clean water or electricity (The World Bank 2016, Mitullah 2016). It is clear that such ubiquity of mobile technology is having a dramatic effect with Hersman (2013, p. 30) going so far as to suggest that "every stratum, every fibre of the fabric of life [in Africa] has changed because of mobile phones". Nowhere can this be seen more clearly than in West Africa where mobile phone adoption has grown rapidly in recent years with 176 million unique subscribers across the sub-region at the end of 2017 (GSMA 2018). Overall subscriber penetration in the region reached 47% in 2017, up from 28% at the start of this decade, and it is estimated that this rapid growth will continue over the period to 2025, when around 72 million new mobile subscribers will be added in West Africa alone, taking subscriber penetration to 54% (GSMA 2018). This is not surprising as the mobile phone is viewed as a vital tool for the unbanked to become financially included (Potnis 2014) as well as for communication, getting online and accessing various education and health services.

This high penetration of mobile phones has created a critical mass of infrastructure which presents the possibility of addressing many of the challenges outlined in the Sustainable Development Goals (SDGs) including the eradication of poverty, zero hunger and good health. Significant emphasis has been placed on the role that ICT may play in addressing these challenges (Masiero 2018). Mobile technologies in particular are key to meeting these

SDGs and have thus become an integral part of many projects in a variety of fields such as healthcare, emergency management, and food and water security (Masiero 2018). Indeed, the view has been put forward that mobile phones are the new holy grail that would uplift developing economies (Steyn & Kirlidog 2013). This would substantiate the widely held belief that the use of mobile phones in healthcare is a tool for human development (Chigona 2012). The aspiration in many developing countries is to leverage such technologies in order to achieve transformation by changing underlying systems of development and towards inclusion by addressing both the symptoms and causes of inequality (Heeks 2014). It is thus clear that the mobile phone plays an important role in improving access to healthcare service delivery in rural and remote settings (Khatun 2016), and that such mobile technologies have the potential to empower individuals and communities, leading to greater social change, an improved quality of life, and strengthened public health systems.

This makes it easy to understand why the number of projects which use mobile devices for providing remote health services and health information (I.e. mHealth) around the world has been increasing dramatically (e.g. Purkayastha 2013, Cameron 2017, White 2016, Sundin 2016, Khatun 2016). There are currently numerous mHealth projects being implemented in developing countries (Khatun 2016), with the World Bank reporting more than 500 mHealth projects in 2011 alone (Agarwal 2016). Thus, it is clear that mHealth solutions are attracting the attention of development agencies, the research community, donors, government organizations and different public-private partnerships in developing countries (Agarwal 2016, Benferdia 2014, Vital Wave Consulting 2009, Purkayastha 2013) because mHealth interventions constitute a promise for health care delivery in such environments (Beratarrechea 2017, Benferdia 2014, Sondaal 2016). The promise is that mHealth has the potential to transform health services and to increase access to healthcare (e.g. Wall et al. 2014, Agarwal et al. 2016, Hurt et al. 2016, Khatun et al. 2016, Beratarrechea et al. 2017, Latif 2017).

In addition, there are many and varied emerging potentialities for mobile technologies in the future (Wall, Vallières et al. 2013) which should be embraced (Walsham 2012). The roll out of fibre and 4G networks and associated infrastructure across many developing countries is leading to increasing bandwidth and speed of connectivity. This, combined with cheap and powerful smartphones built specifically for the African market, raises the possibility that mHealth has the potential to improve healthcare accessibility and provision in remote and resource constrained settings. Over the coming years advances in technology will mean that the mobile phone will be able to do more, including remote diagnosis of various medical conditions and diseases, faster and more reliable transfer of larger amounts of data, more sophisticated monitoring and control of data and the ability to conduct a variety of medical scans with the phone itself. An example of this is the acceleration sensors inbuilt within the phone which will enable patients and health workers to interact more closely, and mobile apps with the potential to produce and manage considerable amounts of data by using the camera and various other measuring and sensing devices to automate the logging of personal health states (Benferdia & Zakaria 2014). It is also suggested that future possibilities for ICT4D and mHealth in developing countries include remote diagnosis and crowd sourcing for health (Latif, Rana et al. 2017), more big/open/real-time data, the use of field sensors/embedded computing, more social media, more crowd-sourcing models, 3D printing (Heeks 2014), and the rise of artificial intelligence (Zheng, Hatakka et al. 2018).

This transformative potential of mHealth, combined with this critical mass of mobile infrastructure, might inspire some to be optimistic about the prospects for mHealth in developing countries. However, many are pessimistic as according to a recent report by the European Union, “a myriad of ... (ICT4D) projects ... never (survive) the pilot phase” (Delponte 2015, p. 112). Furthermore, many such projects prove to have either limited, or unsustainable, impacts on development (Chipidza & Leidner 2019). Thus, it’s now clear that it is difficult to implement, sustain and scale any type of ICT4D

project (e.g. Heeks, Mundy et al. 1999, Avgerou & Walsham 2000, Heeks 2003, Walsham & Sahay 2006, Avgerou 2007, Mechael, Batavia et al. 2010, Ismail, Heeks et al. 2018, Ramadani, Kurnia et al. 2018, Chipidza & Leidner 2019). According to Avgerou "successful examples of computerisation can be found ... but frustrating stories of systems which failed to fulfil their initial promise are more frequent" (Avgerou & Walsham 2000, p. 1). Indeed, Chipidza (2019) makes the claim that many such projects suffer chronic failure, and (2017) have had limited success in achieving their development objectives. Heeks (2018, p. 103) goes further by claiming that "most ICT4D projects fail".

These statements are particularly true of mHealth, where It has become increasingly evident just how difficult it is to sustain mHealth projects beyond pilot implementation (e.g. Anderson & Perin 2009, Curioso & Mechael 2010). The design, implementation and adoption of such systems is beset with wide-ranging challenges and risks and many mHealth projects have been unable to sustain or demonstrate any significant impact at scale (e.g. Anderson & Perin 2009, Curioso & Mechael 2010, Kahn & Yang et al. 2010, Chigona, Nyemba et al. 2012, Manda & Msosa 2012, Wall, Vallières et al. 2014, Sundin, Callan et al. 2016, Latif, Rana et al. 2017). It should be noted however, this traditional view of the likelihood of mHealth success has been strongly challenged in a recent paper by Chipidza (2019) who claims that mobile devices appear to offer higher impact possibilities in developing environments than do what he refers to as more traditional technologies. Of the 14 studies identified by Chipidza involving mobile ICT, a total of twelve (representing 86%) were designated as a complete success.

The ICT4D literature does provide guidance on failure and underperformance, with this being a major research theme from the early days of the field (Sahay & Avgerou 2002) to the present day (Sahay 2017, Walsham 2017, De' 2018). A great deal has been written about the various socio-political, economic, and cultural reasons that ICTs fail to achieve the potential they represent (Hosman & Armey 2017), with numerous studies and examples of ICT4D

implementations which have produced insights into what goes wrong (e.g. Avgerou 2007, ICT Works 2017). It is now clear that the failure of such systems to achieve developmental goals is a complex process involving multiple stakeholders (Chipidza & Leidner 2019). The reasons offered for failure are many and include lack of infrastructure and lack of skills in the intended beneficiary communities (Chipidza & Leidner 2019). Additional examples are provided by Keengwe & Malapile (2013) who suggest that ICT4D initiatives are likely to face a myriad of challenges, while Touray et al. (2013, p. 11) identify a total of 43 barriers to ICT4D in developing countries including various economic, socio-cultural, infrastructural, political and leadership, legal and regulatory, economical, educational and skills, technical and security and safety barriers. Recent work by Ismail (2018) posits that failure in ICT4D can arise from conflict between the different partners in an ICT4D initiative.

Furthermore, the adoption of an overtly techno-centric approach without adequate consideration of socio-technical factors (Wall & Vallières et al. 2013, Wall & Vallières et al. 2014) is likely to contribute to failure and underperformance of ICT4D and mHealth. The adoption of such techno-centric approaches is made worse by the fact that many mHealth systems are not designed in the developing country in which they are to be implemented but are imported from more developed countries in the Global North. The assumption that such technologies will simply fit into the specific environment present in any given developing country and be easily adopted by the user has been described as “fallacy” by Shozi et al. (2012). This is because any technological implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technological and ideological factors.

This paints a bleak picture for those charged with implementing, sustaining and scaling ICT4D and mHealth in developing countries. However, there are many examples of successful ICT4D and mHealth implementations, with examples now appearing more frequently in the literature. One example, as mentioned

above, is the work completed by Chipidza (2019) who identified an 86% success rate of mobile ICT projects. There are also a variety of models proposed to increase the chances of ICT4D success, and these are discussed in more detail in section 3.5.2 below.

1.1.2 Sierra Leone

The Republic of Sierra Leone is a country in West Africa with a land area slightly greater than the Irish provinces of Leinster, Munster and Connaught combined (or approximately half the size of England) with a population of 7.5 million (World Bank 2017). Sierra Leone became a British Crown Colony in 1808, and independence was gained from Great Britain in April 1961 with the country holding its first general elections May 1962. Writing of Sierra Leone in 1883 in "Life of a Sailor" Captain Frederick Chamier observed "I never knew and never heard mention of so villainous a place as Sierra Leone. I do not know where the Devil's Poste Restante is, but the place surely must be Sierra Leone" (Chamier 1850, p. 148). This is interesting from an historical point of view, and sheds light on what European sailors must have thought of the country in the late 19th century. Although much has changed over the 136 years since Captain Frederick Chamier made his observation, it is clear that modern day Sierra Leone still faces many and varied challenges. Perhaps the greatest of these was a brutal and bloody civil war which raged between 1991 and 2002. The civil war was characterised by widespread atrocities including systematic rape and the abduction of children. Estimates put the death toll at between 50,000 and 70,000 with 2.6 million displaced people (Kaldor & Vincent 2006). The country has enjoyed relative political stability since the ending of the civil war, with a new president and stable government elected in peaceful elections in March 2018.

Despite the current political stability, Sierra Leone still suffers from a legacy of unstable government, poor infrastructure, chronic underfunding of the public health system, and an ongoing variety of natural disasters and disease epidemics. According to the World Bank (2017) Sierra Leone is one of the

poorest countries globally with a per capita gross domestic product of $684 USD in 2015. It is ranked 179 out of 188 countries on the United Nations 2016 Human Development Index, and chronic malnutrition is still on the rise with 44% of children below 5 years of age being stunted in 2010, up from 40% in 2005. The World Bank report (2017) goes on to say that Sierra Leone is prone to natural disasters, mainly recurrent floods, drought, and landslides, which are likely to be exacerbated by climate change. Sierra Leone does not appear to be ready to face these challenges with the University of Notre Dame Global Adaption Index (2016) ranking the country 157 out of 181 in a list of those most vulnerable to climate change. This means that Sierra Leone's exposure to natural disasters is likely to worsen in the coming years as a result of its low level of development and capacity to cope with extreme events (World Bank 2017).

All of this has had a very damaging effect on the public health systems in Sierra Leone which remain severely under-funded and resource constrained. A consequence is that the country now has some of the worst health statistics (CDC 2017), and one of the highest under-5 mortality rates on the planet (UNICEF 2016, UNICEF 2017, UNDP 2018). Furthermore, Sierra Leone has the highest maternal mortality rate in the world of 1,100 per 100,000 live births (Seisay & Kamara 2015). This makes Sierra Leone one of the worst places on the planet for a woman to give birth (UNICEF 2013). This is evidenced by the conditions in the health centres in Bonthe District as can be seen in photographs 1.1 and 1.2 below.

Photograph 1.1: A delivery room in Yargoi CHC (photograph taken during fieldwork 26 July 2018)

Photograph 1.2: Patient beds in Gbangbaia CHP (photograph taken during fieldwork 25 July 2018)

Photograph 1.3: A consultation room and drug store in Junctionla MCHP (photograph taken during fieldwork 24 July 2018)

None of this is surprising when the challenges the public health system in Sierra Leone has faced over the past three decades are considered. These challenges are multiple and complex and include Africa's biggest cholera outbreak in 2012 with 22,885 reported cases and 298 confirmed deaths (WHO 2013), a landslide in Freetown in 2017 which killed 1,141 people and left more than 3,000

homeless (World Bank 2017), and four major floods in the last 15 years which have affected over 220,000 people and caused severe economic damage (World Bank 2017). In addition, the most widespread Ebola virus outbreak in history occurred in West Africa between May 2014 and March 2016 affecting Guinea, Liberia and Sierra Leone. According to the World Health Organization (2016) the total death toll in Sierra Leone was 3,955 with 11,308 deaths in total attributed to Ebola across the affected countries in West Africa. It is also estimated that there had been a 23% decrease in health services delivery in Sierra Leone during that time, with the country losing 7% of its healthcare workers (Evans, Goldstein et al. 2015). Sierra Leone announced that it was Ebola free in March 2016 (CDC 2016) but the cost of the epidemic had been immense and wrought devastation across the entire country.

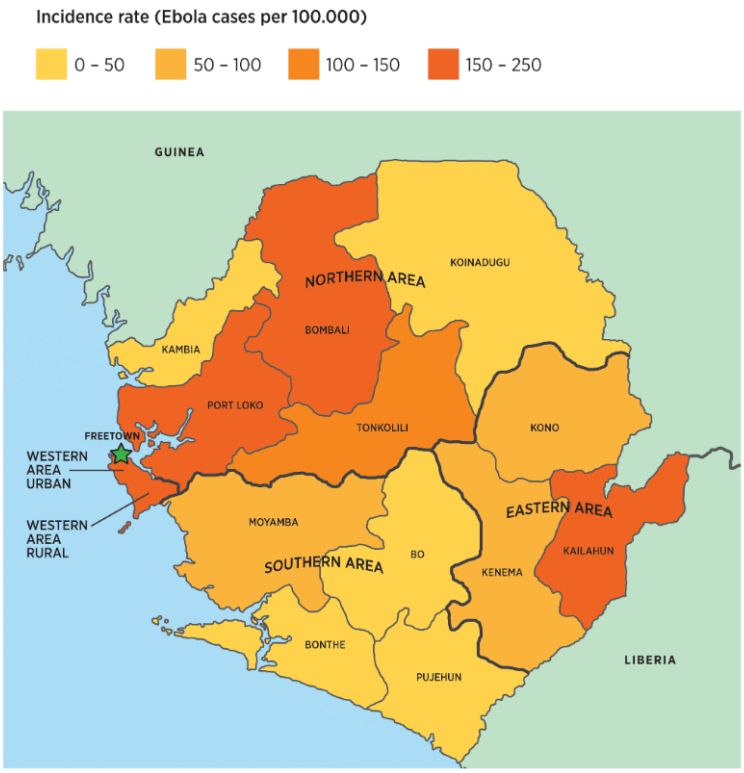

Figure 1.2: Ebola cases per 100,000 in Sierra Leone (Ribacke & van Duinen et al. 2016)

A further reason for the severely resource constrained circumstances results from a decision made by the Ministry of Health and Sanitation (MoHS) in Sierra Leone in 2010 to introduced free health care for pregnant women, breastfeeding mothers and children under 5 years of age (Donnelly 2011, Maxmen 2013). Not surprisingly, initial accounts reported that the uptake of these services rose significantly (Readhead 2012). Unfortunately, the inequitable distribution of health facilities, a shortage of essential drugs and health equipment, and the lack of skilled healthcare workers meant that health centres struggled to keep up with increasing demand (Moszynski 2011, Obermann 2011, Maxmen 2013), which put further strain on the already severely weakened public health system.

The government of Sierra Leone and the MoHS have committed to address the many problems existing within the public health system. It is clear that a variety of approaches is needed to address the chronic under funding and multiple other problems that exist, with one key strategy being to leverage the potential of ICT4D and mHealth in particular. The aspiration is that achieving the SDGs and reaching health related targets could be facilitated by relying on technology, in particular mobile phones for mHealth. This has resulted in mHealth becoming a priority strategy in Africa in general, and an integral part of MoHS policy in Sierra Leone in particular, with many mHealth initiatives being launched over the past few years in Sierra Leone by a variety of non-governmental organisation (NGOs).

One such mHealth project which is funded by Irish Aid and implemented by World Vision Ireland is currently operating in Bonthe District, Sierra Leone where mobile phones and a mobile health application have been given to Community Health Workers (CHWs) as a job aid. CHWs are community-based workers that help individuals and groups in their own communities to access health and social services and educate community members on health issues (Government of Sierra Leone - Ministry of Health and Sanitation 2012). The application allows the CHWs to view which household visits are due, register

pregnant women, make emergency referrals to their affiliated health centre, track their own progress, and collect household data for transmission to the health facility to support clinical and managerial decision-making (Vallières & McAuliffe et al. 2013, Wall & Vallières et al. 2013, Wall & Vallières et al. 2013). This mHealth case forms the basis for the research and is discussed in detail in Chapter 2.

1.2 Theoretical Framing of the Research

As already mentioned, this research examines an mHealth project in Bonthe District, Sierra Leone. The previous sections have outlined the potential for ICT4D and mHealth in developing countries, and also the difficulties associated with the implementation and scaling of these systems and technologies. The many and varied problems faced by the public health systems in Sierra Leone have also been introduced in brief, and the commitment of the government of Sierra Leone to leverage the potential of ICT4D and mHealth to address some of these problems has been stated.

This situation has allowed gaps in the ICT4D body of research to be identified. From these gaps, two specific research problems have been formulated, and these are presented and discussed in section 1.2.1 which follows. Before the research problems and questions are presented it is important to clarify the theoretical frame in which this research is situated. This theoretical frame allowed the research problems to be identified and has also guided formulation of the research questions.

ICT4D and mHealth projects are highly likely to involve multiple interactions of structural, cultural, agency, political, social and technological factors. Such technologies cannot by themselves lead to development or the achievement of any of the SDGs. They have to be deployed by actors in a given social, political, cultural, and technical context under conditions at the time of deployment (Thapa & Omland 2018). Finding a way to understand these social,

political, and cultural contexts and the associated agential interactions is key to this research.

In an attempt to find a way to understand these contexts and agential interactions, this research frames mHealth as a socio-technical entity embedded in the Sierra Leonean public health system. This results from adoption of a perspective which views the use of technology as an inherently social process, or a contextualised social phenomenon. mHealth implementation cannot be viewed as simply the transfer of technology such as mobile phones, solar chargers and associated software applications. Instead, it may be understood as a social system and thus cannot be transferred physically in the same way as software applications or a piece of hardware. All technology is embedded in a structural, social, cultural, and political context, making the transfer of just the technology itself problematic. This is recognized by Braa et al. (1995) who posit that technology is not simply an isolated artefact by itself, but also involves the social and cultural use of the technical artefact.

Thus, any attempt to explain the organisational and social phenomena associated with this mHealth project on the basis of technology properties alone is too limited (Markus & Robey 1988). The socio-technical aspects must be considered which includes the way mHealth makes sense to people and is enacted in the Sierra Leonean context (Markus 1988, Volkoff 2007, Mutch 2010). In other words, the mHealth project in Sierra Leone and all associated hardware, software and other systems should be seen as a component of a larger health information infrastructure including paper forms, the networks, the pre-existing data flow processes (Purkayastha 2010), social factors, market-based incentives, regulatory frameworks, and local cultures (mHealth Alliance 2012).

Therefore, the mHealth project in Bonthe District is framed as a socio-technical entity or concept in the context of the Sierra Leonean public health system. In other words, the hardware and software components of the mHealth project

are viewed as components of a more complex socio-technical ensemble which includes the CHWs, the mHealth implementers, all associated work processes, and social, cultural, and political factors specific to the Sierra Leonean context in which this project is being implemented.

1.2.1 Research Problems

Two specific research problems have been identified and these are now presented and discussed. The first research problem involves the use of philosophical paradigms in ICT4D research. As outlined in the previous sections and in the literature review in Chapter 3, the ICT4D literature contains much on the success and failures of ICT4D and mHealth. However, this body of work is dominated by interpretivist and positivist approaches (Walsham & Sahay 2006, Gomez & Day 2013). This is important as each of these approaches has a number of limitations that constrain ICT4D research (Heeks & Wall 2018). Positivism assumes an objective and quantifiable reality which has resulted in positivist studies in the ICT4D field being subjected to the criticism that supposedly objective empirical methods were in practice subject to social influence and bias (Kanellis & Papadopoulos 2009). Interpretivism also has its critics who claim that the approach fails to provide causal and generalisable explanations of social phenomena (Bevir & Rhodes 2005, Smith 2005). Heeks & Wall (2018) summarise the shortcomings of what they refer to as the philosophical duopoly for ICT4D research. The specific limitations and shortcomings of the positivist and interpretivist philosophical duopoly that dominates ICT4D research are discussed in greater detail in Chapter 4.

One effect of the dominance of interpretivist and positivist approaches in ICT4D research has led many to search for a “third way” (Allen, Brown et al. 2013, p. 835) beyond both positivism and interpretivism and to call for more critical work in ICT4D research (e.g. Walsham 2007, Mingers, Mutch et al. 2013, Heeks & Wall 2018). Despite these calls, it is generally accepted that there is still a relative absence of critical work, especially the explicit use of the critical realist philosophical paradigm, in ICT4D research (Heeks & Wall 2018).

This relative absence of the critical realist philosophical paradigm in ICT4D research was perceived as a gap. Thus, a qualitative, longitudinal case study methodology has been designed for this research, with critical realism and Margaret Archer's (1995) morphogenetic approach providing the philosophical perspective. The research framework has been developed specifically for this research, and to the best of our knowledge this exact framework and methodological approach has never been used elsewhere to examine mHealth, and in particular mHealth in the Sierra Leonean context. Thus, this research may be seen an attempt to build theory by hypothesising the existence of mechanisms in this specific mHealth case and seeking empirical evidence for their validity. The research framework developed is discussed at length and presented in diagrammatic form in Chapter 5. The objective was to address the identified gap by using the research framework to hypothesize the existence of mechanisms in the specific context of this mHealth case. A further objective was to demonstrate how this framework operates when applied to this mHealth case, and to develop a methodological approach appropriate to the research framework. This is a very important and significant theoretical and methodological contribution.

As mentioned, critical realism and the morphogenetic approach are discussed in great detail in Chapter 4 and thus will not be explained in any great detail in this section. However, a brief introduction may be useful at this point. Put simply, critical realism asserts that general elements of an independent reality exist, but our knowledge of specific structures and mechanisms is limited because of the difficulty of accessing them directly through levels of stratification. Mechanisms are best understood as "causal structures that generate observable events" (Henfridsson & Bygstad 2013, p. 911), and events are "specific happenings resulting from causal mechanisms being enacted in some social and physical structure within a particular ... context" (Williams & Karahanna 2013, p. 939). The levels of stratification are presented as three nested domains as proposed by Bhaskar (1975) as shown in Figure 1.2 below. Researchers seek mechanisms, but mechanisms reside in the domain of the

Real and are thus independent of human knowledge or our ability to perceive them. The Actual domain contains events which are generated from both exercised and non-exercised mechanisms. The domain of the Empirical contains the events that we as humans are able to experience.

	Domain		
	Real	Actual	Empirical
Mechanism	X		
Events	X	X	
Experiences	X	X	X

Figure 1.3: The Stratified Ontology of Critical Realism as proposed by Bhaskar (1975, p. 13)

Retroduction is key to any critical realist-based methodology (Bhaskar 1975) and requires the researcher to take "some unexplained phenomenon and propose hypothetical mechanisms that, if they existed, would generate or cause that which is to be explained" (Mingers 2004, p. 94). Retroduction may also be understood as positing mechanisms which, if they were to exist and act in the postulated matter, would account for the phenomena singled out for explanation (Lawson 1997).

The second research problem identified follows on from the first research problem. As stated, there is a lack of critical realist-based research in the ICT4D field in general with critical realist-based research in mHealth in developing countries being particularly scarce. Indeed, as already mentioned no critical realist-based research on mHealth in Sierra Leone specifically was found. This means there is also a lack of results from such critical realist-based research, specifically in the Sierra Leonean context. This was perceived as a gap for a variety of reasons. To address this gap this research will produce mechanism-based explanation of why the mHealth project in Bonthe District evolved the way it did. In other words, the mechanisms which determined the outcome of

the mHealth project in Bonthe District will be hypothesized. This will contribute to providing an explanation of why the mHealth project sustained through the many and varied challenges it faced. Secondly, the relative absence of the critical realist philosophical paradigm in ICT4D research, combined with the total absence of critical realist-based research carried out on mHealth - specifically mHealth in Sierra Leone - means that the results derived from this research framework will be unique. Therefore, this research has potential to add to the knowledge in this field by providing a different perspective as well as specific reasons as to why mHealth projects evolve the way they do, and of the mechanisms that determine the observed outcomes.

1.2.2 Research Questions

The research problems and gaps identified in the previous section are summarised into the following two research questions:

1. How can the critical realist-based research framework developed for this research be applied to an mHealth case in Sierra Leone?

2. Why did the mHealth project in Sierra Leone evolve the way it did, and what are the mechanisms that determined this outcome?

A number of specific research objectives follow on from these research questions and these are presented in section 1.2.3 below.

Research questions in critical realist-based research are required to take a certain form. According to Easton (2010, p. 121) the most fundamental aim of critical realism is explanation, or answers to the question "what caused those events to happen?". In other words, critical realist-based research questions should be of the form "what caused the events associated with the phenomenon to occur" (Easton 2010, p. 123). Taking this into account, the second research question thus asks the question about why the mHealth project in Sierra Leone evolved the way it did, and what were the mechanisms

that determined this outcome. An alternative way to ask this question is why did the mHealth project in Sierra Leone turn out the way it did, and what caused the associated events to occur?

Smith (2018) also provides guidance on how critical realist-based research questions should be structured. He suggests that any research question must include all three elements of the process of generative mechanism causation: context (contextual mechanisms) [C], mechanism itself [M], and outcome [O]. This would mean that the second research question posed could potentially be reformatted to become "How [M], for whom [C], and in what circumstances [C] did the mHealth project [M] in Sierra Leone evolve the way it did [O]?". Alternatively, the second research question could be "in what ways, and under what circumstances [C] did the mHealth project [M] in Sierra Leone evolve the way it did [O]?" (Smith 2018).

1.2.3 Research Goals and Objectives

This research is timely for three main reasons. Firstly, and as previously discussed, the unprecedented spread of mobile phones across developing countries has created a critical mass of infrastructure which presents the possibility of addressing many of the challenges arising within the public health systems in Sierra Leone and many other developing countries. Secondly, as outlined earlier in this chapter the number of mHealth implementations around the world has been increasing dramatically but the design, implementation and adoption of mHealth in developing countries is beset with wide-ranging challenges. This has resulted in widespread failure and underperformance of mHealth, with many projects unable to sustain or demonstrate any significant impact at scale. Thirdly, plans now exist for the widespread scaling of this particular mHealth project across Bonthe District and all of Sierra Leone. There are also plans to introduce and scale this particular project to four other countries: Kenya, Tanzania, Uganda and Mauritania. This research has the potential to contribute in a significant way to these plans.

The timeliness of this research, combined with the research problems identified and the research questions as posed in the previous section, give rise to a variety of research objectives and goals. A number of specific research objectives arise from the first research question. These are as follows:

- To demonstrate the practical application of a critical realist-based research framework and methodology.
- To problematise the detection of mechanisms in this mHealth case.
- To determine the relevance of critical realism as a philosophical approach for ICT4D and mHealth research.
- To build new and innovative theoretical and methodological approaches based on critical realist-based philosophical perspectives.
- To extend existing theory on causal mechanisms. This involves leveraging the mHealth case in Sierra Leone to incrementally refine and enrich theoretical propositions.

Findings from this research can contribute to theory building by describing the mechanisms in this mHealth case in conceptual terms which are then validated in other cases. This includes the objective of establishing whether the mechanism-based results arising from this research are generalisable to other mHealth cases and ICT4D projects in both similar and different social, cultural and political circumstances.

Research objectives and goals arising from the second research question are as follows:

- The identification of mechanisms that play a role in explaining the observed outcomes in this case.
- The provision of clear, concise and empirically supported statements about what caused the events in this case.
- An improved understanding of the causal mechanisms which may facilitate and/or disable this specific mHealth intervention.
- Development of a deeper understanding of the way mechanisms and context interact to produce the observed outcomes in this case.

- Development of more nuanced accounts of mHealth implementation and scaling.
- An assessment of whether or not these results can be generalisable to other mHealth projects outside of Sierra Leone.

The research objectives arising from the second research question mainly involve identifying the mechanisms that played a role in explaining the observed outcomes in this case. The hope is that this will provide a better understanding of how to implement, scale and sustain IS and mHealth in developing countries in general and Sierra Leone in particular.

These research objectives will result in the presentation of a theoretically informed and empirically rich account of how context and mechanisms interact to influence the use of mobile phones in this mHealth case. The research will also deliver a clearer understanding of what theoretical concepts inspired by critical realism and the morphogenetic approach might facilitate a clearer understanding of how mobile phones are being adopted and used by the local health workers in Bonthe District. The focus is on exposing the mechanisms which have caused the events unique to this mHealth case and the specific factors which have combined to generate them. The hope is that this research will provide a better understanding of how to implement, scale and sustain IS and mHealth in developing countries in general and Sierra Leone in particular. A better understanding of how mechanisms and context interact in this case will improve the design of mHealth programmes being implemented by governments and NGOs in developing countries as well as contribute to the existing knowledge of how these factors may or may not contribute to mHealth over time.

There are a number of specific contributions that are expected to be made by this research. The first important contribution to knowledge concerns the object of enquiry, i.e. ICT4D and mHealth in developing countries. This can also be seen as a contribution to the broader field of information systems (IS).

Although there is a significant and growing body of research in the fields of ICT4D and mHealth in developing countries (e.g. Duncombe 2009, Cameron, 2017, Agarwal 2016, MacLeod 2012, Chatfield 2013), the claim has been made that there are still many questions remaining without clear answers in these fields including the important question as to the manner in which the benefits of ICTs can be spread more widely in society (Walsham 2017). It has also been claimed that there remains a lack of rigorous, high quality evidence on the efficacy and effectiveness of ICT4D and mHealth interventions (Agarwal, LeFevre et al. 2016). This is supported by Hurt (2016) who proposes that existing mHealth studies are very diverse and that there is currently little evidence on mHealth interventions in developing countries. The claim is also supported by Sondaal (2016) who identifies a specific gap concerning the lack of work on assessing mHealth's impact on maternal and neonatal outcomes. Furthermore, a paucity of studies which explore the impact of mHealth and the challenges facing these solutions in a developing world context is identified by Kenny et al. (2017). Similar gaps are identified by Thapa (2018) who proposes that existing ICT4D studies tend to be descriptive or prescriptive in nature, and that this gives rise to the absence of any questions as to how and why ICT works in the context of developing countries. This research will address those gaps by identifying mechanisms that will help explain why this particular mHealth project evolved the way it did, and by providing clear statements about what caused the events in this case. This will lead to an improved understanding of the generative or causal mechanisms that made this particular mHealth case sustain in the face of huge challenges.

The second important contribution to knowledge concerns the use of critical realism and the specific philosophical approaches and theoretical frameworks adopted for this research. It is widely accepted that there has been scant consideration of research paradigms in ICT4D research and that the little amount of consideration and engagement that has occurred has shown a dominance of positivist and interpretivist approaches (Heeks & Wall 2018). Further, the issue of how we as researchers theorize what is happening in ICT4D

in a compelling way is raised by Walsham (2017), with Duncombe (2012) pointing to a lack of variety in conceptual and methodological approaches adopted by researchers in this field. This philosophical gap is also recognised by Thapa (2014) who suggests that the ICT4D research literature is thus far dominated by qualitative- and quantitative-based case studies. Because this research presents a "third way" research paradigm - i.e. critical realism - a number of specific calls in the literature asking for the greater use of the critical realism paradigm in ICT4D research (e.g. Heeks & Wall 2018, Thapa & Omland 2018) are answered. This is a significant contribution in itself. The critical realist perspective adopted in this research will also contribute to what Njihia & Merali (2013, p. 75) refer to as the "small but important group of empirical studies" in the IS literature using Archer's (1995) morphogenetic approach.

The third contribution of this research will be to address the challenges associated with the adoption of a critical realist perspective. It is recognised that these challenges are both general as well as specific to both the IS and ICT4D domains (Heeks & Wall 2018). Perhaps the biggest challenge to using critical realism for research in general is the perceived complexity of the paradigm, with many claiming that it is difficult to understand. Much of the literature suggests that critical realism is time-consuming to use and difficult to operationalize (e.g. Reed 2009, Smith 2018). It has also been suggested that the paradigm is "complex" (Fleetwood 2014, p. 182) and that many of the key texts are "often difficult" (Fleetwood 2014, p. 183), impenetrable and verbose. In addition, the lack of methodological clarity associated with critical realism is a concern. According to Danermark et al. (2002) critical realism itself is not a method. Indeed, according to Yeung (1997, p.51), critical realism has been dubbed "a philosophy in search of a method". This leads to a lack of clear guidance on how exactly to put critical realism into practice. Although critical realism's methodology may be understood in theory there is also a need to know more about practical methods and techniques (Fletcher 2016). This lack of methodological clarity is a concern and is likely to be a disincentive for the use of critical realism in practice. This is particularly relevant to the use of

critical realism by graduate students and their academic supervisors who are likely to crave methodological clarity for many obvious reasons. This research will provide a comprehensive and clear study of mHealth using a critical realist philosophical approach. Furthermore, a clear methodology will be provided. Again, this is a significant contribution of this research which is likely to be of particular interest to early-stage critical realist researchers seeking methodological clarity and guidance.

The research will also make a small but significant contribution to the general academic literature on Sierra Leone, and specifically the body of work on ICT4D, development, and mHealth in Sierra Leone. This body of work is small with only a handful of academic works falling into this category. This PhD will contribute to that small body of work.

Moreover, this PhD will contribute significantly to the Sierra Leone mHealth project itself. It is very clearly recognised that this research holds much relevance for the CHWs and the other health workers who are using the mHealth systems in Sierra Leone on a daily basis. It also holds much relevance for the NGO implementing this mHealth project. The research will provide description of the mechanisms which contributed to making this mHealth project successful, and thus there will be guidance on how to scale this mHealth case across Bonthe District. In addition, if these results can be generalisable to other mHealth projects outside of Sierra Leone there will be guidance for the wider mHealth community in general. There is also potential to positively reconfigure CHW practice as a result of this research. This is a significant and tangible contribution which has the potential to enhance the health systems of Sierra Leone which will help many of the poorest and most disadvantaged people on the planet.

All of the above research objectives have the potential to generate knowledge which will benefit the mHealth project in Sierra Leone directly in a significant and tangible way. The identification of mechanisms will bring to light the

underlying causes of any problems and more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors will be made possible. This means the research has the potential to provide specific guidance and offer specific recommendations on future plans to scale the mHealth project in Bonthe District and ultimately across Sierra Leone and further afield.

Finally, and very importantly, is the objective for the researcher to personally reflect on the research process. This involves asking what has been learned on a personal level both from this project and the PhD experience overall. It includes reflection on the fieldwork carried out, and the interactions that occurred with all those involved with the research and the mHealth project, and specifically those that were interviewed and took part in focus groups for this research. In addition, reflection will take place on the process of developing the research framework, writing journal and conference papers, proposals and abstracts, interacting with PhD supervisors, colleagues, and other PhD students in Trinity College Dublin (TCD) and from other Universities and institutions. Finally, reflection will take place on the final PhD writing up process and how this was organised and carried out. It is very important to take time and space to reflect in an effort to understand what was learned from the entire process, and to determine what can be improved in future both on a personal, academic, and professional level.

1.2.4 Significance of the Study and Dissemination of Results

The results of this Doctoral thesis will be relevant to a wide variety of people and organizations. This is because the research has the potential to generate knowledge which will benefit the mHealth project in Sierra Leone directly and in a significant and tangible way. The identification of mechanisms will bring to light the underlying causes of any problems, and more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors will be made possible. This means the research has the

potential to provide guidance on future plans to scale the mHealth project in Bonthe District and ultimately across all of Sierra Leone and wider.

The research will also be able to provide explanation on how mHealth has evolved in other countries and different social, political and cultural contexts. This is because mechanism-based research which explains the formation of a socio-technical phenomenon in one setting can provide plausible hypotheses for investigation of similar phenomena in a similar setting (Avgerou & Masiero et al. 2018). This is important as plans exist to implement and scale this mHealth project across Kenya, Tanzania, Uganda and Mauritania. Thus, the research has the potential to provide guidance in these four countries.

Others interested in this research will include various NGOs, governments, academics, and those working in the fields of ICT4D and mHealth. Specifically, the results will be of particular interest to those planning, implementing, coordinating, scaling and otherwise involved with mHealth in Sierra Leone or in a similar context. The research is expected to inform and guide the mHealth policy of both World Vision and the MoHS in Sierra Leone. The results will be of particular interest to those in the eHealth Hub and the CHW Hub within the MoHS in Freetown.

This work will also be relevant to those in the academic fields of IS, ICT4D, mHealth, global health, and international development. In addition, the research will be of interest to those in the critical realist community and others working in the areas of research ontology, epistemology and methodology.

Finally, the research will hold much relevance for the CHWs and the other health workers who are using the mHealth systems in Sierra Leone on a daily basis. The patients they serve will also benefit from improved and more effective health systems. These people can directly benefit if ways can be found to improve the mHealth project in a significant and tangible way by identifying the underlying causes of any problems. Thus, the knowledge

created by this research has the potential to enhance the health systems of Sierra Leone which will help many of the poorest and most disadvantaged people on the planet. If the results of this research can be generalised to other mHealth and ICT4D projects outside of Sierra Leone, there is potential to have great impact and many of the world's poorest and most disadvantaged people could possibly benefit from improved systems, especially public health systems.

The results of this research will be disseminated widely through various national and international networks. Primarily, both the ADAPT Centre and the School of Computer Science and Statistics (SCSS) in TCD will take the responsibility for sharing research findings through their extensive academic, industry, NGO and government partnerships both in Ireland and abroad. This research has already resulted in a significant number of publications and research outputs in a variety of international academic journals and conferences (see Appendix 5), and it is envisaged that further publications will result from this research (please see the following section for additional detail on this). Research outcomes will also be shared directly with World Vision and the government of Sierra Leone through the MoHS, specifically the eHealth Coordination Hub and the CHW Hub in Sierra Leone. World Vision and the MoHS will be encouraged to host dissemination workshops to develop action plans based on the findings of the research. Internationally, the findings from this research will also be disseminated through World Vision International's networks and partner organisations. The research will also be shared with the National mHealth Coordinating Committee in Sierra Leone whose mandate is to promote collaboration and best practice in mHealth.

1.3 Research Outputs, Contributions and Awards

A total of 19 research outputs have resulted from this research to date. A full list is presented in Appendix 5. These include the editorial and first paper in a special edition of the Electronic Journal of Information Systems in Developing Countries (EJISDC) on "Critical Realism and ICT4D Research" in 2018 which was

co-edited with Professor Richard Heeks (University of Manchester, UK) and Professor Devinder Thapa (University of Agder, Norway). The research has also been presented at variety of conferences including the IFIP WG 9.4 (Information and Communication Technologies for Development International Conference on Social Implications of Computers in Developing Countries) conferences in 2017 and 2019 (forthcoming), the International Association of Critical Realism conferences in 2014, 2016, 2017 and 2019 (forthcoming), the Development Studies Association of Ireland annual conference in 2018, and the UK Development Studies Association annual conference in 2017. Research outputs also include book chapters published by Springer (2015) and Oxford University Press (2019 - forthcoming).

In addition, a number of awards have resulted from the research. These include an honorarium from Yale University for research completed by an international scholar for the Critical Realism Project (2017), and the early career academics grant received from the International Association for Critical Realism (2016). A paper submitted to the eChallenges conference in 2013 also received runner-up best paper award. The paper is entitled "A Socio-Technical Approach to the Implementation of mHealth in Sierra Leone: A Theoretical Perspective" (Wall & Vallières et al. 2013).

There is a detailed publication plan associated with this research which targets specific journals and conferences for publication. The journals to be targeted include the main three specialist journals devoted to ICT4D as follows:

- Information Technology and International Development (ITID)
- The Electronic Journal of Information Systems in Developing Countries (EJISDC)
- Information Technologies for Development (ITD)

The Journal of Critical Realism will also be targeted for publication, as will a number of broader IS journals including, but not limited to, the Information Systems Journal, Management Information Systems Quarterly (MISQ),

Information and Organisation, The Journal of Information Technology, and the European Journal of Information Systems. Attention will also be paid to calls for journal special issues on topics such as ICT4D, mHealth, M4D, research methodology and philosophy, and critical realism.

Conferences to be targeted include the Information and Communication Technologies for Development International Conference on Social Implications of Computers in Developing Countries (IFIP WG 9.4), the International Conference on Information Systems (ICIS), the European Conference on Information Systems (ECIS), the International Conference on Information and Communications Technology and Development (ICTD), and the International Association of Critical Realism Conference.

1.4 Dissertation Roadmap

The remainder of this PhD dissertation is organised as follows:

Chapter 2 provides details of the mHealth case in Sierra Leone. The chapter describes the mHealth case in detail. The history of the mHealth project and future plans for scaling are also detailed.

Chapter 3 presents the literature review. The chapter commences with a review of what can broadly be described as the international development literature, and this is followed by a broad review of development paradigms. The focus then shifts to examine the literature relating to ICT4D and themes in this body of work. Literature on health information systems (HIS) and mHealth is then reviewed. New topics in ICT4D are then briefly examined, such as data for development (D4D), and social media for development (SM4D). The literature review concludes with a summary of gaps in the literature and suggests a future agenda for ICT4D research.

Chapter 4 commences with a broad review of research paradigms in ICT4D research before moving on to discuss critical realism in ICT4D research. A

detailed analysis of the value of critical realism in ICT4D research is then presented which is based on the four main differentiators of research paradigms as proposed by Cresswell (2013), i.e. ontology (what the paradigm understands to be the nature of reality): epistemology (what the paradigm understands about how we construct and evaluate knowledge about that reality): methodology (what research strategy, methods and techniques the paradigm uses in order to gather and analyse data): and axiology (what the paradigm does and does not value in research). Chapter 4 concludes by outlining the challenges to using the critical realist paradigm in general and in ICT4D research in particular.

Chapter 5 presents the research design and methodology adopted for this research. The chapter discusses the ontological, epistemological and methodological approaches adopted by this research, and a detailed research framework is presented. Critical realism and Margaret Archer's morphogenetic approach are discussed and described in detail. The chapter then moves onto a detailed discussion of the methodological approaches adopted before concluding with a brief summary.

Chapter 6 provides details of data collection and analysis. This chapter includes sections on ethical considerations and the research site in Sierra Leone. Data collection and data analysis is also discussed.

Chapter 7 presents the research findings and a discussion of the results arising from this research.

Chapter 8 provides an overall summary of the research and presents final conclusions.

There are also 10 appendices presented including a detailed list of publications arising from this research. The appendices also include lists of persons interviewed, lists of focus group discussions, sample interview and focus group

guides, awards arising from this research, the ethical approval documents received from both TCD and the MoHS in Sierra Leone, and examples of participant information sheets and informed consent forms used in the research.

1.5 The Terminology Chosen for this Research

There is a variety of terminology used in this research which has been considered at length and chosen very carefully. In the academic fields of international development, IS, ICT4D, and global health there is no single agreed vocabulary. Indeed, it is noted by Njihia (2013) that the debate on terminologies used in the ICT4D field is still at an early stage. This means there is frequently more than one single term, abbreviation or phrase used to describe something. For the sake of consistency, it was decided to choose a single vocabulary in this research as far as possible.

Firstly, there are many different terms to be found in the literature for the connection between ICTs and international development. These include ICT4D, ICTD (information and communications technology for development) (Burrell & Toyama 2009, Gomez, Baron et al. 2012), development informatics (Walsham 2013, Heeks 2014), IS-in-DCs (information systems in developing countries) (Brown and Grant 2010), ITID (information technology and international development) (Dodson 2012), community informatics (Naudé 2016), ICT4HD (ICT for Human Development) (Rosenberger 2014), and Tech4Dev (technology for development) (Hirosue, Kera et al. 2015). The term "information and communications for technology" or ICT4D was chosen for this research as the term has been in circulation since 1996 and has been used widely since the 1990s (Heeks 2018). The term has also been adopted by many of the key authors and seminal papers in this field.

There are many sub-sets of ICT4D including ICT4E (information and communications technology for education), ICT4H (information and communications technology for health), eGovernment (electronic

government), mAg (mobile technology for agriculture), Web2forDev (web 2.0 for development), D4D (data for development), and SoMe4D (social media for development). Some of these sub-sets relate to healthcare and the use of mobile technologies in healthcare. These include mHealth (mobile health), M4D (mobile for development), eHealth (electronic health), HMIS (health management information systems), telemedicine, and HIS (health information systems). It should be noted that the terms mHealth, HMIS, telemedicine, and HIS are not exclusive to the ICT4D literature and are used frequently in reference to more developed countries in Europe and the USA. In this dissertation M4D is used to refer exclusively to the use of mobile technologies for development, and mHealth is the term used to refer to the use of mobile technologies in healthcare in developing countries.

Finally, there are a variety of terms used to refer to countries in the Global North and the Global South. These include developed, underdeveloped, first-world, second-world, third-world, the West, the BRICs (Brazil, Russia, India, and China), low- and middle-income countries (LMICs), high-income countries, resource-constrained, and high-resource countries. Walsham (2017, p. 1) refers to "so-called developing countries", whilst Heeks (2018, p. 10) notes that "some people don't like the term (developing country): the idea that countries like the US and UK are "developed" is clearly ridiculous if we equate this with them being the finished article". Despite the concerns expressed by both Heeks and Walsham the phrase "developing country" is widely used in the ICT4D literature, and although it is recognised that this term is not entirely unproblematic, "developing country" is the term chosen for this research.

Chapter 2: The Sierra Leone mHealth Case

2.1 Introduction

As mentioned in the previous chapter, this PhD research is based on an mHealth initiative in Bonthe District, Sierra Leone. This chapter describes the mHealth case in detail and outlines the history of the project and future plans for scaling across Bonthe District, all of Sierra Leone, and 4 countries in Africa. This is adapted from two documents that were prepared as required by the research framework and as discussed in detail in Chapters 5 and 6: namely, a detailed factual case study description of the mHealth case and a chronological account of events.

2.2 Access to Infant and Maternal Health Programme (AIM-Health)

There have been many efforts to improve the public health systems in Sierra Leone over the years. These have involved initiatives led by the Government of Sierra Leone as well as a variety of other NGOs and research institutions. One such initiative was in 2010 when the MoHS introduced the free health care initiative for pregnant women, breastfeeding mothers, and children under-five years of age. This led to a huge increase in the demand for services which placed a significant strain on an already severely resource-poor public health system. Another effort to improve the public health systems was the introduction in 2012 by the MoHS of a policy of integration of voluntary CHWs into the public health system. CHWs would volunteer to work in their communities providing a variety of health care services and acting as the link between the community and the health centre. In an attempt to both leverage and aid the work of the CHWs in Sierra Leone, World Vision Ireland implemented the Irish Aid funded Access to Infant and Maternal Health Programme (AIM-Health) in 2012 (World Vision 2018). The AIM-Health programme was a five-year initiative which was implemented between January 2011 and December 2015 in ten of World Vision's Area Development Programs (ADPs) across Sierra Leone. The overall goal of AIM-Health was to improve

maternal, newborn and child health (MNCH) outcomes and reduce maternal and infant mortality (World Vision 2018)

A key part of AIM-Health was the training of CHWs in the delivery of the 7-11 timed and targeted counselling strategy (7-11/ttC) (Vallières, McAuliffe et al. 2013, World Vision 2019). The 7-11/ttC strategy trains CHWs to deliver 7 key interventions for pregnant women and 11 key interventions for children under the age of 2 as summarised in Table 1 below.

TARGETS	PREGNANT WOMEN: 9 MONTHS	CHILDREN: 0-24 MONTHS
CORE ISSUES	1. Adequate Diet 2. Iron/Foliate Supplements 3. Tetanus Toxoid Immunization 4. Malaria Prevention and Intermittent Preventive Treatment 5. Healthy Timing and Spacing of Delivery and Birth Preparedness 6. De-worming 7. Facilitate access to Maternal Health Service: ANC PNC, Skilled Birth Attendance, PMTCT, HIV/TB/STI Screening	1. Appropriate Breastfeeding 2. Essential Newborn Care 3. Hand Washing with soap 4. Appropriate Complementary Feeding (6- 24 months) 5. Adequate Iron 6. Vitamin A Supplementation 7. Oral Re-Hydration Therapy/Zinc 8. Prevention/Care Seeking: Malaria 9. Full Immunization for Age 10. Prevention/Care Seeking: ARI 11. De-worming (+12 months)

Figure 2.1: Key interventions of the 7-11 Strategy for improving MNCH (Vallières, McAuliffe et al. 2013)

These 7-11/ttC core interventions were then delivered over the course of a minimum of 10 household visits carried out by the CHW at specific times during a woman's pregnancy and after the birth of the child as outlined in figure 2.2 below.

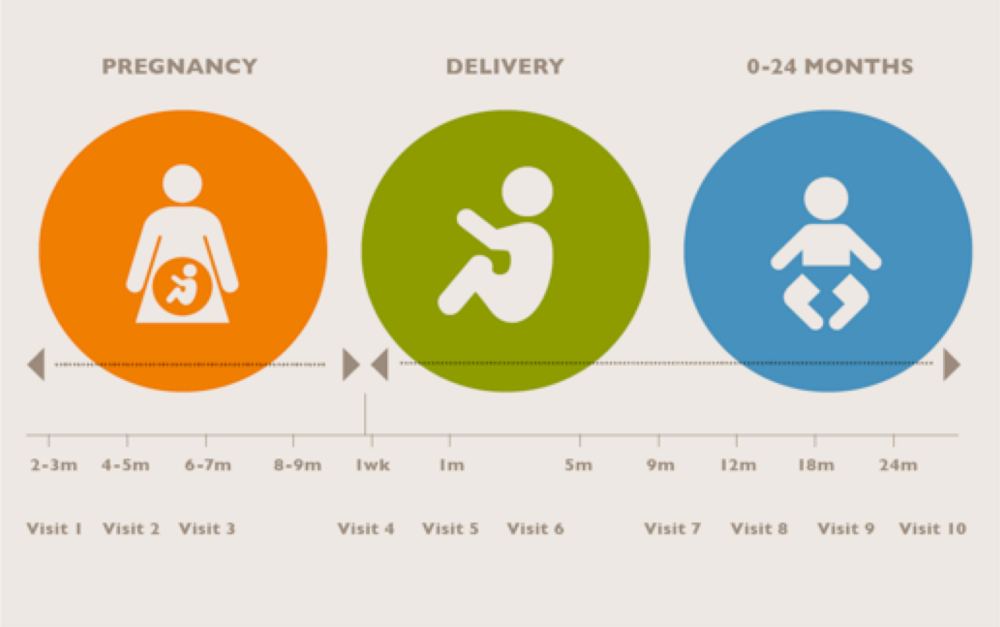

Figure 2.2: The ttC schedule for CHW home visits (Vallières, McAuliffe et al. 2013)

The work of the CHW in relation to the 7-11/ttC strategy could be broken down into 3 processes as described below. The records associated with these processes are all paper based. The 3 processes are as follows:

1. The registration process requires the CHW to report a suspected or confirmed case of pregnancy to the affiliated health centre. Basic information related to the pregnancy is recorded at this point, as well as the estimated delivery date and any other relevant information related to the pregnancy. At this point the woman is issued with a maternal health card and is also registered for visits 1-3 as shown in figure 2.2 above. A second registration takes place after the birth of the child, with a referral being put in place for both mother and baby to visit the health centre to receive postnatal and neonatal health services. The 7-11/ttC visits 4-10 are also scheduled at this point. If the mother and child do not attend the health centre as scheduled a reminder is sent to the CHW to follow-up.

2. The visits and service reminder process include the 10 visits over the first 24 months of the child's life as described in the 7-11/ttC schedule in figure 2.2. The CHW will carry out the key interventions as shown in figure 2.1 above

during the course of these 10 visits. Timing plays an important role here as key messages (e.g. breastfeeding and other essential newborn care) need to be communicated to the mother and family at the appropriate time. The CHW will check the maternal health card to ensure that appropriate vaccinations and health services have been given. If such services and vaccinations have not been given, the CHW will make a referral to the appropriate health centre. If the woman fails to attend the health centre, another reminder is sent to the CHW to follow-up with the mother.

3. The referral process involves a CHW referring a woman to the health centre for any reason. Once a referral is made, the woman has 48 hours to get to the health centre. The health centre will check with the CHW whether or not the woman has attended as referred, and the CHW will also have to answer a number of questions from the patient health card before the referral is closed. If the patient has not attended as referred, a reminder is sent to the CHW to follow-up and find out why the patted did not attend the health centre.

CHWs would receive training in the 7-11/ttC strategy. In addition, the mHealth component of Aim-Health was designed to designed to work with the 7-11/ttC strategy, and CHWs would also receive training in this mHealth component. This is now discussed in the following section.

2.3 The mHealth Component of Aim-Health

As already noted in Chapter 1, the public health systems in Sierra Leone face many and varied challenges, and the government of Sierra Leone has committed to address these challenges in a variety of ways. One approach sees a particular focus on ICT4D and mHealth in the belief that ICTs, and mobile technologies in particular, are key to strengthening the public health system. mHealth has thus become an integral part of government policy in Sierra Leone. This is evidenced by the recent establishment of both the CHW Hub and the eHealth Hub within the MoHS in Freetown. These hubs are key to the development and implementation of CHW and mHealth policy at national, district and community level. The eHealth Hub is also responsible for

coordination of the many mHealth initiatives currently in operation across the country. The mHealth initiative at the centre of this research is now discussed.

AIM-Health contained an mHealth component which commenced as a pilot in Bonthe District in January 2013. The pilot mHealth project was a collaborative effort between the Centre for Global Health in TCD, the School of Computer Science and Statistics in TCD, the University of Sierra Leone, the MoHS in Sierra Leone, and World Vision International. The initiative comprised three different strategies for the implementation of a volunteer CHW programme to improve maternal, newborn and child health across four of World Vision Ireland's ADPs in Bonthe District.

The mHealth project had been specifically designed to work with the 7-11/ttC strategy, the objective being to design a mobile phone application to replace the paper-based element of 7-11/ttC. This would have obvious benefits as the paper-based systems were bulky and difficult to transport, prone to damage and loss, and required significant additional work on the part of the CHWs to complete and keep all records updated. The paper-based records were also inefficient and were frequently incomplete. The mHealth application would be designed to facilitate the three 7-11/ttC processes as described in the previous section. It would also provide CHW with reminders for upcoming household visits and list missed household visits. The app would thus facilitate the follow-up for each pregnancy and for missed or late visits. The app effectively automated the 7-11/ttC process.

Although the mHealth pilot launched in January 2013, planning for the introduction of the project had commenced many months previous to this. A variety of meetings took place between Irish Aid, World Vision Ireland, World Vision Sierra Leone, and the MoHS in Sierra Leone throughout 2012, with more frequent meetings happening from mid-2012 onwards. These meetings discussed the introduction of the AIM-Health project and how this would be organised. The meetings also discussed the mHealth component, how this

would be introduced, the areas where it would be piloted, and a variety of other issues connected to the project. From these meetings it was decided to hold a separate technical and workflow deliberation meeting to discuss the specifics of the mHealth component design and the introduction of the pilot project in Bonthe. This 5-day meeting was held in Freetown in October 2012. Attendees included representatives from all the key stakeholder groups involved with the mHealth project, namely: TCD, various members of the MoHS Directorate, the Telecommunications Regulatory Body of Sierra Leone (NATCOM), Mobile Network Operators (Airtel Sierra Leone), World Vision, Software Developers (Thoughtworks), and a variety of representatives from World Vision. In addition, representatives of the CHWs and health centre staff were also in attendance.

During this 5-day workshop, participants were asked to examine existing CHW and health worker workflows using the old paper-based systems. Existing workflows and procedure mappings were subsequently discussed in terms of the introduction of the mobile application and consideration was given to how this would affect CHW and health worker workflows and responsibilities. These discussions were used to revise user journeys and identify what workflow changes would be required as a result of introducing the mHealth mobile application. The revised user journeys were subsequently ranked in order of priority for the purpose of delivering 7-11/ttC. Prioritization allowed the stakeholders to revise which existing user journeys were supported by the mHealth app and make amendments to this accordingly.

In addition to the revision and prioritization of user workflows and tasks, the workshop also mapped participating stakeholders in the form of user personas (i.e. CHWs, health centre staff, pregnant women, the District Health Management Team (DHMT), etc). The mapping of user personas was completed in an attempt to think through the various local languages, both written and oral, that would be required for the mHealth mobile application. Additionally, voice recording requirements for this iteration of the app were

considered. This was an important step as much of the local language of Mende does not have a written form. This caused difficulty in developing the mHealth application and resulted in additional translations for Mende being sought from district level health staff and World Vision employees in Bonthe District. Although Mende does not always have a direct written form, this was not seen as a huge problem as English is taught in local schools. This meant that the voice recordings could be recorded in Mende, while written text on the phone remained in English. This was not expected to cause any problems for the CHWs as literate users would be familiar reading English text.

Additionally, data flow and data security arrangements between the servers and the mobile phone were also discussed and subsequently mapped at this meeting. The agreements regarding the hosting of the server were made, and it was decided exactly who would have access to which level of data collected via the mHealth mobile application. This included access to individual household health data information. The location of the server was a key consideration as there is no reliable power grid available in Sierra Leone but the backend mHealth infrastructure and servers required 24-hour power. This meant that the servers could not be hosted in the MoHS as was initially planned, as the MoHS did not have a reliable power supply. Instead, it was decided to host the servers within the World Vision data centre in Freetown which had reliable and constant power supplied from its own generator. Hosting the servers outside of the MoHS gave rise to a number of ethical considerations including the storing of medical patient records on servers outside the MoHS, security and confidentiality of the data, and who would have access to these records. It was decided that hosting the servers in World Vision would be temporary until a more satisfactory solution could be found.

A decision was also made at the technical and workflow deliberation meeting in October 2012 that the storage feature of the mHealth app should allow inputted data to be stored locally on the phone, with the potential to send this data to the servers at a later time. This was seen as a crucial feature of the

application to prevent data loss in a context where poor mobile network and connectivity are common. As can be seen from figure 2.3 mobile phone coverage in Bonthe District in January 2012 was not universal and could have been described as patchy at best.

Figure 2.3: Mobile network coverage in Bonthe District when the mHealth pilot was launched in January 2013 (Wall, Vallières et al. 2013)

It was also a consideration that at there is not always a reliable supply of electricity at the local and community level in Bonthe District. This was a problem as the mobile phones would need to be charged reasonably frequently. To provide a means of charging the phones each CHW was provided with a portable solar power charger. In addition to charging their own phone, it was noted that the charger might also provide the CHWs with a supplemental source of income as they could potentially charge other community members phones for a fee if they so desired.

Subsequent to the technical and workflow deliberation meeting in October 2012 much was done to prepare for the mHealth pilot which was scheduled for January 2013. Perhaps most important was the testing of a first version of the mHealth mobile application by a sample of 15 CHWs, half of which were illiterate, for a period of five days in January 2013. This testing process provided

an opportunity for the CHWs to ask questions, practice using the application, and feedback their experience. A training manual was also developed for the CHWs which covered basic topics such as how to turn on the phone, set the correct date and time, login to the mobile application, play the pre-recordings, and choose the various modules. Slightly more complex topics such as selecting the appropriate visit module, synching with the server, completing the patient forms, and revising individual CHW case details were also covered.

It was noted that during the initial iteration process, CHWs demonstrated different levels of ease with mobile phones and the mHealth app. They needed significant time to become familiarized with the phone, and this was especially the case for illiterate users. The use of a mobile phone which was commonly available in Sierra Leone, and thus likely to be familiar to the CHWs, minimised the amount of time which would have to be spent on training the CHWs in the use of the phone. It was decided that the three main user interfaces upon which the mHealth application relied (i.e. text, image and audio) made it much simpler for CHWs to understand and execute the mHealth app functionality. To facilitate training, all phones used were identical. Though smartphones were widely available at this time, it was decided that CHWs would be less familiar with such phones and also that smartphones would require more frequent charging. In addition, smartphones were less common in rural areas and therefore could potentially cause a variety of other problems for the CHWs, including making them a target for theft of the phone. Using socially, culturally and locally appropriate phones meant that CHWs were immediately more comfortable with the entire process. As a result of these considerations it was decided to use Nokia C2-01 mobile phones for the mHealth pilot project.

The technical aspects of the mHealth component of this project, including the back-end infrastructure, data flows, and server infrastructure, as well as all the associated design processes of the mobile app have been described by in detail by Wall (2013) and will not be outlined in any detail in this section. The most important technical component was the mHealth mobile application which was

the result of collaboration between World Vision, the Bill and Melinda Gates Foundation, Dimagi, Grameen Foundation, Airtel Sierra Leone and Thoughtworks. This specific mHealth app was chosen as it was best suited to the Sierra Leonean context for a variety of reasons. These reasons include the penetration of mobile phones in Sierra Leone not being as high as in other parts of sub-Saharan Africa, and also that Sierra Leone was at that time facing a human resource for health crisis. This made the MOTECH Suite, which was seen as being accessible and relatively easily understood by CHWs, best suited to the Sierra Leonean context.

The design of the mHealth application was based on Grameen Foundation's MOTECH (on the backend) and Dimagi's CommCare (on the front-end). The design and development process followed a bottom-up approach involving key stakeholders at the technical and workflow deliberation meeting held in October 2012 in Freetown. On the frontend, the CommCare mobile application was designed to replace paper registers and reporting forms with customised electronic forms localised for the native languages. The application was effectively a digitisation of the 7-11/ttC strategy which allowed CHWs to view late or missed household visits, and also to register pregnant women, make clinical referrals to their affiliated health centre, and collect household data for transmission to the health facility in order to support clinical and managerial decision-making. The mobile component also facilitated emergency response communication and reinforces behaviour change messaging to improve case management through the use of a pictorial and local language interface accessible to low-literate users. Key to this process is the ability for CHWs to access their patient information even offline. Patient information is always available to the CHWs on their mobile device allowing them to record updates and receive reminders when mobile network connection is unavailable.

On the backend, the MOTECH solution permits access to key performance monitoring indicators in the form of date-specific, exportable, aggregated reports. Grameen's MOTECH app was originally designed to enable pregnant

women to receive SMS or voice messages about their pregnancy (MacLeod, Phillips et al. 2012). Those with back-end access are able to see registered case information, completed and missed visits and services information, time taken for service completion information, as well as other key data. This data can be used for a variety of purposes including performance feedback to the CHWs, and the reporting of various other CHW and health related data to a variety of other interested stakeholders. These reports can then be used by CHW supervisors and community health committees for feeding back to CHWs to update them on both their individual and collective progress. This information enables real-time decisions and adjustments to be made, enabling a more effective CHW workforce.

Deployment also required VPN monthly connectivity, SMS/Voice SMS alerts, and a closed user group to be set up for voice calls between CHWs and their supervisor. A private connection for CHWs to access application servers through the VPN tunnel, Internet access for servers for maintenance and administration and reliable power supply for servers was also established.

2.4 The mHealth Pilot Project in Bonthe District (January 2013 to April 2014)

A first version of the mHealth app was tested by a group of 15 CHWs, half of which were illiterate, for a period of five days in January 2013. This testing period provided the opportunity for CHWs to ask questions, make suggestions, and practice using the application. This gave them direct input to the design and development process. This, and input from the other stakeholder groups, guided the design and development of the final version of the mHealth app which was given to CHWs as part of the pilot project in Bonthe District in January 2013.

As previously mentioned, the mHealth component of AIM-Health commenced as a pilot in Bonthe District in January 2013, with the pilot expected to be completed by April 2014. The pilot project commenced on time and was

considered to be a success. It was thus decided to continue the project beyond the planned pilot period.

The mHealth pilot project was launched in Bonthe District in January 2013, with the pilot expected to be completed by April 2014. Bonthe District is made up of 11 chiefdoms and one municipality. These chiefdoms are as follows: Jong, Imperi, Sogbeni, and Kpanda Kemoh. These four chiefdoms contained a total of 333 CHWs at the time the pilot was launched. Participants for the mHealth component were recruited using a list of all of these 333 CHWs who were enrolled in the AIM-Health program. As part of the pilot initiative, 217 of the total 333 CHWs were given a Nokia C2-01 mobile phone and a solar charger. A total of 115 of these CHWs were set up on a closed user group where they could make free calls to a pre-defined list of colleagues including other CHWs, supervisors and health centre staff. The other 102 CHWs were set up on a closed user group and additionally had the use of an mHealth mobile application which allowed them to view which household visits were due, register pregnant women, make emergency referrals to their affiliated health centre, track their own progress, and collect household data for transmission to the health facility to support clinical and managerial decision-making.

Ongoing training and support for the mHealth pilot was provided throughout 2013 by the World Vision mHealth management team who were based in Mattru Jong, Bonthe District. The mHealth pilot was considered to have worked extremely well, and significant amounts of data were collected by the mobile phones. There were incidences of phones being damaged, lost and stolen but these were not significant and when this happened the phone was usually replaced by World Vision. There were also reported cases of corruption of the mHealth software and other technical issues with the phone hardware and software. Again, this was usually dealt with efficiently by the World Vision mHealth management team.

Although the mHealth pilot was expected to finish by April 2014 it was

considered such a success and therefore continued past that date. However, Ebola struck in May 2014 and brought the original pilot to almost a complete standstill. The effect Ebola had on the original mHealth pilot and the way Ebola reconfigured the CHWs use of the mobile phones discussed in the following section.

2.5 Ebola in Sierra Leone (May 2014 to March 2016)

The advent of the Ebola virus outbreak not only stopped the mHealth pilot project in its tracks, it also put on hold ambitious plans to scale up the mHealth project to provide all 333 CHWs with mobile phones set up on a closed user group and with the mHealth application. Also, now on hold was a further scale up to all 24 of World Vision's ADPs in Bonthe (originally planned for late 2014), which was to be followed in 2015 by a scale up to all World Vision ADPs in Sierra Leone.

All of these plans were thrown into chaos when the Ebola virus epidemic struck in May 2014. The epidemic impacted the mHealth project severely with many key people leaving, scarce resources being redeployed, and government restrictions on the movement and association of people. Additionally, the capacity of the mHealth management team in Bonthe was greatly reduced during the course of the Ebola epidemic, examples of this being the AIM-Health Project Manager being redeployed and the Digital Health M&E Technical Specialist leaving the project entirely.

Despite the advent of the Ebola virus many of the CHWs continued to use the original Nokia C2-01 mobile phones and mHealth app when making household visits, registering pregnant women and making referrals. In addition, a different cohort of CHWs were given Nokia ASHA Java based mobile phones as part of an Ebola project run jointly by World Vision and the DHMT in Bonthe District. ASHA phones were also given to CHWs who had lost or damaged their original Nokia C2-01 mobile phone. The original mHealth app was also installed on the Nokia ASHA phones. Over 200 ASHA phones were given out to CHWs at

this time. At the time of the research field visit in July 2018 only one of these ASHA phones was still being used by a CHW as shown in photograph 2.1 below.

As part of the Ebola project the CHWs were trained to use the mobile phones (both the original Nokia C2-01 phones and the new ASHA phones) as part of a community mobilization project which allowed CHWs to provide information on Ebola to the community, take sick people to the health centre, and report suspected Ebola cases. Although the activity of the CHWs was restricted during this time, the CHWs continued to fulfil their 7-11/ttC duties and data continued to be collected on the phones that still existed and had a functioning mHealth app installed. This happened even though many of the original Nokia C2-01 phones had been broken, damaged or stolen. Also, the original MOTECH app had stopped working at some time during the Ebola crisis as it had ceased to be supported on the Java platform.

The CHWs did receive a significant amount of training, especially on Ebola, during this time, and their use of the phones was in line with this training. However, they also used the phones in innovative and unexpected ways. This was surprising as there were extensive challenges associated with the work of the CHWs at this time including restrictions on movement and association. The CHWs were trained in many of the Ebola related projects including the Ebola community sensitisation, mobilization and disease surveillance programme. This included the Ebola 117 hotline where anyone could call 117 if they suspected a case of Ebola, the EBODAC project[1] itself, and Ebola common centres.

CHWs used the phones extensively during this period as they were the only resource available. If they didn't have a mobile phone there was nothing else. Additionally, using the phones meant less physical contact with people and paper-based records. The audio voice messages on the mHealth app also

[1] https://www.worldvision.ie/what-we-do/health/ebola-vaccine-programme

meant less physical contact was required. CHWs could meander through the community at will and use the phones for Ebola surveillance and monitoring. The CHWs also tackled many myths that had built up around Ebola during the outbreak. These included a belief that the health centres were deliberately infecting people with Ebola. The CHWs challenged this myth and people in the community believed them. This is because CHWs were selected by the community and therefore were held in high esteem and viewed as trustworthy. This allowed CHWs to continue to bring people to the health centres if they were sick. It was also because the CHWs have what has been referred to as a "referral mentality which is inbuilt".

During this time the CHWs never lost interest nor faith in the phones. Even after Sierra Leone was declared Ebola free in March 2016 (CDC 2016) the phones continued to be used. As already mentioned, the mHealth app had stopped working at some point during the Ebola outbreak but the phones still continued to be used. There was a belief that the phones helped the CHWs do a better job. There was also a belief that the phones created a stronger relationship between the CHWs and the health staff, as well as the CHWs and the community. Additionally, the phones gave the CHWs a certain status, and a greater incentive to not to lost status and position as a result of poor work performance which could now be very effectively monitored by the mHealth application.

Photograph 2.1: Adama Kamara is a CHW from Mokaba MCHP. She is pictured here with one of the original Nokia ASHA mobile phones given out in 2014 as part of the Ebola mobilization project (photograph taken during fieldwork 24 July 2018).

2.6 Aim-Health+ and mHealth2 (January 2017 to December 2021)

As mentioned, by the time the Ebola epidemic was over in March 2016 there was no data whatsoever coming from the original Nokia or ASHA phones. This is because the mHealth application ceased to be supported by Dimagi - and therefore stopped working correctly - at some point during the Ebola virus outbreak. Additionally, there were lots of technical hardware and software problems with both the original Nokia C2-01 and ASHA phones. By this time

almost all of the original Nokia C2-01 and ASHA phones were not working because they had been stolen, lost or damaged. These technical limitations did not stop the CHWs from continuing their work, with most still carrying out their duties on the 7-11/ttC programme. However, no data was being collected on the phones for the reasons already outlined.

Even though Sierra Leone was declared Ebola free in March 2016 (CDC 2016), the epidemic had a devastating impact on both the mHealth project and the country as a whole. Despite this, in late 2016 preparations began for the introduction of the next iteration of the AIM-Health project. This is called AIM-Health+ and will run for a duration of five years between 2017 and 2021. One of the overall aims of AIM-Health+ is to reduce both infant mortality and maternal mortality by 20%. Another objective is to achieve these outcomes through the use of mobile technology and mobile phones. Thus, AIM-Health+ will have an mHealth component called mHealth2 which will use Samsung J2 Android mobile phones with a new mHealth android app installed.

The planning for AIM-Health+ and mHealth2 commenced as early as 2017. Throughout 2017 key people were drafted back onto the mHealth management team in Bonthe including the original AIM-Health programme manager who was reappointed in September 2017. Additionally, a new Digital Health M&E Technical Specialist (pictured in photograph 2.2 and 2.3 below) was also recruited in September 2017. Many meetings took place between all stakeholders throughout 2017 where it was decided to launch a pilot for the mHealth2 project in Bonthe District.

The pilot for mHealth2 was launched in two of the Bonthe District chiefdoms in August 2018; namely Imperi and Sherbro Island. The new Samsung J2 mobile phones and mHealth application were given to approximately 300 CHWs in these areas in August 2018 as part of the mHealth2 project, and training of the CHWs and others in the mHealth team also occurred at that time. The new mHealth application, which is similar to the older java based mobile app used

in the first mHealth project, is also specifically designed to work with the 7-11/ttC strategy.

mHealth2 was fully operational by September/October 2018 and plans now exist for the widespread scaling of this project across all of Sierra Leone, as well as the other 4 countries included in the AIM Health project namely Kenya, Tanzania, Uganda and Mauritania (World Vision 2015). A variety of monitoring and evaluation efforts are currently being put in place by both World Vision and Irish aid in an attempt to evaluate both the AIM-Health+ and mHealth2 projects. In addition, there are ongoing research efforts being led by both TCD and UoSL which focus on the mHealth2 project specifically.

Photograph 2.2: Joe G Miller (World Vision Sierra Leone Digital Health M&E and Technical Specialist) working on the Samsung J2 Android mobile phones and new mHealth mobile application (photograph taken on 21 July 2018 in World Vision Mattru Jong office)

Photograph 2.3: Joe G Miller (World Vision Sierra Leone Digital Health M&E and Technical Specialist) working on the Samsung J2 Android mobile phones and new mHealth mobile application (photograph was taken on 21 July 2018 in World Vision Mattru Jong office)

2.7 mHealth Project Timeline

This section provides a timeline for AIM-Health and AIM-Health+, the mHealth pilot project and the mHealth2 project. Other important events are also shown. Additional detail can be seen for each item in the timeline in previous sections of this chapter.

2010 - The MoHS in Sierra Leone introduces the free health care initiative for pregnant women, breastfeeding mothers, and children under five years of age.

January 2011 to December 2015 - World Vision Ireland implements the AIM-Health Programme. A key part of AIM-Health was the training of CHWs in the delivery of the 7-11/ttC strategy.

2012 - The MoHS in Sierra Leone introduces a policy of integration of voluntary CHWs into the public health system.

2012 - Planning for the mHealth pilot project commenced in 2012. Various meetings between the mHealth stakeholders took place at various times throughout the year.

October 2012 - Technical and workflow deliberation meeting held in Freetown.

January 2013 to April 2014 - The mHealth pilot project in Bonthe District was launched in January 2013 and expected to run to April 2014.

January & February 2013 - PhD field research in Bonthe District.

October & November 2013 - PhD field research in Bonthe District.

May 2014 to March 2016 - The Ebola virus outbreak in Sierra Leone.

January 2017 to December 2021 - World Vision Ireland implements the AIM-Health+ Programme.

2017 - Planning for AIM-Health+ and mHealth2 commenced as early as 2017. Throughout 2017 key people were drafted back onto the mHealth management team in Bonthe District. Various meetings also took place between the stakeholders throughout 2017.

July & August 2018 - PhD field research in Bonthe District.

August 2018 - The pilot for mHealth2 was launched in two of the Bonthe District chiefdoms: Imperi and Sherbro Island.

September & October 2018 - mHealth2 was fully operational, with a variety of monitoring and evaluation procedures in place designed to evaluate both the AIM-Health+ and mHealth2 projects

2018 & 2019 - Planning for the widespread scaling of mHealth 2 across all of Sierra Leone and the other 4 countries included in the AIM Health project (Kenya, Tanzania, Uganda and Mauritania) will take place throughout 2018 and 2019.

Chapter 3: Literature Review: International Development and ICT4D

3.1 Introduction

Chapters 3 and 4 present a review of the literature relevant to this research. The purpose of the literature review is to synthesize the existing literature in the academic fields of development, ICT4D, M4D, mHealth and the theoretical and methodological approaches used in ICT4D research. Firstly, a review of the literature on development and development paradigms is presented. Next, the main body of work on ICT4D is reviewed, with themes in this body of work being identified. Sub-sections of the main ICT4D body of work are then reviewed, including the literature on M4D and mHealth. This highlights the main debates, gaps and weaknesses in the literature. Next, a review of the body of work on theoretical and methodological approaches to ICT4D is presented. The objective of reviewing this work is to identify relevant debates in the literature and to obtain a solid ontological, theoretical and methodological foundation for this research.

The search methodology adopted for this literature review was guided by Thapa (2014) who relies on Webster and Watson (2002). The search was based on keywords commonly used in the fields of ICT4D, information systems, research methodology, and philosophical approaches to research (with a particular focus on the critical realist paradigm). Because there is no single agreed vocabulary or terminology used in ICT4D (Njihia & Merali 2013) the keywords used encompassed all the main terms associated with ICT4D as presented in section 1.5 above. This included ICT4D, ICTD (information and communications technology for development), development informatics, IS-in-DCs (information systems in developing countries), ITID (information technology and international development), community informatics, ICT4HD (ICT for Human Development), and Tech4Dev (technology for development). The search criteria also included the many sub-sets of ICT4D including ICT4E

(information and communications technology for education), ICT4H (information and communications technology for health), eGovernment (electronic government), mAg (mobile technology for agriculture), Web2forDev (web 2.0 for development), D4D (data for development), and SoMe4D (social media for development). Some of these sub-sets relate to healthcare and the use of mobile technologies in healthcare and include mHealth (mobile health), M4D (mobile for development), eHealth (electronic health), HMIS (health management information systems), telemedicine, and HIS (health information systems). Although the terms mHealth, HMIS, telemedicine, and HIS are not exclusive to the ICT4D literature and are used frequently in reference to more developed countries in Europe and the USA, it was decided to keep these terms within the search criteria. In addition to there being no universally agreed terminology for ICT4D, a variety of terms are used to refer to countries in the Global North and the Global South. These include developed, underdeveloped, first-world, second-world, third-world, low- and middle-income countries (LMICs), resource-constrained, and high-resource countries.

These keywords were then used to search Google Scholar and the other library databases available through the TCD library. This generated a significant amount of results as evidenced by the list of references at the end of this PhD. Papers that did not focus on developing countries were excluded, as were papers which focused on the technical aspects of ICT4D and mHealth (e.g. papers on software and mobile application development).

The search was not restricted to any specific set of journals, conferences or dates with all search results considered to be relevant (excepting the exclusions noted). However, priority was given to literature originating from the main ICT4D journals and conferences as identified by Heeks (2010) in his ICT4D journal ranking table. These included the EJISDC, ITID and ITD journals, and the IFIP WG9.4 and ICTD conferences. Snow-balling techniques were then used to identify further relevant literature. Furthermore, an author-based search was

conducted on the most cited authors which included Richard Heeks, Geoff Walsham, Devinder Thapa, Sundeep Sahay, Roy Bhaskar and Margaret Archer. A backward and forward search of the most sited authors was also carried out. All this was done in an attempt to ensure that the most relevant articles were identified and included. This methodology produced many redundant results which were excluded. It is recognised that the literature review methodology adopted has limitations. Despite these limitations however, it is believed that the literature selected includes all key and relevant work in the fields reviewed and represents a comprehensive and detailed summary of the current status of the various fields.

The remainder of this literature review is organised as follows. The next section examines international development and ICT4D, highlights the important relationship between ICT4D and development, and provides definitions of development and the development agenda. Development paradigms are discussed in section 3.3, with the review of the main body of ICT4D literature being provided in section 3.4. Section 3.5 reviews the literature on M4D and mHealth, and the chapter concludes with section 3.6 which provides an overall summary and outlines the gaps in the literature. A future research agenda for ICT4D is also presented. Chapter 4 provides examination of the literature relating to research paradigms in IS and ICT4D. Critical realism and the use of the paradigm in ICT4D research is discussed in detail, as are the challenges to using critical realism for ICT4D research.

3.2 International Development and ICT4D

There are many definitions of ICT4D provided in the literature. A recent definition by Heeks (2018, p. 10) defines ICT4D as "the application of any entity that processes or communicates digital data in order to deliver some part of the international development agenda in a developing country". Other definitions are given by Heffernan et al. (2013) as any "individual or groups of communication technologies, whose adaptation or impact supports ongoing and/or future development aims and objectives", and Lund (2010) who defines

ICT4D as “the opportunities of Information and Communications Technology (ICT) as an agent of development.” Of additional relevance is the claim by Chipidza (2019) that ICT projects are considered an important means of achieving development goals in developing countries.

Many of these definitions of ICT4D include the terms development and international development. Any reliance on these definitions thus requires clarity on the meaning of these terms. However, clarity and certainty around these terms has proven elusive. It has been claimed that the role of technology in development is not always clear and there is a need to explicate the meaning of development and the role of ICTs within development (Hatakka & De 2011). Furthermore, it has been recently suggested that the research to date is inconsistent in theorizing how, and why, development outcomes do or do not occur following the introduction of ICT4D (Chipidza & Leidner 2019).

This makes clarity and understanding of the term’s development and the international development agenda important, as to understand failure or success in the context of ICT4D there is a need to first define what is meant by development (Chipidza & Leidner 2019). Additionally, ICT4D sits clearly at the junction of development and ICT (Haikin & Duncombe 2013) and it is clear that ICT4D is playing an increasingly significant role in international development. According to Heeks (2018) the real potential benefit of ICT4D is its contribution to international development. This would strongly suggest that there is a need to further clarify how the role of ICT in development is conceptualised (Harindranath & Sein 2007). Another question arising is how to relate “information and communication technology” (ICT) to “development” (D) (Thapa & Sæbø 2014), with recent increasing engagement (Heeks, Thapa et al. 2018) and confusion (Chipidza & Leidner 2019) around the question of what we mean by the “D” in ICT4D.

Adding to the complexity and lack of clarity is the ongoing debate around what exactly is meant by ICT4D and whether the work is about ICT carried out “in

developing countries" or ICT "for development". This is an important debate, as work in "a developing country" is often judged against work "for development". This may result in ICT work being reported as having underachieved or failed and may lead to a questioning of the efficacy of research in the whole field (Brown and Grant 2010). All of this has made development a topic of interest and open debate within the ICT4D community, with the focus of the debate being on how, not if, ICT can lead to development (Hatakka & De 2011).

Taken together, all of this makes a clear definition and understanding of development, and what constitutes the international development agenda, essential to the ICT4D community. However, providing definitions of these terms has proven to be a challenge. Rocha (2013) suggests that development definitions and measurements vary greatly, with Chipidza (2019) proposing that different scholars ascribe different meanings to development and different ICT4D studies adopt different perspectives of development. Furthermore, these are complex terms that have changed meaning over the decades (Lee, Jang et al. 2008, Hatakka & De 2011). Another challenge is the lack of an explicit definition of development in research projects and a variety of conceptions of what development actually means (Ordóñez 2015), with different competing theories to characterize the notion of development (Thapa & Sæbø 2014). This uncertainty is made worse by the claim that ICT4D continuously grapples with varying and evolving notions of what counts as development, and there still exists a significant gap in outlining where the current boundaries of this field lie (Marathe, Chandra et al. 2016). This all means that there exists a certain detachment from development outcomes from ICT4D academics and practitioners (Ordóñez 2015).

Although many scholars have provided detailed reviews on the topic of development and international development (e.g. Sumner, Tribe et al. 2008) it is not the purpose of this literature review to delve deeply into this body of work or to contribute significantly to this debate. However, it is useful to

provide definitions of the key terms that are part of the ongoing discourse. Despite the difficulties and challenges of arriving at an accepted definition of development, some authors have claimed that the question "what is development?" has been relatively well-answered and well-documented in the literature (Thapa & Omland 2018). Additionally, there exists many differing definitions of what constitutes development and the international development agenda. Recent work completed by Chipidza (2019) is of great relevance in this regard. In their attempt to better understand the notion of development, they find that the very meaning of development varies. They suggest that four meanings of development emerge from the literature reviewed as follows: (1) development as increased freedom, (2) development as expanded inclusion, (3) development as increased economic productivity, and (4) development as improved well-being (Chipidza & Leidner 2019).

Of additional importance is the work carried out by Naderveen (2001) who suggests that development is generally defined as an organized intervention in collective affairs according to a standard of improvement that varies according to class, culture, historical context, and relations of power. Horner (2017) advances the debate by suggesting that development is often linked with the imminent processes of active intervention and is particularly significant in shaping outcomes within an international development setting. Of additional relevance is the useful table provided by Rocha (2013) which provides definitions for different varieties of development including economic development, sustainable development, human development, socio-institutional development, and the development agenda. Perhaps of most relevance to this literature review is the definition of the development agenda as defined by the Monterray Consensus (in Rocha 2004, p. 12), the main goal of which is "to eradicate poverty, achieve sustained economic growth and promote sustainable development as we advance to a fully inclusive and equitable global economic system". Furthermore, of much relevance is Sen's (2014) definition of human development as the expansion of human freedom

to live the kind of lives that people have reason to value which can be achieved by the expansion of people's capabilities.

In addition to providing definitions, it is also important to have some understanding of the nature of development in the specific context of ICT4D. Heeks (2018) suggests that there are three different breadths of understanding development consisting of generic development, geographically specific development, and geographic- and agenda-specific development. Generic development may be understood as any progressive change in a society, with geographically specific development being any progressive change in a developing country. Geographic- and agenda-specific development are taken to refer to particular progressive changes in a developing country. As previously mentioned, this is important as ICT4D sits clearly at the junction of development and ICT (Haikin & Duncombe 2013), and a clear understanding of the notion of development is required for the conceptualisation of the role of ICT in development (Harindranath & Sein 2007).

3.3 Development Paradigms and ICT4D

As discussed in the previous section, some degree of certainty around the exact meaning of development and what constitutes the international development agenda is essential for the ICT4D community. This section of the literature review presents an overview of the body of work which discusses the major development paradigms and assesses how these may have relevance to ICT4D.

Development paradigms can be defined as "overarching ideas of what development means and how it should be achieved" (Heeks 2018, p. 18). Development paradigms are important because they contribute to setting the development agenda, with the core ideas arising from the sustainable development paradigm (in particular environmental sustainability and social justice for those marginalised by inequality) providing the foundation for the SDGs (Peprah 2017, Heeks 2018). In addition, they have been "important shapers of ICT4D from 2016 onwards" (Heeks 2018, p. 22). This is discussed at

length by Heeks (2018) who suggests that although ICT does not form an explicit part of any development paradigm, its role is highly dependent on the paradigm. He posits that not only do different paradigms imply different rolls for ICT, they may also imply different development outcomes. This makes understanding of development paradigms important for the ICT4D practitioner as one ICT4D project implemented under a specific development paradigm may have a different emphasis and outcome than the same ICT4D project implemented under an alternative development paradigm.

This is also discussed at length by Kleine et al. (2010) who propose that before any ICT4D project is assessed the development paradigm at play needs to be understood. This is in order to refine our understanding of the development processes which may be guided by the paradigm. More importantly, any ICT might succeed according to one meaning of development while simultaneously hindering achievement according to another meaning (Chipidza & Leidner 2019). An example of this is given by Ordóñez (2015) who reference work carried out by Zhang & Chib (2014) who identify different development paradigms existing in India and China. They suggest that the modernisation discourse is dominant in China, while the focus is on a technocratic perspective in India which prioritises achieving goals such as economic growth, industry development, and governance. These paradigms are discussed in more detail in the following paragraphs, but it is important to recognise that ICT4D projects in each of these countries are highly likely to be designed, developed, implemented and scaled differently as each paradigm will dictate how specifically the ICTs are used for development.

There has been much written about development paradigms. While there is not universal agreement on the exact name, period of duration, or overall purpose of each specific development paradigm there is some uniformity of opinion among scholars. Peprah (2017) provides a summary of what he refers to as the six development paradigms as follows: colonial economic growth in the 1950s; economic growth and development in the 1960s; the basic needs

approach in the 1970s; economic growth and development in the 1980s; sustainable development in the 1990s; and, globalization with the Millennium Development Goals (MDGs) in the period 2000 to 2015. Rocha (2013) also discusses development paradigms, and reviews the experiences, concepts, and prevailing paradigms on development from the perspective of economic and international organizations and offers a framework to integrate them.

Moreover, also of relevance is the work completed on development paradigms by Thapa (2014). He suggests that a paradigm of development existed up to the 1940s, the main aim of which was industrialization and colonization. This had the effect of classifying development as economic growth. This was followed by what he calls the modernization paradigm which prioritised economic growth combined with political and social changes. This paradigm characterised development as a displacement of the values, beliefs, and actions of traditional societies in developing countries. It advocated that national growth could be achieved through imitating the more developed countries in the Global North and encouraged developing countries to become "modern."

Recent work by Chipidza et al. (2019) also addresses the issue of development paradigms. They highlight what they identify as four different perspectives on what constitutes development in the context of ICT4D. Firstly, development as freedom takes place if the freedoms of target beneficiaries are increased. Second is the notion of development as expanded inclusion. This means that development takes place when previously disenfranchised groups are afforded access to ICT artifacts. Thirdly, development as increased economic productivity occurs when economic productivity rises due to an ICT intervention. Fourthly and finally, development as improved well-being takes place when target beneficiaries feel more satisfied, happy, or fulfilled as a result of an ICT intervention.

Of great importance to the topic of development paradigms is the work of Richard Heeks who has written extensively on this topic (e.g. Heeks 2018). Heeks presents a detailed and comprehensive narrative on development paradigms and proposes that international development began only after World War II with a galvanisation of the process of decolonisation (Heeks 2018). This is credited as starting with Harry Truman's speech from 1949 (Esteva 1992) when he proclaimed, "we must embark on a bold new programme for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas" (Esteva 1992, p. 6).

In addition, Heeks (2018) presents a chronological history of development paradigms. He suggests that the first development paradigm can be traced back to the 1950s with the notion of modernisation as a philosophy of development. The modernisation paradigm dominated the third quarter of the twentieth century and saw developed nations as advanced while developing countries were viewed as backward and underdeveloped. This paradigm proposed that in order for development to happen, there must be a transfer of technology from developed countries to developing countries. The notion of the transfer of technology from developed to developing countries which was at the core of the development paradigm turned out to be problematic. This led to the rise of a new development paradigm in the 1970s which has come to be known as the dependency paradigm. The dependency paradigm proposed that development could only happen when countries broke away from what it called the "exploitative world system" (Heeks 2018, p. 18). This paradigm resulted in a number of unexpected consequences including developing countries establishing barriers to imports, which led to the more able developing countries seeking to create their own technologies and the less able developing countries falling further behind technologically. Additionally, the dependency model was problematic as it was seen to disregard the needs of ordinary citizens in developing countries as it inevitably resulted in an increase in goods of high cost but low quality.

These problems with the dependency paradigm resulted in the birth of a new paradigm which has come to be known as the basic needs paradigm. According to Heeks (2018) this paradigm lasted throughout most of the 1970s and 1980s and prioritised a focus on basic human needs with a high degree of state intervention. The basic needs paradigm was followed by the neo-liberalism development paradigm which lasted for much of the following four decades. The neo-liberalism paradigm prioritised the power of market forces over the power and influence of state governments. This paradigm returned to the notion of technology transfer from developed to developing countries. The difference under the neo-liberalism paradigm was the technology transfer would happen under market forces. This resulted in a relatively free flow of technology between countries throughout much of the 1980s and 1990s. The paradigm resulted in the erosion of much of the technological capabilities that developing countries had built up during the previous years (Heeks 2018).

Amartya Sen and a variety of other authors have heavily criticised the neo-liberalism paradigm (Sandbrook 2000) for a variety of reasons, the main one being that it ignored the main needs of the poorest people in developing countries. This criticism was one of the reasons why there was a move away from neo-liberalism and towards the new human development paradigm. The human development paradigm placed priority on delivering health, educational, income and related improvements to the mass of poor citizens in developing countries. Heeks (2018) argues that we are now in the post-development paradigm. According to Heeks (2018, p. 19) this is more of an "anti-development paradigm" which argues that the very notion and discourse of development has been a means to entrench the interests of the Global North. This paradigm does however see ICTs as having great potential to help indigenous peoples and it also allows for alternative approaches to emerge.

In addition, the work carried out by Lee (2008) is relevant as she provides a comprehensive narrative on development paradigms. She suggests that although the modernisation paradigm was dominant in the 1960s,

modernisation has been challenged as a development paradigm. This paradigm associated development with economic growth which was seen as a universal linear path in which the industrialised countries of the Global North were ahead of developing countries in the Global South. This was because developing countries lacked capital, modern technology, and modern social values. The transfer and acquisition of modern technology was therefore a central part of the development paradigm. Additionally, Lee (2008) suggests that modernisation came under attack from the dependency paradigm in the 1970s. This may have been as a result of the dependency paradigm arguing that linkages between rich and poor countries were the cause of underdevelopment. The paradigm suggested that the solution was for the poor countries to break away from the world system and seek their own self-reliant path. Lee goes on to suggest that the human development paradigm has recently come to the fore. The emphasis brought by this paradigm is on building freedoms and the capacity of individuals to make and implement choices that expand their quality of life. Lee (2008) also posits that the human development paradigm prioritises the role of technology and leads towards open access to foreign technology imports as an important component of development success.

Sein (2005) has also written extensively about development paradigms and proposes four different paradigms of ICT in development. These are broadly in agreement with the development paradigms suggested by authors such as Heeks (2018), Lee (2008), and Tahpa (2014) and consist of functionalism, social relativism, radical structuralism and neo-humanism. Sein argues that functionalism is arguably the most common paradigm. It proposes a neutral view of ICT in developing countries. The main actors are likely to be foreign and from more developed countries who are seen as advocates and drivers of technology in the developed country. The foreign actor acts as a champion for technology, and the host government is usually passive or neutral in the process. Examples of this paradigm are projects aimed at reducing the digital divide, capacity building and infrastructure building. There are however a

number of critics of this paradigm (Sein 2005); the main criticisms including claims that the paradigm views technology as a tool which often becomes the end rather than the means, and the danger that ICT can be a mechanism of control if dependency on the technology occurs in the developing country.

The second paradigm proposed by Sein (2005) is the social relativism paradigm. This paradigm represents the modernisation perspective of development and holds a neutral view of ICT in developing countries. According to social relativism the main actors are frequently from outside of the local population, an example of this being an external NGO working in a developing country. This perspective views technology as an ensemble, or from a socio-technical perspective. Also relevant is the debate around the use of appropriate technology which is seen as being uncritical of the potential dysfunctional side effects of using particular tools and techniques which may have been developed in more developed countries. The third paradigm proposed is the radical structuralism paradigm. This paradigm is proposed as an alternative perspective for development where the main participants can come from either inside or outside of the developed country. These actors take the form of activists for the exploited classes within the developed country, with the notion of radical structuralism being best understood through the debate on call centre outsourcing which is either hailed as a great success or as an exploitation of people in developing countries. Finally, neo-humanism is an alternative perspective of development where the main actors originate within the developed country. The main aim of neo-humanism is emancipation, an example of this being the establishment of knowledge networks, e-Democracy, or locally developed software in a developing country.

3.4 Information and Communications Technology for Development (ICT4D)

As discussed in Chapter 1, the last two decades have seen ICT become more important and ubiquitous across developing countries. This has been accompanied by the development of the relatively new and ever-growing academic field of ICT4D (Walsham 2012, Walsham 2017, De', Pal et al. 2018).

The field is concerned with ICT-based interventions in developing countries and the use of ICTs for socio-economic and international development (Walsham 2017, Heeks & Wall 2018). As mentioned in section 3.1 above, a variety of definitions of ICT4D are provided in the literature (e.g. Lund & Sutinen 2010, Heffernan et al. 2013, Heeks 2018). Although no one single definition of ICT4D is relied on by this research, of great importance is the definition provided by Heeks (2018, p. 10) who says that ICT4D is "the application of any entity that processes or communicates digital data in order to deliver some part of the international development agenda in a developing country". Additionally, of relevance is the recent work by De (2018) who posits that ICT4D research seeks to examine the social and economic changes in developing countries brought about by the deployment and use of ICT.

The definitions of ICT4D provided above are relatively recent and it is important to note that the priorities of ICT4D, and thus the associated definitions of ICT4D, have changed and evolved since of the inception of the field. In other words, there have been different priorities associated with different periods in the history of ICT4D. This can be more clearly understood by an examination of the development paradigms as discussed in the previous section. Both Walsham (2017) and Heeks (2014) recognise this and provide some clarity by giving a useful history of the ICT4D field. They identify distinct "periods" (Walsham 2017) and "waves" (Heeks 2014) which chart the birth and development of the ICT4D field since its inception.

Walsham (2017) proposes that ICT4D research can be considered to date from the mid-1980s when it was a sub-field of the broader IS field. He breaks down the history of the ICT4D sub-field and identifies three distinct periods. These are the "early beginnings" period from the mid-1980s to the mid-1990s; the "expanding horizons" period from the mid-1990s to the mid-2000s; and the "proliferation" period from the mid-2000s to the present day. An important research achievement in the field is identified as the adaptation of key themes from mainstream IS applied to developing countries. The start of critiques on

development, gender, the nature of development, role of new technologies, need for interdisciplinarity etc are also associated with specific periods, and the creation of various key journals and conferences in the ICT4D field are mapped. These include the ITD journal launched in 1986, the EJISDC which started in 2000, and the IFIP WG 9.4 conference on "Social Implications of Computers in Developing Countries" which was held for the first time in 1988 in India. In addition, the ITID journal started in 2003 and the ICTD conference began in 2006.

The history of the ICT4D field provided by Heeks (2014) identifies four waves which correlate roughly with the periods identified by Walsham in the previous section. The first wave was from the 1960s to the mid-1980s and saw the first links between ICTs and development. Wave two occurred between the mid-1980s and the mid-1990s and was typified by significant academic impetus with the formation of the ITD journal and the IFIP WG 9.4 academic group. Wave three occurred between the mid-1990s to up the mid-2000s and involved expansion of research due to the Internet, and the associated growth of debate about ICTs and development. According to Heeks, this wave also saw the founding of the EJISDC and ITID journals. Wave four occurred between the mid-2000s and the mid-2010s and saw a shift in focus towards mobile technologies and more robust evidence about the impact of ICTs in development. According to Heeks, this wave saw much work around the building and development of conceptualisations such as Sen's capability approach, actor-network theory, structuration theory and the technology acceptance model. In addition, wave four also saw advent of the ICTD series of conferences in 2006.

Despite the many ICT4D specific journals and conferences that have emerged over the past years, the claim has been made that it is difficult to get ICT4D related work published. Writing several years ago, Walsham (2007) noted that few papers on IS in developing countries have been published in premier IS journals such as MISQ and Information Systems Research. However, this has

changed over the intervening period with a more recent paper by (Walsham 2017) recognising a large increase in the number and range of published work on the topic, with a considerable and growing body of ICT4D literature being published in top IS journals and conferences. Both Naudé (2016) and Heeks (2017) also highlight this extensive growth in the academic ICT4D literature, with Walsham (2012) noting that the field has spread widely from its origin in small specialist groups and is now experiencing a massive upsurge. According to Gomez (2013, p. 2) "the magnitude of the growth in the field of ICTD is unquestionable", with Heeks (2010) pointing to a 2,000% increase in publications in the ICT4D field between 1999 and 2008.

This has led scholars such as Patra et al. (2009), Naudé (2016), and Ramadani (2018) to conclude the ICT4D field is reaching maturity. This claim is supported by the growth in ICT4D specific journals and conferences. These were briefly mentioned in the previous section and include the EJISDC, ITID, and ITD journals, as well as conferences such as IFIP WG 9.4 and ICTD. Heeks (2010) provides a useful journal ranking table which includes all the 15 ICT4D journals that existed at the time of writing the paper in 2010. Impact factors are given for all journals and less well-known journals are also included such as the African Journal of Information and Communication, the Journal of Health Informatics in Developing Countries, and Information Development. The top three journals according to Heeks (2010) are ITID, EJISDC and ITD. Further work on this has been carried out by Xia (2012) who gathered Google Scholar data with the Publish or Perish software to rank open access journals (including the EJISDC) by Hirsch-Index. In addition to these ICT4D specific publication outlets, there have been occasional ICT4D related special issues in many prestigious journals such as MISQ (Walsham 2017) and the Information Systems Journal. There has also been a significant amount of other ICT4D related research published in a wide variety of journals and conference proceedings, with the References section of this PhD providing evidence of that claim.

Despite this however, some scholars have been less optimistic about the prospects of publishing ICT4D research, with the topic being debated for years (Ramadani 2017). It is argued that many have found it difficult to get accepted into top ranking journals and they have been forced to publish in unranked journals or develop their own journals and conferences (Naudé 2016, Ramadani 2017). It has also been suggested that many of the main ICT4D journals are of low rank and quality which arises from low novelty of theory, low impact, and low acceptance from the original player (in particular from African researchers) (Naudé 2016). However, this argument is countered by Walsham (2017) who suggests that if researchers wish to aspire to publish work in high ranking journals there is a need to engage with publication outlets from other relevant areas such as development studies, anthropology, geography, and computer science. In addition, Walsham (2012) argues that interdisciplinarity in ICT4D research is needed, and that such interdisciplinarity would open the possibility of publishing in other specialist journals previously not available to the ICT4D researcher.

The potential for interdisciplinarity in ICT4D research and the associated increase in publication opportunities results from the field of ICT4D being highly practical and oriented towards real-world action and practice. The focus is on creating new systems, making an impact, and the furtherance of development goals (Heeks 2018). According to Heeks (2018) ICT4D research has tended to follow this lead: evaluating design and implementation methods, evaluating development impact, proposing new approaches, tools and strategies. The field is thus highly practical (Heeks 2018), revolving around real-world actions in the design and use of digital technologies for development goals. However, the role of ICT4D goes beyond the notions of real-world action and practice, and also seeks to achieve progressive social change and to deliver specific development goals (Heeks & Wall 2018). ICT4D research is thus heavily engaged with practice since it must generally study, and sometimes directly involve these real-world actions (Heeks 2018). The ICT4D field is therefore seen

as a part of a wider concern for global development, and thus can be considered to be of great significance at this point in time (Walsham 2017).

It has also been claimed that ICT4D is interdisciplinary, multidisciplinary, and transdisciplinary (Thapa & Sæbø 2014, Naudé 2016). Indeed, Walsham goes as far as to claim that the field is "quintessentially multidisciplinary" (Walsham 2012, p. 91). The field of ICT4D involves a whole range of disciplinary approaches including IS, computer science, geography, anthropology, development studies, medicine, environmental engineering, social science, and community informatics (Thapa & Sæbø 2014, Ramadani 2017, Walsham 2017), as well as the fields of agriculture, sociology, medicine, engineering, telecommunications, and social work (Naudé 2016). This is why it is important to understand the multi-perspective approach of the ICT4D domain (Thapa & Sæbø 2014). The interdisciplinary, multidisciplinary, and transdisciplinary nature of the ICT4D field is likely to allow for new publication opportunities for ICT4D researchers in future.

3.4.1 Taking Stock of ICT4D

Sub-section 1.1.1 of Chapter 1 above introduced the potential for ICT4D. A broad introduction to ICT4D was provided, and this was followed by a discussion on the growth of mobile technologies and mHealth in developing countries. The benefits and potentialities of ICT4D and mHealth were then proposed. The section concluded with an examination of the main problems associated with the implementation and scaling of such systems, and approaches to address the problems were identified. This section continues that discussion by taking broad stock of the ICT4D field. This includes an examination of the main ICT4D discourses and identification of the main themes in the research.

According to Njihia (2013, p. 882) the developing country context is "complex, characterized by interweaving of actors, agencies, and agendas of political, public, private, and third sector institutions, civil society, and foreign and global

players". This complexity and variety of interweaving agendas has been reflected in the ICT4D literature, with many attempting to take stock of the field and providing literature reviews (e.g Burrell & Toyama 2009, Patra et al. 2009, Heeks 2010, Gomez et al. 2012, Andersson & Hatakka 2013, Gallivan & Tao 2013, Gomez & Day 2013, Steyn & Kirlidog 2013, Marathe et al. 2016, Walsham 2017). As noted by Walsham (2017) many of the literature reviews from a decade or more ago focused mainly on the landscape of ICT4D research at the time and discussed future opportunities for ICT4D. Examples include key papers by Walsham & Sahay (2006) and Chrisanthi Avgerou (2008). Walsham & Sahay (2006) discuss the landscape of ICT4D research, provided examples from the existing literature, and discussed future opportunities. Avgerou (2007) claims the ICT4D literature reflects the broad thematic categories of the wider IS field and she tells us that long-standing themes of IS research such as systems development and implementation, IS management, ICT and competitive advantage, IS and organizational change were clearly present in the literature. However, she also proposed that the research stream of IS in developing countries, the nature of its research concerns and on-going debates were poorly understood beyond a circle of specialists. This was presented as a problem as an understanding of the research in developing countries by the wider IS research community was necessary in order to proceed from basic to more elaborate and in-depth research accounts of IS phenomena not only in developing countries but in the world at large.

Avgerou (2008) also identified three main strands of discourse which dominated the ICT4D field at the time her paper was written. Firstly, she identifies the theme of developing countries attempting to catch up with technologies used in more developed countries; secondly, the theme of adapting technologies to local contexts is highlighted; and finally, she identifies the theme of using technology as an enabler. Avgerou (2010) goes on to build on her previous work by conducting a multidisciplinary review of the ICT4D literature in an attempt to identify the nature of ICT innovation processes in developing countries. Similar themes are identified by Donner (2010) who

offers a systematic review of fourteen studies of the use of mobile technology in small and medium sized enterprises. Further notable papers from this time period include Davison et al. (2005) who presented a review of open access journals in developing countries, Wan et al. (2009) who conducted a comprehensive review of 82 single-journal bibliometrics studies conducted between 1998 and 2008, and Hedström (2008) who examined the ICT4D e-government projects literature published between 2004 and 2008. In addition, two literature reviews from Mukherjee (2009) conducted studies of ICT4D related articles published in open access journals in the first half of the 2000s.

However, as noted by Walsham (2017), much has changed over the last decade in terms of themes and focus of the ICT4D academic literature and its various sub-fields. The more recent body of work still includes many detailed surveys of the literature (e.g. Gallivan & Tao 2013, Thapa & Sæbø 2014, Naudé 2016, Naudé 2016, Chipidza & Leidner 2019), but there has been a notable shift in focus towards the setting of a future agenda for the field (Heeks 2014, Heeks 2014, Walsham 2017, Thapa & Omland 2018). In addition, there is an increasing body of work reviewing the literature in the ever-growing sub-fields of ICT4D such as M4D and mHealth (these sub-fields are discussed in section 3.5 below). Furthermore, there is also a shift in focus towards the categorisation of research theories, methods, and topics in ICT4D research (e.g. Andersson & Hatakka 2013, Heeks, Thapa et al. 2018, Heeks & Wall 2018, Chipidza & Leidner 2019) and this is discussed in more detail in Chapter 4.

A recent example of a comprehensive ICT4D based literature review is the work completed by Chipidza (2019). They attempt to better understand how and why ICT projects succeed, as well as asking what success means in the ICT4D context, by conducting a literature review of ICT4D studies published during the period 2000 to 2016. They found that numerous studies focus on how ICT4D projects are conceptualized, designed, and implemented. A second category of articles focused on how the implemented ICT4D artifact is used by target beneficiaries, with a further section of the literature focussing on how the

usage of ICT4D artifacts expanded to more users, communities, and geographical regions. A fourth category of articles examined by Chipidza looked at ICT4D project outcomes, with the final category examining the long-term development outcomes activity of the ICT4D value chain which predominantly occurred at the societal or national levels of analyses.

Also relevant is the work completed by Naudé (2016) which explores the country productivity, collaboration behaviour and citation impact of ICT4D researchers by examining all 378 articles published in the EJISDC over a 14-year period. A further example is also provided by Naude (2016) who conducts a systematic analysis of 378 articles published in the 59 volumes of the EJISDC in the period 2000 to 2013 with the aim of creating a bibliometric profile of the journal by investigating variables such as the article productivity, Web citations and non-Web citations, authorship patterns, background of the authors, institutional collaboration, degree of collaboration, as well as most productive authors and institutions together with their countries and regional affiliations.

Additional recent literature reviews of the field include work carried out by Ramadani (2018) who reviews ICT4D research published between 2007 - 2016 in an attempt to identify the characteristics of ICT4D streams in the literature. A further example is also provided by Ramadani (2017) where theories, contexts, and topics in ICT4D are identified. Furthermore, work completed by Touray (2013) who conducted a systematic literature review of the literature published between 2000 and 2011 which examined the barriers and success factors in ICT4D, and Wan et al. (2009) who conducted a comprehensive in-depth review of 82 single-journal bibliometric studies conducted between 1998 and 2008 covering a wide range of subject disciplines and geographic locations.

3.4.2 Themes in ICT4D Research

As previously mentioned, many of the more recent literature reviews in ICT4D focus on the identification of research themes and topics within the ICT4D body of literature, with a variety of distinct and diverse themes being identified. One

of the main themes since the inception of the field has concerned ICT4D failure, underperformance and success and this is discussed in section 3.4.3 which follows. The other main theme in this body of work concerns M4D and mHealth and this is discussed in section 3.5. This section is concerned with some of the other main ICT4D themes that have been identified in the literature, a variety of which are now discussed.

Ramadani (2018) identifies two distinct ICT4D streams as exploring the social context of ICT4D, and how developing countries can catch up with the rapid technological development in developed countries. In a separate paper, Ramadani (2017) identifies further specific themes in the current body of work as follows: ICT barriers and success factors, ICTD project outcomes, healthcare informatics, e-government adoption and implementation, human computer interaction, and gender issues in ICT4D. Thapa (2014) suggests that the ICT4D body of work focusses on a variety of different subjects including the diffusion of ICT artifacts, infrastructure building and the implementation of ICT services, impact evaluation of ICT interventions, linking ICT and development, and the digital divide. In addition, a variety of other themes can also be identified in the literature including the need to focus more closely on the IT artefact (Orlikowski & Iacono 2001), and the theme of transformation in ICT4D (De', Pal et al. 2018).

One theme of importance involves a topic that has been discussed for many years: that concerning the perceived crisis in IS and ICT4D. This theme has been recently revisited by Walsham (2012) who asks whether or not these fields are in crisis. He suggests that, ironically, this crisis may have been caused by the success of ICTs which have led to concerns that the distinct research contribution of both the IS and ICT4D fields might become lost and that the field itself may decline (Walsham 2012). Walsham also suggests that the IS field needs a core and he issues a unifying call for ICT4D researchers to find such a core to rally around. He even goes so far as to suggest that a unifying core might be built around the question "are we making a better world with ICTs"?

Another identifiable and increasingly important theme is that of ethics in ICT4D, sometimes referred to as E4D. This theme fits very well with what has become known as the political and ethical turns in ICT4D (Heeks & Wall 2018), and involves researchers engaging more with issues of power, rights, and justice in ICT4D. Walsham (2012) suggests that ethical and political questions should include asking how we can use ICTs to support the poor of the world, and can mobile phones enable the poor to access the Internet and thus reduce poverty? This also involves asking who benefits from our research. Also, of importance is the ongoing conversation around personal data and the ethical use of firewalls, data encryption, and biometrics. Such technologies give rise to many privacy concerns around data protection. This includes consideration of the common practice of sharing phones in developing countries where it is not uncommon for a household or neighbours to share a single phone (Rotheram-Borus, Tomlinson et al. 2012). This is likely to be a theme of increasing importance in ICT4D research over the coming years. Furthermore, of increasing importance is the theme of advanced technologies such as artificial intelligence (AI4D) and their use in development.

There has also been much work carried out on the geographical distribution and content of ICT4D literature. One important example is the work completed by Williams (2013) who reviewed a total of 563 papers published between 1990 and 2011, including analysis of 27 articles from the EJISDC, 33 articles from ITID and 11 articles from ITD. He concluded that most papers were contributed by authors from North America, followed by Asia, Europe, Africa, Oceania and Latin America. The prominent countries were the USA (40%) the UK (10%) and India (10%), followed by Australia (5%), Canada (4%) and South Africa (3%). Also of relevance is the work of Gomez (2012, 2013) who conducted an ICT4D content analysis of 948 research papers published between 2000 and 2010, using two conference series and five journals, namely the EJISDC, ITID, ITD, Journal of Community Informatics and the International Journal of Information and Communication Technologies for Human Development. Looking at the geographic distribution of papers results indicated that most papers focused

on India when compared to other countries. Thapa & Sæbø (2014) who conducted a literature review by analysing 80 ICT4D papers came to similar conclusions. They propose that current research in the ICT4D area is mainly conducted in sub-Saharan countries, India and Latin America with large areas of the developing world being under-researched. In particular, they note a lack of research in Arabic countries, other countries in Asia, as well as mountain regions such as Bhutan and Nepal. In addition, the work carried out by Gitau (2010) who examined the participation of African researchers in the field of ICT4D between 1990 and 2009 is also highly relevant. They estimate the African contribution to international ICT4D research and scholarship to be in the region of 1% to 9%.

In addition, the complex social, political, economic, and cultural contexts in which the technology operates (Thapa & Sæbø 2014) has also emerged as a key theme in the literature. The developing country context is complex, characterized by interweaving of actors, agencies, and agendas of political, public, private, and third sector institutions, civil society, and foreign and global players (Njihia & Merali 2013). This facilitates a view of ICT4D as a contextualized social phenomenon and an inherently social process. This ties in with the theme of ICT4D failure, with a great deal having been written about the various socio-political, economic, and cultural reasons that ICTs fail to achieve the potential they represent (Hosman & Armey 2017). Indeed, numerous studies provide examples of ICT4D implementations which have produced insights into what goes wrong (e.g. Avgerou 2007, ICT Works 2017, Keengwe & Malapile 2013, Touray 2013, Ismail 2018). In addition, the adoption of an overtly techno-centric approach without adequate consideration of socio-technical factors (Wall et al. 2013, Wall et al. 2014) is likely to contribute to failure and underperformance of ICT4D and mHealth. The adoption of such techno-centric approaches is made worse by the fact that many mHealth systems are not designed in the developing country in which they are to be implemented but are imported from more developed countries in the Global North.

A further popular theme in the literature is the hardware associated with ICT4D implementations, especially the hardware associated with mHealth. Writing a number of years ago, Wall (2014) reports that many mHealth initiatives use lower-end mobile phones. The most commonly used phones in his study included the Nokia 2700, the Nokia C2-01, and a variety of other low-end Android phones (such as those manufactured by Micromax, Spice, and Karbon). It is suggested that in comparison to higher-end smart phones, mHealth initiatives that make use of low-end mobile phones are arguably better suited to developing countries (Sanner, Roland et al. 2012). Furthermore, factors such as greater affordability, increased local access for repairs and servicing of the phones, lowered susceptibility to theft (Tomlinson, Solomon et al. 2009), more efficient battery power and a greater user familiarity with low-end mobile phones resulting in higher mobile phone literacy, have all been identified as characteristics that make low-end phones particularly adaptable to developing countries (Sanner, Roland et al. 2012). Much of the literature also suggests that solar chargers are becoming increasingly common in areas of poor or sparse power supply (e.g. Hoefman 2000, Boyce 2012, Källander, Tibenderana et al. 2013, McCord, Liu et al. 2013). However, it is suggested that such chargers are problematic for a variety of reasons including their susceptibility to breakage, their inability to charge a fully drained battery, and their ineffectiveness in cloudy or rainy conditions which in some developing countries can last an entire season.

The theme of hardware and software is closely related to discussions about mobile telecommunications infrastructure in developing countries. Despite increasing network coverage, mobile network connectivity in rural areas of many developing countries remains unreliable (Chigona, Nyemba et al. 2012), although there is recognition that there is an increasing availability of mobile coverage and bandwidth across Africa in particular (GSMA 2018). The lack of electricity and a reliable power infrastructure in developing countries is also seen as a constraint (Chetley 2007).

Another topic of interest in the ICT4D body of work concerns software and the importance of localization of the software (Wall, Vallières et al. 2014). The most common mHealth software in developing countries include Internet browsers, interactive voice response (IVR), plain-text SMS, and locally installed handset and SIM card applications (Sanner, Roland et al. 2012). Common examples of mHealth software include MOTECH, ChildCount, CommCare, Text to Change, eMOCHA, and DHIS Mobile (Wall, Vallières et al. 2014). There is also a particular focus on making mHealth software easily understood to the end-user. It is suggested in the literature that this might be achieved by the adoption of a variety of strategies, but unfortunately user-centric design appears to be the exception rather than the rule in mHealth programs (Braun, Catalani et al. 2013). This is closely related to the topic of end-user flexibility when using mHealth hardware and software. This theme concerns the ability of the end-user to use the mHealth hardware or software for personal use or in unexpected ways, for example health workers loading personal content (music, etc) on the phones, using the camera to take pictures, or making personal phone calls. The literature suggests that this can be problematic, as in many instances the end-user will require assistance to reload or fix corrupted and missing software (Pascoe, Lungo et al. 2012). There are a number of strategies available to minimise these risks including burning the application into the internal memory of the mobile handset (Purkayastha 2010).

As already mentioned, another important theme in the ICT4D body of work includes the diverse philosophical, epistemological, theoretical, and methodological positions put forward by ICT4D researchers (Njihia & Merali 2013). This key theme is discussed in detail in Chapter 4. Also, of importance is the ever-expanding theme of ICT4D failure, underperformance and success which is discussed in the following section.

3.4.3 ICT4D Success, Failure and Underperformance

ICT4D success, failure and underperformance has been written about extensively over the last two decades and represents one of the most common

themes in the literature (e.g. Keengwe & Malapile 2013, Touray, Salminen et al. 2013). This body of work includes the reasons why it is difficult to implement, sustain and scale any type of ICT4D project in a developing country context (e.g. Heeks, Mundy et al. 1999, Avgerou & Walsham 2000, Heeks 2003, Walsham & Sahay 2006, Avgerou 2007, Mechael, Batavia et al. 2010, Ismail, Heeks et al. 2018, Ramadani, Kurnia et al. 2018). Indeed, it is suggested by Heeks (2018) that a recurrent figure of 70% of ICT4D projects are classified as a failure. However, it should be noted that this has recently been challenged by the work of Chipidza (2019) who identified an 86% success rate of mobile ICT projects.

ICT4D success, failure and underperformance has already been introduced in section 1.1.1, and the topic of implementing, scaling and sustaining M4D and mHealth specifically is discussed in section 3.5.2 below. This section focusses on the broader category of ICT4D. In previous sections it was suggested that the ICT4D literature provides a great deal of guidance on ICT4D failure and underperformance, with much having been written about the various socio-political, economic, and cultural reasons that ICTs fail to achieve the potential they represent (e.g Avgerou 2007, Hosman & Armey 2017, ICT Works 2017). It is suggested that the failure of ICT4D is a complex process involving multiple stakeholders (Chipidza & Leidner 2019). The reasons offered for failure are many and include lack of infrastructure and lack of skills in the intended beneficiary communities (Chipidza & Leidner 2019). Additional examples are provided by Keengwe & Malapile (2013) who suggest that ICT4D initiatives are likely to face a myriad of challenges, while Touray et al. (2013, p. 11) identify a total of 43 barriers to ICT4D in developing countries including various economic, socio-cultural, infrastructural, political and leadership, legal and regulatory, economical, educational and skills, technical and security and safety barriers. Recent work by Ismail (2018) posits that failure in ICT4D can arise from conflict between the different partners in an ICT4D initiative.

Furthermore, it has been posited that the adoption of an overtly techno-centric approach without adequate consideration of socio-technical factors (Wall et al. 2013, Wall et al. 2014) is likely to contribute to failure and underperformance of ICT4D and mHealth. The adoption of such techno-centric approaches is made worse by the fact that many mHealth systems are not designed in the developing country in which they are to be implemented but are imported from more developed countries in the Global North. The assumption that such technologies will simply fit into the specific environment present in any given developing country and be easily adopted by the user has been described as "fallacy" by Shozi et al. (2012, p. 135). This is because any technological implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technological and ideological factors.

The catalogue of ICT4D failure and underperformance in the literature will likely discourage those implementing ICT4D and mHealth in developing countries. However, the literature does provide many examples of successful ICT4D and mHealth implementations (e.g. Hussain & Brown 2018), with much written on the factors influencing the success of ICT4D projects (e.g. Mozelius, Hansson et al. 2009, Musiyandaka, Ranga et al. 2013, Touray, Salminen et al. 2013). An important example is the work by Touray et al. (2013) who identify a total of 43 barriers to ICT4D success. They propose eight possible critical success factors as follows: socio-cultural, infrastructural, political and leadership, legal and regulatory, economical, educational and skills, security and safety and technical. They highlight lack of Internet exchange points as an important ICT barrier and suggest that ICT barriers in developing countries do not differ to ICT barriers in developed countries to any great extent. Related to this is the work of Julian Bass (2011) who posits that ICT4D success is hampered because effective ICT4D usage requires a human, informational and institutional infrastructure of data, skills, leadership, policy, as well as effective technology. This again brings us back to the importance of a socio-technical perspective in ICT4D and the assertion by Shozi et al. (2012, p. 135) that the assumption that such technologies developed in more developed countries will

simply fit into the specific environment present in any given developing country and be easily adopted by the user has is “fallacy”.

Many other authors have suggested various ways of increasing the chances of ICT4D success. These include Haikin (2013) who talks about the search for a “magic bullet” in ICT4D which will lead to better project outcomes. His work identifies issues and success factors relevant to participatory ICT4D and its potentially empowering role for local communities. In addition, Renken (2013) draws attention to the importance of ICT4D champions who consist of key actors who make a substantial difference to ICT4D projects by putting themselves on the line in order to drive projects forward. He suggests that the presence of such an ICT4D champion is likely to increase the chances of ICT4D success. Furthermore, of relevance is the work of Mozelius (2009) who asks the important question of what makes some ICT4D projects more successful than others. He suggests that the following are crucial for ICT4D successful: authentic local needs, local ownership, realistic limitations, competence network, communication strategy, planning horizon, documentation/measurable results, resources and sustainability, and fun/motivation.

Furthermore, the literature suggests that ensuring ICT4D success is not as simple as applying solutions that have worked in more developed countries, as such solutions need to be negotiated against the needs of developing countries (Braa, Monteiro et al. 1995, Sahay & Walsham 1997, Sahay 1998). The needs of local users and the contexts in which these systems will be used should also be addressed. Those involved in the design, implementation and management of ITC projects and systems in the developing country must improve their capacity to address the specific contextual characteristics of the organisation, sector, country or region within which their work is located (Avgerou & Walsham 2000).

In addition, there are also are many models proposed to increase the chances of ICT4D success. These include the design-reality gap model (Heeks 2002), the set of nine "Principles for Digital Development" (DP 2015), and the set of nineteen critical success factors as outlined by Pade-Khene (2011).

3.5 Mobile for Development (M4D) and mHealth

As outlined in Chapter 1, there has been an unprecedented spread of mobile phones across the world (White, Thomas et al. 2016, Walsham 2017) with such technologies now being pervasive and ubiquitous in many developing countries (Sahay, Sein et al. 2017, Heeks 2018). This has contributed to an explosion in the use of ICTs in such developing environments (Walsham 2017) which is important as significant emphasis is now being placed on the role that ICT can play in addressing the many challenges existing in the areas of healthcare, emergency management, and food and water security (Masiero 2018). The potential of ICT to address the challenges in healthcare and to provide access to health-related services is recognised as a significant factor in achieving the SDGs (Hurt, Walker et al. 2016). Mobile technologies are seen as key to this, and it is evident that mobile phones play an important role in improving access to healthcare service delivery in rural and remote settings (Khatun, Heywood et al. 2016). mHealth offers an unprecedented opportunity to transform the health services available to people across the globe (Latif, Rana et al. 2017), and has tremendous potential to impact health care delivery and health outcomes in developing countries (White 2016). In addition, mHealth interventions promise improved health care delivery (Benferdia & Zakaria 2014, Beratarrechea, Moyano et al. 2017), the potential to transform health services and to increase access to healthcare in developing countries (e.g. Agarwal, LeFevre et al. 2016, Hurt, Walker et al. 2016, Beratarrechea, Moyano et al. 2017, Latif, Rana et al. 2017), and vast improvements in healthcare delivery in developing countries (Kenny, Heavin et al. 2017). Specifically, mHealth has been proposed as an effective solution to improve maternal and neonatal health (Sondaal, Browne et al. 2016), and to impact chronic disease management (Hurt, Walker et al. 2016) in such environments.

Taking all of this into account it is not surprising that these levels of enthusiasm combined with the interest shown by development agencies, researchers, and policy makers (Benferdia & Zakaria 2014) have led to the rapid proliferation of mHealth solutions (Agarwal, LeFevre et al. 2016), with the number of mHealth projects being implemented in developing countries increasing dramatically (e.g. Purkayastha, Manda et al. 2013, Khatun, Heywood et al. 2016, Sundin, Callan et al. 2016, White, Thomas et al. 2016, Cameron, Ramaprasad et al. 2017). mHealth is now a common approach to improve healthcare access in developing countries (Sundin, Callan et al. 2016), and there are increasing numbers of mHealth projects being implemented for healthcare delivery, disease surveillance, health education, and training of the health workforce (Khatun, Heywood et al. 2016). The World Bank has reported that there were more than 500 mHealth projects in developing countries in 2011 alone (Agarwal, LeFevre et al. 2016), with countries such as Bangladesh having more than 20 mHealth initiatives in place in 2015 (Khatun, Heywood et al. 2016).

Thus, it is not surprising that the potential for mobile technologies in developing countries has resulted in a large increase in publications in the ICT4D field over the last 20 years (Heeks 2010, Gomez 2013). One of the fastest growing topics is the use of mobile phones for development (Duncombe 2009), with mHealth research growing exponentially in recent years (Cameron, Ramaprasad et al. 2017). Toyama (2010, p. 13) talks about the "enthralment" with the topic of mobile phones in the ICT4D literature and Gomez (2013, p. 17) concludes that studies about mobile phones are gaining momentum so rapidly that "if they continue growing at the current pace, they will outnumber studies of all other technologies put together". Gomez (2013) also reports on a content analysis of 948 papers from selected peer reviewed journals and conferences published in the academic literature on ICT4D and discovers that the "shift in focus toward mobile phones and away from information systems or software is remarkable" Gomez (2013, p. 7). Agarwal (2016) supports this assertion by suggesting that there are hundreds of mHealth studies and initiatives. When this is considered in light of reports of an increase in the use

of mHealth applications, many of which are primarily designed for use in developing countries (MacLeod, Phillips et al. 2012, Chatfield, Javetski et al. 2013), the trend towards mobile in the ICT4D literature should not be surprising.

Despite the growth in mHealth research and publications in recent years, Walsham (2017) cautions that we do need to be careful of claims made concerning the effects of mobile phones in the Global South. This may be because the research on mHealth has been ad-hoc and selective without a clear definition of the mHealth domain (Cameron, Ramaprasad et al. 2017). In addition, it has been claimed that the growth of mHealth in developing countries is rather slow and no existing studies have conducted an in-depth search to identify the reasons for mHealth success or failure (Latif, Rana et al. 2017). More worryingly, it is claimed that there remains a lack of rigorous and high-quality evidence on the effectiveness of mHealth interventions in developing countries (Agarwal, LeFevre et al. 2016, Hurt, Walker et al. 2016). This is a problem, as without a roadmap for research the full potential of mHealth may not be realised (Cameron, Ramaprasad et al. 2017). Despite this however, the potential of mHealth in developing countries is widely recognised and is now discussed in the section which follows.

3.5.1 The Potential of mHealth in Developing Countries

Despite the concerns expressed in the previous section, there are many potential advantages and benefits of mHealth in developing countries and these have been written about extensively in the ICT4D body of work. According to the literature, mHealth has the potential to bridge the systemic gaps needed to improve access and use of health services among underserved populations (Agarwal, LeFevre et al. 2016). Khatun (2016) reports that mHealth can improve the speed of access to qualified healthcare providers, thus saving time and reducing cost. mHealth has also shown positive changes in clinical outcomes, adherence, and health communication, as well as decrease in travel time for both health workers and patients, increased ability

to receive expert advice, and new forms of cost-effective education (Hurt, Walker et al. 2016).

In addition, mHealth has the potential to improve timely health data collection and transfer (Tomlinson, Solomon et al. 2009) and can improve supply chain management of essential drugs and diagnostic tools, thus helping to prevent stock-outs in already poorly resourced health centres (Barrington, Wereko-Brobby et al. 2010). Moreover, mHealth can facilitate disease surveillance and improve the ability to identify and manage disease outbreaks and epidemics through more time-efficient health information systems (Robertson, Sawford et al. 2010). mHealth can also allow for more efficient diagnosis and greater adherence to medicines, medical procedures and protocols (DeRenzi, Lesh et al. 2008, Routen, Silas et al. 2010), as well as help in making appointments, and providing caregivers with tools to better monitor and care for patients (Benferdia & Zakaria 2014). mHealth can also enhance case-management and offer a greater continuity of care for patients through better access to patient histories and electronic medical records (Rotheram-Borus, Richter et al. 2011), improve patient communication (Siedner, Haberer et al. 2012) and provide medical adherence support (Pop-Eleches, Thirumurthy et al. 2011, Zurovac, Sudoi et al. 2011). In the case of medical emergencies, mHealth can strengthen referral systems, thus reducing the delays faced by patient travel (Tamrat & Kachnowski 2012). mHealth can also facilitate transmission of health data more quickly, easily and cheaply than the physical transport of paper-based systems. This is because for many health centre workers in developing countries it is not uncommon for health data to be recorded in several paper registers before being manually aggregated and physically transferred from the health centre to district level management teams prior to being digitized and aggregated for analysis (Purkayastha 2010). Poor road infrastructure combined with a lack of access to transport can also make the recording, care and transport of this data a difficult and expensive process. mHealth has the potential to send health information via mobile phones which can address

some of these structural barriers prevalent across all levels of a health system (Tomlinson, Solomon et al. 2009).

mHealth can also strengthen referral systems and reduce the delays faced by patient travel (Tamrat & Kachnowski 2012). In addition, mHealth can improve supply chain management of essential drugs and diagnostic tools, thus helping to prevent stock-outs in already poorly resourced health centres (Barrington, Wereko-Brobby et al. 2010). mHealth also has the ability to bridge the distance and time gap between the urban and the rural and to overcome difficult terrain and poor infrastructure. In an environment where interaction and the exchange of information has increasingly become stretched across time and space, mHealth has the potential to fulfil a demand for immediate communication as well as for control over the exchange and use of information. Additionally, mHealth offers new ways of transmitting and accessing data anywhere and at any time. As such, mHealth is opening up new opportunities for communication, facilitating innovative new work practices and empowering people to make things happen. mHealth systems can also improve the timeliness of data collection and transfer (Tomlinson, Solomon et al. 2009) and such systems are playing a central role in education and training programmes for both healthcare workers and patients, epidemic outbreak tracking and diagnostic and treatment support (Vital Wave Consulting 2009). Furthermore, mHealth can lead to an improved ability to identify and manage disease outbreaks (Robertson, Sawford et al. 2010) and can improve patient communication (Siedner, Haberer et al. 2012), provide medical adherence support (Zurovac, Sudoi et al. 2011, Pop-Eleches, Thirumurthy et al. 2011), as well as enhancing case management and offering a greater continuity of care for patients through better access to patient histories and electronic medical records (Rotheram-Borus, Richter et al. 2011).

Moreover, mHealth has the potential to address issues of motivation, retention and support of health workers (Wall, Vallières et al. 2014). It can do this through better time efficiency and improved health worker support (Källander,

Tibenderana et al. 2013). In the case of developing countries, where many governments rely on lower cadres of health workers such as CHWs, mHealth is seen as a promising tool to help support community level health programs (Strachan, Källander et al. 2012). Given that CHWs vary considerably in terms of their training, experience and literacy levels, the availability of timely clinical information, learning materials and regular household visit reminders are seen as important mHealth tools that can be used to empower CHWs in their role bridging communities and formal health systems (Braun, Catalani et al. 2013, Källander, Tibenderana et al. 2013).

3.5.2 Difficulties Implementing, Sustaining and Scaling mHealth

Despite the potential of mHealth as discussed in the previous section, the majority view would seem to be that most mHealth projects do not survive beyond the initial pilot phase even though they are supported with strong financial, logistical and clinical support from NGOs, government ministries and private actors (Wall, Vallières et al. 2014, Sundin, Callan et al. 2016). It has been shown many times that the design, implementation and adoption of mHealth in developing countries is not without a wide range of challenges and risks (Kahn, Yang et al. 2010, Chigona, Nyemba et al. 2012, Manda & Msosa 2012). This has become clear over the last two decades as it has become increasingly evident just how difficult it is to implement, scale and sustain mHealth projects beyond pilot (Anderson & Perin 2009, Curioso & Mechael 2010). Even in the case where mHealth initiatives manage to progress beyond pilot phase, many fail to achieve success at scale (Anderson & Perin 2009, Curioso & Mechael 2010). A report by Anderson & Perrin (2009) analyses the outcomes of 51 "mHealth for development" projects. Of the 51 projects, only 7 were classified as potentially being at scale, with the other 44 projects being classified as either pre-deployment, completed pilot, or continuing pilot. In contrast to this majority view, recent work by Chipidza (2019) identifies 86% of mobile ICT projects as complete successes. This may indicate that the chances of successfully implementing and scaling mobile ICT projects, including mHealth projects, is increasing.

The literature provides extensive comment and guidance on the underperformance and failure of mHealth. A great deal has been written about the various socio-political, economic, and cultural reasons that mHealth fails to achieve the potential it represents, with numerous studies and examples of mHealth implementations which have produced insights into what goes wrong. The reasons for failure are many and diverse. Khatun (2016) posits that illiteracy, lack of English language proficiency, combined with lack of trust and technological incapability impede mHealth success. Touray et al. (2013, p. 11) identify a total of 43 barriers to ICT4D in developing countries including various economic, socio-cultural, infrastructural, political and leadership, legal and regulatory, economic, educational and skills, technical and security and safety barriers. The importance of training to the success of mHealth is highlighted by Kenny et al. (2017). They suggest that without adequate training, healthcare workers are likely to resist adopting mHealth as they may lack the skills necessary to adopt the mHealth solution (Kenny, Heavin et al. 2017).

Further reasons are put forward by Ismail (2018) who posits that failure in ICT4D can arise from conflict between the different partners in an ICT4D initiative. In addition, Latif et al. (2017) present a comprehensive report concerning the factors hindering the growth of mHealth in developing countries. They suggest that there are seven main barriers to mHealth as follows; inadequate health literacy, cultural and language barriers, lack of skilled medical staff, lack of infrastructure, cost, limitations for crowdsourcing, and phone battery life. Ahmed (2017) provides guidance by reporting on what is required for mHealth success which includes the availability of technical support, good network coverage, user-friendliness of the applications, and the replacement of failing or lost telephones and batteries. They also highlight motivation of the health workers, an adequate level of literacy, and adequate financing of the project as being factors which are likely to increase acceptance of the technology (Ahmed, Gagnon et al. 2017).

One key theme in the literature concerns the adoption of an overtly techno-centric approach without adequate consideration of socio-technical factors (Wall, Vallières et al. 2013, Wall, Vallières et al. 2014). A techno-centric approach is highly likely to contribute to failure and underperformance of ICT4D and mHealth (Wall, Vallières et al. 2013, Wall, Vallières et al. 2014). The adoption of such techno-centric approaches is made worse by the fact that many mHealth systems are not designed in the developing country in which they are to be implemented but are imported from more developed countries in the Global North. The assumption that such technologies will simply fit into the specific environment present in any given developing country and be easily adopted by the user has been described as fallacy (Shozi, Pottas et al. 2012, p. 153). This is because any mHealth implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technological and ideological factors.

The issue of techno-centric approaches has also been discussed by Wickramasinghe (2018) who view mHealth implementation as a difficult and complex process. They suggest that mHealth is much more than an adoption of technology and it involves people issues more than technological issues, with such people issues being primarily to blame for the unsuccessful efforts of mHealth implementations (Wickramasinghe 2018). Malvey et al. (2017) also discuss socio-technical issues and suggest that local health policy, as opposed to technology, represents the main challenge when implementing mHealth. In addition, they propose that emerging and future challenges to mHealth include demographics, resource scarcity, various regulatory considerations, and payment and security issues (Malvey & Slovensky 2017).

Furthermore, it has been suggested that the implementation of mHealth programs is predominantly led and funded by NGO and government bodies and mainly takes the form of short-term pilot projects (McNamera 2003, Curioso & Mechael 2010, Kahn, Yang et al. 2010). Such an externally driven proliferation of pilot programs has led to many paralleled and uncoordinated efforts in

developing countries (McCann 2012) and this has resulted in claims that the mHealth sector suffers from a particularly debilitating case of “pilotitis” (Kuipers, Humphreys et al. 2008).

The proliferation of top-down implementation approaches which exclude local users who will have to use the mHealth systems, the environmental conditions existing in many developing countries, and various other cost-related considerations have also been put forward as reasons for mHealth underperformance (Braun, Catalani et al. 2013). Changes to protocol are typically enforced by a person of authority with the aim of ensuring health workers adhere to policies, protocols, and workflows as a requirement. As such, many programs miss an opportunity to enhance both health worker and patient participation in the design and implementation processes (Braun, Catalani et al. 2013). Though important to obtain buy-in from key decision makers and managers in order to introduce new technology into an existing workflow, adoptability is increased when end-users are made part of the design and implementation process (Høstgaard, Bertelsen et al. 2011, Darby, Black et al. 2012). Such top-down approaches adopt a techno-centric outlook which starts with the technology and attempts to make it fit into the local environment. This approach is made worse by the fact that many mHealth systems are not designed and developed in the developing country in which they are to be implemented but are imported from more developed countries in the Global North.

The literature also suggests that cost and financial considerations remains one of the most significant barriers to mHealth implementation and scaling in developing countries. Availability of adequate funding is essential if technology driven interventions are to be maintained (Lucas 2008). This is not always easy to achieve, and costs may not be readily discernible from the results of any pilot implementation (Lucas 2008). There are many examples of mobile solutions where costs remain unknown because the mHealth project has never been brought to scale (Manda & Msosa 2012). Cost also has important

implications for the implementation and scale-up of mHealth programs (Sanner, Roland et al. 2012). Increasing mobile phones in circulation as part of an mHealth program has important implications for the number of training sessions, training manuals, as well as both hardware and software updates. There is some evidence that technological interventions are heavily reliant on external financial support and thus prone to collapse as soon as external funding ceases to exist (Manda & Sanner 2012). If an mHealth solution is going to be widely adopted by health service providers across different cadres, it must be seen to provide tangible benefits (Archer 2009), offering savings in terms of both time and out of pocket expenditures (Purkayastha 2010). Features such as remote diagnosis and digital health data entry can also significantly reduce travel time and opportunity costs and imply potential savings for patients and health workers alike.

Finally, the specific type of hardware and software suitable for mHealth is also discussed in the literature. In comparison to higher-end smart phones, mHealth initiatives that make use of low-end mobile phones are arguably better suited to developing countries (Sanner, Roland et al. 2012). Factors such as greater affordability, increased local access for repairs and servicing of the phones, lowered susceptibility to theft (Tomlinson, Solomon et al. 2009), more efficient battery power and a greater user familiarity with low-end mobile phones resulting in higher mobile phone literacy have all been identified as characteristics that make low-end phones particularly adaptable to developing countries (Sanner, Roland et al. 2012). The lack of electricity in developing countries is also seen as a constraint (Chetley 2007) and this is why it is suggested in the literature that solar chargers are becoming increasingly common in areas of non-existent or sparse power supply (Hoefman 2000, Boyce 2012, Källander, Tibenderana et al. 2013, McCord, Liu et al. 2013).

This paints a bleak picture for those charged with implementing, sustaining and scaling ICT4D and mHealth in developing countries. However, as already mentioned the recent work by Chipidza (2019) who identified 86% of mobile

ICT projects as complete successes gives hope that ICT4D implementors are beginning to get things right. This may be because of the many examples of successful ICT4D and mHealth implementations that can be found in the literature which have managed to sustain and achieve success at scale (e.g. Hussain and Brown 2018). There has also been much written on the factors influencing the success of ICT4D projects (e.g. Mozelius, Hansson et al. 2009, Musiyandaka, Ranga et al. 2013), with many models proposed to increase the chances of ICT4D success. These include the design-reality gap model (Heeks 2002), the set of nine "Principles for Digital Development" (DP 2015), and the set of nineteen critical success factors as outlined by Pade-Khene (2011).

3.6 Summary

The previous sections have provided a review of the body of work concerning ICT4D and mHealth. The following sections will identify gaps in the literature and make a number of suggestions for a future research agenda for ICT4D and mHealth research.

3.6.1 Gaps in the Literature

As shown in the previous sections there is a significant and growing body of research in the fields of ICT4D and mHealth in developing countries (Duncombe 2009, MacLeod, Phillips et al. 2012, Chatfield, Javetski et al. 2013, Agarwal, LeFevre et al. 2016, Cameron, Ramaprasad et al. 2017). Despite this however, Walsham (2017) suggests that there are still many questions remaining without clear answers in these fields including the important question as to the manner in which the benefits of ICTs can be spread more widely in society Walsham (2017).

There are also many other gaps and questions remaining unanswered in the ICT4D field. The claim has been made that there remains a lack of rigorous, high quality evidence on the efficacy and effectiveness of ICT4D and mHealth interventions (Agarwal, LeFevre et al. 2016). This is supported by Hurt (2016) who proposes that existing mHealth studies are very diverse and that there is

currently little evidence on mHealth interventions in developing countries. The claim is also supported by Sondaal (2016) who identifies a specific gap concerning the lack of work on assessing mHealth's impact on maternal and neonatal outcomes. Furthermore, a paucity of studies which explore the impact of mHealth and the challenges facing these solutions in a developing world context is identified by Kenny et al. (2017). Similar gaps are identified by Thapa (2018) who proposes that existing ICT4D studies tend to be descriptive or prescriptive in nature, and that this gives rise to the absence of any questions as to how and why ICT works in the context of developing countries.

The issue of how we as researchers theorize what is happening in ICT4D in a compelling way is raised by Walsham (2017). Contributing to this is the issue of the manner in which ICT4D and mHealth is theorized, with Duncombe (2012) pointing to a lack of variety in conceptual and methodological approaches adopted by researchers in this field, and Heeks & Wall (2018) highlighting the lack of philosophical approaches which extend beyond the philosophical duopoly of interpretivism and positivism in ICT4D research. This philosophical gap is also recognised by Thapa (2014) who suggests that the ICT4D research literature is thus far dominated by qualitative- and quantitative-based case studies.

Other gaps in the literature are identified by a variety of authors including Thapa (2014) who highlights the need for clarification of the link between ICT and development. In addition, Walsham (2017) suggests that we need to know more about the extent to which ICTs are contributing to development, as does (Zheng, Hatakka et al. 2018) who proposes that ICT4D researchers frequently lack nuanced appreciation of the meaning and context of development. A further gap is identified by Thapa (2014) who puts forward the notion that social-cultural issues such as de-politicization, corruption, caste structures, and context-dependent power structures are currently less investigated in the ICT4D field. Moreover, the need for additional research on the digital divide, gender issues, and the rural versus urban argument is urgently needed (Thapa

& Sæbø 2014). Finally, Sondaal (2016) identifies a specific gap as the lack of work on assessing mHealth's impact on maternal and neonatal outcomes as the mHealth case is designed around a maternal and child health programme.

3.6.2 Future Agenda for ICT4D Research

It has been recognised for many years that there is a need for new research priorities in the field of ICT4D (e.g. Walsham 2012, Heeks 2014, Thapa & Sæbø 2014, Walsham 2017). This has led to many calls for a future agenda for ICT4D research (e.g. Walsham 2012, Heeks 2014, Heeks 2014, Thapa & Sæbø 2014, Walsham 2017, Heeks 2018), as it is not enough to pursue the traditional agenda in future if the broader IS field, and thus the ICT4D field, is to remain an exciting one with a vision which can inspire and unite (Walsham 2012).

One of the key questions arising is how do we as researchers make a better world with ICTs? This question has been put forward by both Thapa (2018) and Walsham (2012, 2017) and involves setting a new agenda which prioritises seeking to understand how ICT4D can lead to sustainable development for societies and their inhabitants. This new agenda may be achieved through least two different avenues, firstly by developing greater knowledge about ICT4D and secondly through the practical contributions to development that research may provide (Thapa & Omland 2018). It may also be achieved by renewing the broader ethical agenda in ICT4D research (Walsham 2012).

Another way to achieve this may be through the adoption of a transdisciplinary or multidisciplinary perspective in ICT4D research (Walsham 2017, Zheng, Hatakka et al. 2018). This involves welcoming other disciplines with open arms (Walsham 2012) and with respect (Walsham 2017). This is important because it will expand the ICT4D field of study into many non-traditional settings (Walsham 2012). According to both Zheng (2018) and Walsham (2017) such linkages should be developed between ICT4D and the fields of computer science, development studies, ethics, anthropology human geography, development economics and rural development. These links are needed as the

nature of ICT4D and the technologies being used is dynamically evolving, with social media, artificial intelligence and the internet of things (Zheng, Hatakka et al. 2018), as well as mobile sensing devices to automate the logging of personal health states (Benferdia & Zakaria 2014), crowd sourcing for health (Heeks 2014, Latif, Rana et al. 2017), increasing amounts of big data, open data and real-time data, as well as 3D printing (Heeks 2014), and artificial intelligence (Zheng, Hatakka et al. 2018) becoming more common in developing countries.

A further important future research agenda for ICT4D addresses what Heeks & Wall (2018) refer to as the philosophical duopoly of positivist and interpretivist approaches that currently dominate ICT4D research. This may involve the rejecting of these dominant methodological paradigms (Walsham 2012) in favour of a move towards more critical approaches (Walsham 2012, Heeks, Thapa et al. 2018, Heeks & Wall 2018). There are many reasons for this move including the claim that positivism is too restricted to address this new world of ICT4D (Walsham 2012). The move towards critical approaches in ICT4D research is discussed at length in Chapter 4 below.

A less pleasant future agenda for the ICT4D field is what Zheng (2018) refers to as the "dark side" of ICT4D. This involves ICTs used for surveillance and control, which includes big data, social media and cloud computing. Such technologies will further enhance the capacity of authorities and commercial entities to access a wide variety of personal data (Zheng, Hatakka et al. 2018). Zheng (2018) claims that there is little discussion on this important issue, and also on the implications of ICT4D which may be controlled more frequently by capital and commercial interests in future. In addition, there is the possibility that such technology will be used by governments to enforce their ideologies and maintain control of populations in a variety of ways. This is particularly relevant as the application of artificial intelligence may in the near future have a dramatic effect on developing countries (Zheng, Hatakka et al. 2018).

Finally, is the claim that here is a significant amount of reinvention of the wheel in ICT4D research (Zheng, Hatakka et al. 2018), with new entrants to the field tending to neglect earlier research for the reason that technologies have changed rapidly. Taking stock of ICT4D research and capitalising on existing knowledge may enable the field to move forward quicker without repeating earlier pitfalls (Zheng, Hatakka et al. 2018).

Chapter 4: Research Paradigms in ICT4D Research

4.1 Introduction

There has been scant consideration of research paradigms in ICT4D research. The little amount of consideration and engagement that has occurred has shown a dominance of positivist and interpretivist approaches (Heeks & Wall 2018). This philosophical duopoly results in limitations and weaknesses that could potentially constrain ICT4D research. This chapter examines a "third way" research paradigm, namely critical realism. An argument is made that the critical realist philosophical approach is both suitable and particularly appropriate for use in ICT4D research. The main strengths and advantages of the paradigm for ICT4D research are then presented. The generic values of the critical realist paradigm include exposure of context, a contingent causality that reflects real-world ICT4D experiences, support for use of theoretical frames in ICT4D, legitimisation of different stakeholder views and reduction of research bias. An additional strength of the paradigm is support for ICT4D's interventionist approach and its goal of delivering international development. Furthermore, specific values in addressing current trends in ICT4D research are highlighted. These strengths of critical realism in ICT4D research are presented in section 4.3 and are analysed based on the four main differentiators of research paradigms as proposed by Cresswell (2013), i.e. ontological value, epistemological value, methodological value, and axiological values of the paradigm. The chapter concludes with consideration of the challenges associated with using critical realist-based philosophical approaches in ICT4D research, before arriving at the conclusion that delivery of critical realism's utility will require the ICT4D research community to take actions that enable this emergent research paradigm to flourish.

4.2 Research Paradigms in ICT4D Research

As noted in Chapter 3 there is an ever-growing body of literature in the ICT4D field. Although many topics and themes exist in this body of work there is a lack of explicit consideration of research philosophy in general and of research paradigms specifically (Gomez & Day 2013, Heeks & Wall 2018). It is claimed that this lack of deeper reflection, whilst understandable, is problematic (Heeks, Thapa et al. 2018). This is important as any research paradigm adopted guides research in a particular direction and can "delineate fundamentally different ways of seeing the world and carrying out research" (Saunders 2016, p. 142). Furthermore, the research paradigm adopted shapes the researchers view of the world: it determines the nature and type of the research questions that can and can't be asked, the methodologies that should and should not be used, and the manner in which we analyse our data and present our findings (Hughes 2016). Research paradigms and philosophical perspectives are therefore important as they determine what we see and do not see, and what we do and do not do in ICT4D research (Heeks & Wall 2018).

This lack of explicit consideration of research philosophy and paradigms poses a challenge to identifying the particular paradigms in use in ICT4D research. Despite this, analysis has taken place (Gallivan & Tao 2013, Gomez & Day 2013) which shows that both interpretivist and positivist approaches dominate the current body of ICT4D work (Walsham & Sahay 2006, Gomez & Day 2013). Heeks & Wall (2018, p. 2) refer to this as the "philosophical duopoly" within ICT4D and express concerns that each of these paradigms has limitations and weaknesses which could potentially constrain ICT4D research. These criticisms have been the subject of debate, particularly within the social science community, for many years and may be jokingly summed up by the claim that "positivism is useful but not true, and interpretivism is true but not useful". Although this debate about the relative merits and weaknesses of positivism and interpretivism has been ongoing for a long time it is interesting to note some scholars have argued that many of the alleged metatheoretical

differences between positivism and interpretivism are spurious (e.g. Weber 2004).

This is not to say that positivism and interpretivism are universally criticised. Both paradigms have their advocates, but it has been suggested that absolutist claims for one or the other approach are mistaken (e.g. Lin 1998), with the major weaknesses and limitations associated with positivism and interpretivism being frequently pointed out by many authors (e.g. López 2005, Carlsson 2009, Archer, Bhaskar et al. 2013). One of the most serious concerns expressed is that both philosophical approaches suffer from the "epistemic fallacy", i.e. that they reduce statements about reality to statements about human knowledge of that reality, thereby assuming that what exists is only what we observe and experience (Fletcher 2016). In other words, the "epistemic fallacy" represents an attempt to analyse ontological statements in terms of epistemological statements and is caused by the failure of both positivism and interpretivism to recognize the fundamental difference between ontology and epistemology. Positivism in particular has been heavily criticised in this regard as it argues against the existence of any objective reality, assuming that the social world exists externally and that its properties can be measured through objective methods. Although this is a perfectly valid philosophical position to adopt, this stance is problematic within the field of ICT4D where supposedly objective empirical methods could in practice be subject to social influence and bias (Kanellis & Papadopoulos 2009). A further criticism of positivism is that its initial suppositions tend to be arbitrary and that they are not derived from logic. These criticisms of positivism have prompted some to claim that it is "near obligatory for self-respecting social scientists to distance themselves from positivist approaches" (Keat 1980, p. 1). These and other criticisms have resulted in calls for a need to move "beyond-positivism" (e.g. Rutzou 2016, p. 327).

Equally, the interpretivist paradigm has its detractors with many seeking to move beyond interpretivism. The paradigm seeks culturally derived and

historically situated interpretations of the social world. The belief is that if we want to understand social action, we have to understand the meanings ascribed to those actions by people. Similar to positivism, this philosophical approach has been criticised by many. Specifically, interpretivism takes "the view that 'reality' is not objective and exterior but is socially constructed and given meaning by people in their daily interactions with others ... [it] focuses on the ways that people make sense of the world especially through sharing their experiences with others via the medium of language" (Easterby-Smith 2015, p. 52). Again, this leads us towards the "epistemic fallacy" as the interpretivist philosophical position assumes that subjective phenomena can be understood through the meanings ascribed to them by individuals. Moreover, interpretivist approaches have been criticised because of the highly subjective nature of the approach which is heavily influenced by the personal perspectives of the researcher. In addition, it is claimed that such approaches leave room for researcher bias and fail to provide causal and generalisable explanations of social phenomena (Bevir 2005, Smith 2005).

These, and many other, concerns about the philosophical duopoly of positivism and interpretivism have led many scholars to claim there is a "crisis in the social sciences" (Rutzou 2016, p. 327). This perceived crisis has resulted in the search for a "third way" research paradigm (Allen, Brown et al. 2013, p. 835) beyond both positivism and interpretivism, and has led to calls for the greater use of the critical realism paradigm in ICT4D research (e.g. Heeks & Wall 2018, Thapa & Omland 2018). Critical realism and ICT4D research are discussed in detail in the following section.

4.3 Critical Realism in ICT4D Research

As seen from the previous section many would seem to be the appetite to move beyond both positivism and interpretivism, with this appetite being particularly strong in the social sciences. The search for what has become known as a "third way" research paradigm (Allen, Brown et al. 2013, p. 835) has resulted in calls for more critical work and approaches in both IS and ICT4D

research (e.g. Dobson, Myles et al. 2007, Walsham 2007, Mingers, Mutch et al. 2013, Heeks & Wall 2018), with critical realism being proposed as one such approach (Allen, Brown et al. 2013). Rutzou (2016, p. 331) summarises this position by suggesting "the current situation is an invitation towards a more reflexive social science based in the need to be critically realist, and critical realism certainly seems to provide a number of compelling solutions". Critical realism was originally developed as an alternative to traditional positivist and constructivist models of social science (Carlsson 2009). Indeed, Carlsson (2009) suggests that critical realism was primarily developed as an answer to the positivist crisis. Whether or not this is the case, it has been suggested that "social science needs to become critical realist" (Rutzou 2016).

It could be argued that the search for a third way research paradigm is particularly relevant to the ICT4D field, and that this field too needs to become more critical realist. It is claimed that critical realism can address the "frequent clashes" between positivist and interpretivist paradigms within the sub-discipline (Burrell & Toyama 2009, p. 89). Furthermore, the nature of ICT4D research is highly contextual (Prakash 2007) and is heavily dependent on the social, cultural and political conditions existing in the local environment. Many authors have argued that positivist models and frameworks examining technology implementation do not consider the socio-political contexts in which they are deployed (e.g. Njihia & Merali 2013, Wall, Vallières et al. 2013) nor how these socio-technical factors may influence the acceptance and use of the technology. Critical realist approaches are better equipped to take these socio-technical factors into account, and this is discussed in greater detail in the sub-sections which follow.

Whether or not social science needs to become more critical realist, it is clear that critical realism has been appearing more frequently in the IS literature over the last two decades and its use is growing in the field (Mingers et al. 2013). Despite this however, it is claimed that critical realism is still being used by "relatively few scholars" in IS research (Allen, Brown et al. 2013, p. 836) and

there does not appear to be much reliance on the critical research approach in ICT4D (De', Pal et al. 2018). Whether or not critical realism is being used by few scholars, there is no doubt that the paradigm is growing in importance in both IS and ICT4D research. The growing importance of critical realism in the IS field is evidenced by the publication of a special edition of MISQ (vol. 37, no. 3, 2013) devoted to the topic. This growth in the use of critical realism in IS research may be because such a perspective "holds much appeal for social scientists" (Raduescu & Vessey 2008, p. 38) and is "particularly attractive for the study of IS" (Zachariadis, Scott et al. 2013, p. 856). Thus, it should come as no surprise that there is a growing interest in critical realism in IS research (Carlsson 2009), and that critical realism is "emerging as a potentially important stream in information systems research" (Myers & Klein 2011, p. 27). This view is also accepted by Wynn & Williams (2012, p. 787) who state that "critical realism is emerging as a viable philosophical paradigm for conducting social science research" which according to Wynn & Williams (2012, p. 805) will "continue to gain acceptance in IS research, leading to several opportunities for subsequent researchers to extend the proposed methodological principles".

Despite the growing importance and increased frequency of critical realism in the fields of IS and ICT4D, to date there has been little consideration of the specific strengths and advantages of critical realism for IS and ICT4D research and practice (Heeks & Wall 2018). This is changing however, and critical realism is slowly beginning to gain traction in the ICT4D field in particular. This is evidenced by the publication of a recent special edition of EJISDC (Vol. 84, issue 6, 2018) co-edited by Richard Heeks, Devinder Thapa, and P.J. Wall which aims to investigate the role critical realism can play in ICT4D research. Critical realism is also beginning to make an appearance in the other main ICT4D journals and conferences, and there are also many critical realist-based ICT4D papers appearing in other mainstream IS journals and conferences.

A critical realist approach has specific strengths and advantages for both IS and ICT4D research. It has been claimed that critical realism can add to IS research by opening up a particular methodological space that lies between empiricism and interpretivism (Mingers 2004). This may be because the critical realist accepts an ontology which includes observable entities and underlying structures which are similar to positivists and interpretivists (Bhaskar 1998), but "leverages elements of both to provide new approaches to developing knowledge" (Wynn & Williams 2012, p. 787). For this and other reasons, critical realism has been proposed as a way to transcend a number of inconsistencies between the stated philosophical assumptions and the actual practice of IS research under both positivism and interpretivism (Smith 2006).

Other specific advantages associated with use of the critical realist paradigm have been proposed by Mingers (2013). He suggests three specific advantages of the paradigm as follows:

1. Critical realism defends a strongly realist ontology that there is an existing, causally efficacious, world independent of our knowledge. The paradigm defends this position against both classical positivism other various forms of constructivism.
2. Critical realism recognizes that our access to this world is limited and always mediated by our perceptual and theoretical lenses. It accepts the notion that that knowledge is always local and historical, with this being known as epistemic relativity. The paradigm also accepts that all viewpoints must be equally valid, with this being referred to in the literature as judgmental relativity.
3. Critical realism accepts the existence of different types of objects of knowledge, and these could be physical, social, or conceptual. These different types of objects of knowledge have different ontological and epistemological characteristics, and thus they therefore require a range of different research methods and methodologies to access them.

Alongside these generic strengths and advantages of critical realism, it is clear that the paradigm has the potential to bring much to the ICT4D field specifically. It has been suggested that critical realism can be viewed as a means to building solid explanations in social sciences at large and particularly in the discipline of ICT4D (Masiero 2018). Furthermore, the emancipatory value of this approach is seen as an asset to ICT4D research as such an approach brings ontological realism combined with epistemological relativism, and an iterative, pluralist, and reflexive methodology (Heeks & Wall 2018). Specifically, there are two main strengths of critical realism for ICT4D research. Firstly, there are specific generic values including exposure of context, a contingent causality that reflects real-world ICT4D experiences, support for use of theoretical frames in ICT4D, legitimisation of different stakeholder views, and reduction of research bias and support for ICT4D's interventionist approach and its goal of delivering international development (Heeks & Wall 2018). Secondly, specific value in addressing current trends in ICT4D research, namely the growing search for causal links between "ICT" and "D," and the political and ethical turns in ICT4D that are spurring researchers to engage more with issues of power, rights, and justice (Heeks & Wall 2018).

Moreover, critical realism possesses the generic ability to address issues seen as concerns for ICT4D research (Heeks & Wall 2017). These concerns are discussed at length by Heeks & Wall (2018) and include facilitating use of theoretical frames that connect ICTs to development impact. In addition, critical realism encompasses difference by reflecting the contingent and contextualized link between cause and effect seen in ICT4D practice and legitimizing the views of different stakeholders on ICT4D phenomena. The critical realist paradigm also supports what has become known as the political turn in ICT4D by exposing the structures and mechanisms of power that underpin application of ICTs in development contexts while still allowing space for consideration of human agency. Additionally, there are advantages to this approach from a methodological perspective as a critical realist approach requires data to be triangulated thus reducing both real and perceived bias of

individual ICT4D respondents, researchers, and methods. Importantly, the paradigm engages with underlying structure, as well as asking for reflexivity, and challenging the researcher to look more deeply into their work and practice. Lastly, critical realism seeks progressive social change by supporting the "ethical turn" in ICT4D by seeking the outcome of a more just and equitable society and necessitating investigation of the social structures that underpin rights, ethics, and justice. This approach directly supports ICT4D's intervention orientation and its goal of delivering international development.

All this makes the use of critical realism an attractive proposition for the ICT4D researcher. This is one of the reasons why a qualitative, longitudinal case study methodology has been designed for this research, with critical realism and Margaret Archer's (1995) morphogenetic approach providing the philosophical perspective. Critical realism and the morphogenetic approach are adopted to reveal mechanisms that explain how the interaction of different structural, cultural and agency factors have influenced the mHealth project. It is claimed that the approach adopted "offers exciting prospects in shifting attention toward the real problems that we face and their underlying causes and away from a focus on data and methods of analysis" (Mingers, Mutch et al. 2013, p. 795). Allen et al. (Allen, Brown et al. 2013, p. 835) proposes that such an approach can aid in "fostering explanation in terms of real structures, mechanisms, powers and tendencies, rather than mere description or crude prediction". The research design and methodology adopted for this research, as well as a detailed description of critical realism and the morphogenetic approach, will not be discussed in any detail in this chapter but instead will be presented in Chapter 5.

The following sub-sections of this chapter will present an analysis of critical realism in ICT4D research based on the four main differentiators of research paradigms as proposed by Cresswell (2013). This analysis is based on the recent work of Heeks & Wall (2018). The four main differentiators of research paradigms are:

- Ontology: what the paradigm understands to be the nature of reality.
- Epistemology: what the paradigm understands about how we construct and evaluate knowledge about that reality.
- Methodology: what research strategy, methods and techniques the paradigm uses in order to gather and analyse data.
- Axiology: what the paradigm does and does not value in research.

It is useful to present this analysis in this way because "although there are many different classifications of philosophical problems, the division of philosophy into ontology (or metaphysics), epistemology, and axiology (ethics and aesthetics) still seems the most efficient and general one" (Woleński 2004, p. 3).

4.3.1 Generic Value of Critical Realism for ICT4D Research

There is much generic value to using critical realism for ICT4D research. Firstly, there is value to making the research paradigm used in any research clear, whether or not this is ICT4D research and whether or not the paradigm being used is critical realism. However, this happens to be of particular relevance to the ICT4D field because there is a lack of explicit consideration of research philosophy in general and of research paradigms specifically in social science in general and ICT4D research in particular (Gomez & Day 2013, Heeks & Wall 2018). This is important as the research paradigm adopted shapes the researchers view and perception of the world in a fundamental manner. It determines the nature and type of research questions asked, how these research questions can be phrased, the methodologies used, the manner in which data is analysed, and the way findings are presented (Hughes 2016). Research paradigms have a fundamental effect on the researcher's ontological perception of the world, and thus dictate the conduct of the research. They determine what we as researchers can see and the manner in which we see it. They also determine how our research is executed and managed. They tell us what we can and can't do in our research. Moreover, research paradigms can

help expose assumptions and improve consistency and validity of the work (Myers 1997). This makes the generic value of all research paradigms and making clear the particular paradigm used for the research, clear. In particular, "explicit recognition of research philosophies can help researchers' self-development, their capacity to analyze the work of themselves and others, and the academic credibility of a research field" (Heeks 2007, p. 252). To be specific about the paradigm in use addresses these concerns about research questions, methodologies and the presentation of the research findings. Such specificity also addresses the concerns as expressed by Myers (1997) concerning the consistency and validity of the research.

In addition to the advantages of making the research paradigm used in any research clear, the critical realist paradigm specifically has many generic strengths and advantages for ICT4D research in particular. These include its ontological realism combined with its epistemological relativism, and the iterative, pluralist, and reflexive methodology the paradigm brings to research in general. Moreover, of relevance is its emancipatory values and the ability of critical realism to legitimize different stakeholder views and to support ICT4D's developmental aims. Furthermore, critical realism exposes the importance of context in shaping ICT4D outcomes. Other specific generic values come from addressing current trends in ICT4D research, the growing search for causal links between "ICT" and "D" and the political and ethical turns in ICT4D that are spurring researchers to engage more with issues of power, rights, and justice (Heeks & Wall 2018).

There is also a much broader generic value in making explicit the use of research paradigm in ICT4D research. This applies whether or not the paradigm used is critical realism. Clarity in this regard will allow the ICT4D sub-discipline to achieve greater maturity and recognition within its cognate disciplines of IS and development studies. This is an important consideration, as it will allow ICT4D research to meet the standards of the main IS journals such as MIS Quarterly and Information Systems Research, with one of the more important

standards of these journals being an expectation of engagement with paradigms (e.g. Walsham 2007, Nielsen 2015).

4.3.2 Ontological Value of Critical Realism for ICT4D Research

Ontology concerns the nature of reality and can be defined as the science or study of being (Blaikie & Priest 2019). This section outlines the specific ontological value critical realism brings to ICT4D research.

It is useful to begin by providing a definition of critical realism as "the philosophical stance that what we experience are some of the manifestations of the things in the real world, rather than the actual things" (Easterby-Smith 2015, p. 714). Critical realism adopts a stratified ontology as shown in figure 4.1 below. Put simply, critical realism asserts that general elements of an independent reality exist, but our knowledge of specific structures and mechanisms is limited because of the difficulty of accessing them directly through levels of stratification. This stratification is presented in figure 4.1 as three nested domains as proposed by Bhaskar (1975).

The stratified nature of critical realism is discussed in greater detail in Chapter 5 so only brief detail is given here in an attempt to provide context. Put simply, researchers seek mechanisms, but mechanisms reside in the domain of the Real and are thus independent of human knowledge or our ability to perceive them. The Actual domain contains events which are generated from both exercised and non-exercised mechanisms, and the domain of the Empirical contains the events that we as humans are able to experience. It is important to have a clear understanding of what is meant by "mechanisms" and "events" in this context as critical realism starts from an ontology that identifies structures and mechanisms, through which events and discourses are generated, as being fundamental to the constitution of our natural and social reality (Carlsson 2009). Put briefly, mechanisms lie within the domain of the Real, and are defined as "causal structures that generate observable events" (Henfridsson & Bygstad 2013, p. 911). These mechanisms have an intransitive

objective reality independent of human thought or belief which means they are not merely social constructions. Events lie within the domain of the Actual and are defined as "specific happenings resulting from causal mechanisms being enacted in some social and physical structure within a particular ... context" (Williams & Karahanna 2013, p. 939). Mechanisms and events are discussed in great detail in Chapter 5 below.

	Domain		
	Real	Actual	Empirical
Mechanism	X		
Events	X	X	
Experiences	X	X	X

Figure 4.1: The Stratified Ontology of Critical Realism as proposed by Bhaskar (1975, p. 13)

This discussion of critical realism is important in the context of the ontological value it brings to ICT4D research because at the heart of critical realism is realism about ontology (Archer, Decoteau et al. 2016). This means that critical realism pays attention to questions about the nature of what is known. This is in contrast to the more traditional focus of social science on epistemology and methods in research (Archer, Decoteau et al. 2016). This more traditional focus derives from the positivist and interpretivist notions of causality which only paint a partial picture because they describe only what can be observed at the level of the empirical (Smith 2018). Many scholars would argue this to be inadequate from an ontological perspective, not least because of the critical realist notion of a generative mechanism, as a latent, unobservable causal power existing at the level of the real provides a concept that subsumes other research explanations (Mingers 2004)

Also of relevance to the discussion of the ontological value of critical realism to ICT4D research is the importance of context in ICT4D research (Andoh-Baidoo

2017) , with some criticising what they see as a lack of engagement with context in ICT4D research and practice (Dodson, Sterling et al. , Turpin and Alexander 2014). Critical realism can help to address these contextual issues because context is represented in the domain of the Real which includes structures and mechanisms that can generate events. Alternative research paradigms such as positivism and interpretivism can encompass context only at the empirical level of what can actually be observed (Smith 2018).

Critical realism can help address these contextual issues as it requires an investigation of context because context is represented by the domain of the Real. Other research paradigms can encompass context but only within critical realism is it an integral and required component (Ram, Edwards et al. 2015). It forces that involvement with ICT4D context to focus on what is present – relations, systems, ideas, resources – rather than conceiving development contexts solely in terms of lack or absence (Njihia & Merali 2013).

It is also possible to identify two further values that the contextualist ontology of critical realism brings to the current state of ICT4D research. The first is its incorporation of causality. The open systems view taken by critical realism is one that does not provide for causal mechanisms that operate in the same way at all times and in all contexts; but it does develop an understanding of causality. As Njihia & Merali (2013, p. 866) explain, critical realism "should tell us with good reason why things are as they are now and where they could be heading, based on the causal tendencies of identified generative mechanisms".

This is especially relevant in ICT4D today. The focus of ICT4D research has been shifting over time from issues of readiness and availability through adoption to development impact (Heeks 2014). But the current interest in development impact has been hampered by lack of research that investigates or demonstrates a causal connection between technology and development (Andersson & Hatakka 2013). There is work that claims to show a causal link – for example relating ICTs and poverty alleviation, or ICTs and economic growth

– but investigation reveals it often confuses correlation with causality (Steyn & Kirlidog 2013). One reason is that this work comes from a positivist tradition where there is no inherent need or basis for examining causality beyond the sense "of causality as a constant conjunction of events" (Smith 2005, p. 31). If, instead, research on ICT4D development impact took a critical realist approach, then consideration of the underlying functioning of causality would be inherent.

Of course, the causality exposed by critical realism is not, as noted, a universal. For example, critical realism will not show that introduction of ICTs always alleviates poverty. Nor would we expect it to, since that is not what is observed in practice. Instead, it will help explain the mechanisms by which ICTs alleviate poverty in some circumstances but will also help analyse why these mechanisms in other cases do not operate. Critical realism can therefore engage with one of the main tensions in ICT4D research: between difference and commonality (Burrell & Toyama 2009). Where some ICT4D researchers focus on the individual and contextual differences that explain variation in ICT4D outcomes, others look for commonalities that offer universal insights. Though some combination of the two would be beneficial for both research and practice, the dominance of distinct disciplinary approaches and paradigms acts as a barrier to this. Encouraging greater use of critical realism would enable the desired combination: allowing identification of common mechanisms but also identifying the mechanisms of contextual difference that create the complex interaction and patterns of outcome seen in practice.

Such a combination enables the utilization of various theoretical frames within ICT4D, which themselves integrate common mechanisms with contextual difference. For example, ICT4D has been subject to criticism about its relationship with development: its failure to be explicit about its definition of development (Walsham & Sahay 2006, Burrell & Toyama 2009) and its relative lack of engagement with development studies (Heeks 2006). Since these earlier criticisms, there has been some improvement, but this remains a

significant shortcoming (Andersson & Hatakka 2013). One barrier has been that common theoretical frames of relevance fit poorly with the positivist or interpretive research paradigms that have dominated ICT4D. But their combination of contextual difference and commonality, and underlying mechanisms which are experienced by individuals mean they are well-suited to critical realism (e.g. Oosterlaken 2011).

The "political turn" in ICT4D (Heeks & Wall 2018) refers to researchers engaging more with issues of power, rights, and justice. Walsham (2012) suggests that ethical and political questions should include asking how we can use ICTs to support the poor of the world, and asking who benefits from ICT4D research, and how exactly they might benefit. This is of relevance as critical realism, unlike other research paradigms, has particular features that facilitate political research. Political theory often conceives power in terms of underlying structures and mechanisms that shape but do not determine (e.g. Clegg 2013). This is precisely the ontological perspective of critical realism. It contrasts with the determinism of positivism (and its logical impossibility of denying the politics of research and observation while researching politics) and interpretivism's struggles to recognise social structure or the way in which power constitutes beliefs (Torgerson 1986, Bevir and Rhodes 2005). In addition, the critical aspect of critical realism means it has a central concern with the ways in which power structures society. Hence, we find examples of explicitly critical realist research on issues of power and politics (e.g. Patomäki 2003, Faria 2004, Wigger and Horn 2016).

A potential danger of taking a more political perspective on ICT4D is that research may be overly-structuralist: focusing only on social structures of power and ignoring the agency of individual and collective human actors. This is a familiar problem, found in social science generally (Layder 1994) as well as arising within ICT4D and related fields (Heeks & Renken 2018). Incorporation of both structure and agency to study power can be achieved by adoption of particular theoretical frames (e.g. Lukes 1877, Stevenson & Greenberg 2000).

But a broader solution – and arguably a necessary foundation for any theoretical accommodation of structure and agency – would be to employ a research paradigm that allows a role for both structure and agency. Critical realism regards structure and agency as "existentially interdependent but essentially distinct" (Bhaskar 2009, p. 123) with – as noted above – one of the clearest interpretations being provided by Margaret Archer's work on morphogenesis. Critical realism is therefore particularly appropriate as a foundation to support the growing agenda for politics-oriented research in ICT4D.

4.3.3 Epistemological Value of Critical Realism for ICT4D Research

Epistemology is the theory of knowledge (Woleński 2004). In this context, epistemology is what the critical realist paradigm understands about how we construct and evaluate knowledge about reality.

As can be seen from figure 4.1 above, human experiences lie within the domain of the Empirical. This allows for different perceptions of any of the events that might occur within any ICT4D project. Events lie within the domain of the Actual, and thus there may be different perceptions of an event such as the design of an mHealth mobile application or the appointment of an ICT4D project champion for example. This has the effect of legitimising the observed reality of these events, with the possibility that different individuals may express different views (Chib 2012). This is something that positivism fails to cope with. A further advantage of critical realism in this instance is that it allows for explanation of why these differences might occur (Heeks & Wall 2018). Thus, critical realism emphasises the methodological requirement for triangulation of multiple perspectives. This means the paradigm facilitates use of stakeholder theory in ICT4D research and therefore the use of stakeholder analysis in ICT4D practice. This is something which has been advocated as a means to provide greater insights into the trajectories of ICT4D projects (Bailur 2006).

In addition, human experiences and observations of the events generated within the Actual lie within the domain of the Empirical. However, the underlying, intransitive structures and mechanisms of the Real domain cannot be directly experienced. This means that they cannot be directly measured by research (Danermark, Ekström et al. 2002). However, as indicated by figure 4.1 the Empirical lies within the Actual and the Real. Thus, any experience is shaped by the context of that experience. Effectively it is not objective but is contingent and transient. This means that different observers will give different accounts of events depending on their own historical experiences and their own position within those social structures (Dobson 2001).

4.3.4 Methodological Value of Critical Realism for ICT4D Research

This section examines three main methodological features of critical realism. Methodology concerns the research strategy, methods and techniques that any paradigm uses in order to gather and analyse data. The three methodological features of critical realism examined are iterative retroduction, pluralism, and reflexivity. Retroduction (Bhaskar 1975) is discussed in greater detail in the following chapter but put briefly retroduction requires the researcher to take some unexplained phenomenon and propose hypothetical mechanisms that would generate or cause that which is to be explained (Mingers 2004). Retroduction may also be understood as positing mechanisms which, if they were to exist and act in the postulated manner, would account for the phenomena singled out for explanation (Lawson 1997). In effect, retroduction involves moving back across the domains from the Empirical via the Actual to the Real, and represents the way by which the domains are connected within active research. In practice, retroduction is generally considered to be part of an iterative cycle in which mechanisms are postulated from existing data, evidenced or otherwise through gathering of new data, and supported or revised or rejected iteratively during the analysis of that data (Easton 2010).

According to Heeks & Wall (2018) the transitive relation between the Empirical and the Actual gives rise to critical realism requiring pluralism of methods. This is required in order to improve the validity of insights into events and their underlying mechanisms (Downward & Mearman 2006). This is important and typically understood in terms of two types of triangulation. Firstly, data triangulation is most often operationalised by gathering data from different stakeholders, thus allowing for multiple perspectives and inter-subjective insights into the events of the Actual. Method triangulation means critical realism is associated with mixed-methods research: combining qualitative and quantitative methods. This is represented in figure 4.2.

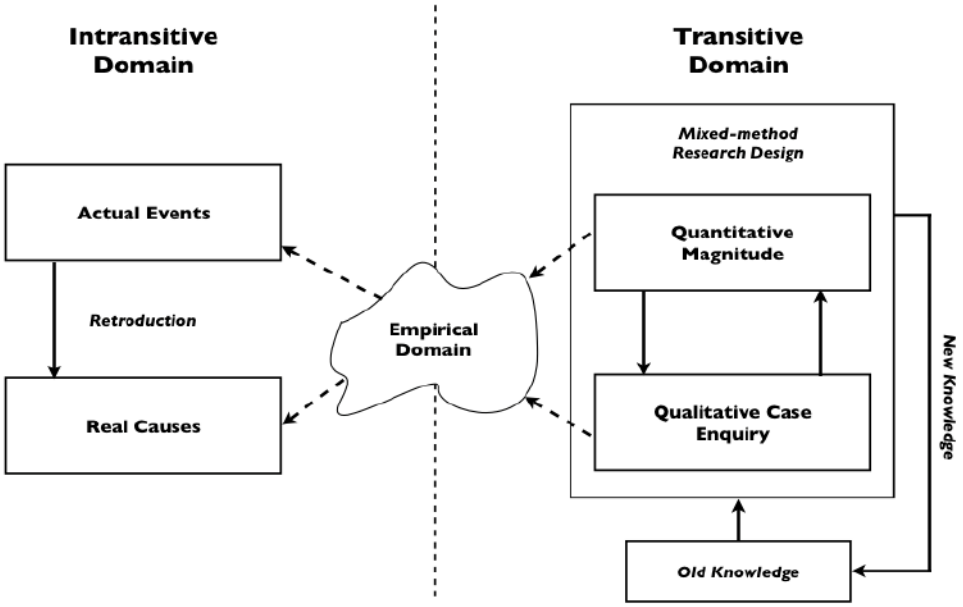

Figure 4.2: Methodology of critical realism (Heeks & Wall 2018, as adapted from Zachariadis, Scott et al. 2013)

Because the empirical is subject to the influence of context then data gathered will be value-laden. In addition, this will also be true of the research process itself. Critical realism therefore asks of its researchers that they and their research participants be reflexive: "a dynamic process of interaction within and between ourselves and our participants, and the data that inform decisions, actions and interpretations at all stages of research" (Etherington 2004, p.36).

This process can also be retroductive: seeking to expose the underlying mechanisms that can explain the events of the research process.

Concerns about lack of rigour in research - in particular poor reliability and poor validity - can be found in every academic discipline. So, the expression of such concerns in specific relation to ICT4D research (e.g. Chib 2012) makes no particular reflection on the ICT4D sub-discipline. Equally, good practice in any research paradigm can go a long way to addressing shortcomings in research rigour.

As previously discussed, ICT4D research is seen to suffer from a lack of credible investigation into causality (May & Diga 2015), something which undermines internal research validity. Both positivism and critical realism address this but critical realism has an arguable additional value because its iterative retroduction forces ongoing contemplation and critique of the relation between causes and effects. Additionally, as noted above, its contingent approach to causality provides a better reflection of the varied cause-effect patterns seen in ICT4D in practice.

There are frequent concerns about bias in ICT4D research and the way in which it can undermine both reliability and validity. These include biases of case and respondent selection (Burrell & Toyama 2009), biases of the researchers themselves (Krauss 2012), and biases of individual research methods (Dearden). Interpretivism seeks to address respondent and researcher bias by embracing them as integral to its worldview. But it struggles to deal with the other biases. By contrast, critical realism's methodological pluralism and triangulation force multiple viewpoints and data sources and methods to be incorporated. More generally, critical realism's mandated reflexivity forces ongoing introspection about the nature of the research process and its overall rigour including biases of context, respondents and researcher. In so-doing, it may be able to improve rigour and mitigate biases. Critical realism also forces reflection on the value of ICT4D research; something, again, that is a concern

of those seeking to develop the field (Krauss & Turpin 2013).

4.3.5 Axiological Value of Critical Realism for ICT4D Research

Axiology refers to what any given research paradigm does and does not value in research. Important here is the way critical realism contrasts itself to the way positivism argues against the existence of any objective reality. Positivism assumes that the social world exists externally, and that its properties can be measured through objective methods. Put simply, positivism assumes value-free research. Critical realism challenges this assumption. Firstly, critical realism's epistemology assumes research to be value-laden. It is shaped by experiences that are observed and experienced within a particular context. Furthermore, values such as emancipation are prioritized, thus making critical realism-based research values-driven. This means recognizing the way in which the social structures and mechanisms of the real domain can sometimes serve to generate events and processes that are oppressive and outcomes that are unequal. But beyond merely understanding the world, the critical in critical realism inspires changing the world through engagement with practice. Put another way, it inspires "developing ways of working with practitioners to help them understand their situation, identify barriers and opportunities for change and implement solutions" (Ram, Edwards et al. 2015, p. 465).

As discussed in the literature review in Chapter 3, ICT4D research is highly practical and oriented towards real-world action and practice with the main focus being on creating new systems, making an impact, and the furtherance of development goals (Heeks 2018). ICT4D research has tended to follow this lead by evaluating design and implementation methods, evaluating development impact, proposing new approaches, tools and strategies (Heeks, Thapa et al. 2018). The field is thus highly practical (Heeks 2018), prioritising the design and use of digital technologies for development goals. This is in contrast to other academic disciplines which lend themselves to theorization and abstraction. Critical realism is concerned with engagement and change and is supportive of practice-oriented disciplines. Thus, it can be seen as

specifically compatible with a wide variety of theories and approaches such as action research (Karlsson and Ackroyd 2014).

Additionally, of relevance is what has become known as the "ethical turn" in ICT4D (Heeks & Wall 2018). This refers to researchers engaging more with issues of power, rights, and justice in ICT4D. Walsham (2012) suggests that ethical and political questions should include asking how we can use ICTs to support the poor of the world, and whether or not mobile phones can enable the poor to access the Internet and thus reduce poverty. This also involves asking who benefits from ICT4D research and how exactly they might benefit. This focus has been advanced by Amartya Sen's work and its focus on justice within ICT4D (Sen 2008). It has also been advanced by the growing interest in ethics and social justice within wider development (Oosterlaken 2015). Although the exact relation of critical realism to ethics and justice is debated (Sayer 1997, Norrie 2009), at a basic level the emancipatory impulses of critical realism resonate with the ideas of ethics, and critical realism would thus be supportive of work on ICT4D and ethics. However, at a deeper level it could be argued that the foundations of rights, ethics and justice in the ICT4D field lie within the structures of society, and thus these all derive from and are largely determined by social structures (Heeks & Renken 2018). If that argument is accepted, then critical realism becomes uniquely appropriate for work on ICT4D and ethics given its combined desire to both understand and progressively change the social structures that envelop ICT4D.

Additionally, consideration should be given to how ICT4D goes beyond the unspecific notion of practice. As the "4D" element directly indicates, ICT4D is seeking to achieve progressive social change and to deliver specific development goals. While individual goals vary, foundational orientations of the SDGs are towards transformation: changing underlying systems of development; and towards inclusion: addressing both symptoms and causes of inequality (Heeks 2014). The congruence of critical realism can therefore be argued given its fit with at least these main goals of development. As discussed

above, critical realism is values-driven and orients not only towards understanding how structures and mechanisms constrain development, but also towards interventions that bring about emancipatory change. Dodson et al. (2013, p. 27) argue that the additional concerns of ICT4D, relating to both practice and change, create a problem: "the [ICT4D] research community is not unified on how to harmonize the difficult and sometimes competing goals of conducting experiments, producing social change, and studying the phenomena of ICT use in developing countries". Critical realism emerges as a basis for this harmonisation given that it encompasses research, practice, and developmental social change.

4.4 Challenges to Using Critical Realism in General and for ICT4D Research

The benefits and specific values of critical realism to ICT4D research have been discussed in the previous sections of this chapter. Despite all the advantages and strengths that such an approach can bring to the field of ICT4D, it is recognised that the adoption of a critical realist perspective comes with many challenges and that these challenges are both general as well as specific to the IS and ICT4D domains (Heeks & Wall 2018).

Perhaps the biggest challenge to using critical realism for research in general is the perceived complexity of the paradigm, with many claiming that it is difficult to understand. Much of the literature suggests that critical realism is time-consuming to use and difficult to operationalize (e.g. Reed 2009, Smith 2018). It has been suggested that the paradigm is "complex" (Fleetwood 2014, p. 182) and that many of the key texts are "often difficult" (Fleetwood 2014, p. 183), impenetrable and verbose. Indeed, many attempts have been made to simplify the key critical realist texts (e.g. Collier 1994) in an effort to make them more accessible. This is not helped by the claim that critical realism is replete with neologisms which take a while to understand (Smith 2018). Neologisms in critical realism include key words and concepts such as retroduction, mechanism, retrodiction, and abduction to name but a few. To make this worse, many of these key words are poorly defined and understood. An

example of this is the notion of a mechanism which is discussed in detail in Chapter 5. Volkoff & Strong (2013, p. 821) suggest that there has been little discussion of exactly what mechanisms are. This is particularly relevant to any aspiring researcher intending to use critical realism, as there is no existing set of ICT4D-related mechanisms to which researchers can turn (Smith 2018). It has been suggested by Smith (2018) that building a repertoire of mechanisms should be the first item on the agenda for those interested in advancing a critical realism approach to ICT4D research. Additionally, there would appear to be a lack of consensus on the exact definition of mechanism, with scholars such as Astbury & Leeuw (2010) and Raduescu & Vessey (2008) claiming that causal mechanisms are ill-defined, and Volkoff & Strong (2013, p.821) positing that "we still lack a concrete sense of what a generative mechanism looks like".

In addition, it is claimed that understanding critical realism in any detail or depth is made more problematic because the key ideas of the paradigm often run counter to how many researchers think about research (Smith 2018). This may result from the relative complexity of combining a realist ontology with a relativist epistemology that is required by the paradigm. This is made worse by the relatively new and novel nature of critical realism which means there isn't a long history of established work to draw on (Smith 2018), with this being particularly true of critical realism within the ICT4D field. These difficulties are exacerbated when working within the social sciences and in particular the fields of IS and ICT4D as the most difficult element of employing a critical realist philosophy is attempting to deal with highly complex social situations in an analytical manner (Smith 2018).

Of additional concern is the lack of methodological clarity associated with critical realism. According to Danermark et al. (2002) critical realism itself is not a method. Indeed, according to Yeung (1997, p.51), critical realism has been dubbed "a philosophy in search of a method". This leads to a lack of clear guidance on how exactly to put critical realism into practice. Although critical realism's methodology may be understood in theory there is also a need to

know more about practical methods and techniques (Fletcher 2016). This lack of methodological clarity is a concern and is likely to be a disincentive for the use of critical realism in practice. This is particularly relevant to the use of critical realism by graduate students and their academic supervisors who are likely to crave methodological clarity for many obvious reasons.

In addition to these practical difficulties, there are also many and varied philosophical criticisms of critical realism. Positivists would claim that critical realism lacks objectivity and places limits on the generalizability of its findings. This would include the "provisional, fallible, incomplete, and extendable" nature of its explanations (Dobson 2009, p. 808). Interpretivists make the claim that the realism part of critical realism is misguided (Heeks & Wall 2018).

These are issues facing any user of critical realism, but there are also issues specific to those wishing to use critical realism in ICT4D research. Firstly, is the pre-existing orientation of many ICT4D researchers towards alternative paradigms (Heeks & Wall 2018). As discussed in section 4.2 above the philosophical duopoly of interpretivist and positivist approaches have dominated the current body of ICT4D work for the last number of decades (Walsham & Sahay 2006, Gomez & Day 2013). This means that students, supervisors and other researchers are unlikely to use the critical realist paradigm for their research as expertise does not exist, or where it does exist is likely to be at early stages of development. This is an important consideration as such lack of expertise can create a negative cycle around the use of critical realism. If critical realism is not used widely in academia this will lead to a lack of publication outlets for critical realist-based research. This means the paradigm is unlikely to be used for research as few research supervisors, journal editors and reviewers will be attracted by this negative perception of critical realism. In turn, this is likely to perpetuate a lack of culture and capabilities around the paradigm. All of this creates a negative cycle associated with critical realism, with the lack of ICT4D academic culture

and capabilities around critical realism fostering a lack of both drivers and enablers to greater use of the paradigm in the field.

According to Heeks & Wall (2018) this may be a less-challenging issue for ICT4D doctoral researchers who have both the time and the requirement to delve into complex ideas and research paradigms. However, it is likely to represent a significant challenge to busy and time-poor PhD supervisors who will be likely to resist supervising students who wish to travel down this particular philosophical path. Furthermore, this will present a big obstacle for other types of ICT4D researchers, in particular those working in the field with NGOs who may be reluctant to invest time in coming to terms with what they might see as a highly complex and little-used philosophical paradigm that is associated with methodological uncertainty and unclarity. Solving this particular issue will require journal editors, senior academics and PhD supervisors to encourage greater engagement with research paradigms in general, and the critical realist paradigm in particular. Additionally, it will require academic supervisors to engage with, and actively encourage the use of, the critical realist paradigm. This is bound to develop a more fertile ground for critical realism (as well as other paradigms) to flourish.

Despite these challenges however, and as was discussed in section 4.3 above, there is no doubt that the use of critical realism in IS and ICT4D research is increasing. There are many reasons for this as previously outlined. Firstly, the use of the paradigm may be an attempt to address either the positivist crisis as posited by Carlsson (2009) or the crisis in the social sciences as proposed by Rutzou (2016). Additionally, there is an increasing recognition that the social world is complex and that we are operating in an open system. Smith (2018) suggests that if this is accepted by researchers, then why would anyone think that research, particularly social science research, should be easy? Indeed, according to Smith (2018, p. 8 of 10) “if it appears that ICT4D and social science research is simple, you are probably doing it wrong (or the research is, at least, incomplete).”

4.5 Summary

This section proposes that the field of ICT4D has been long on practice and short on intellectual depth, and that there has been scant consideration of research paradigms in the field. What little consideration and reflection there has been has shown the field to be dominated by a positivist and interpretivist philosophical duopoly. It is suggested that this philosophical duopoly results in limitations and weaknesses that might limit and constrain ICT4D research. This chapter proposes the value of a "third way" research paradigm: critical realism. It is argued that a critical realist approach is suitable and particularly appropriate for use in ICT4D research for a variety of reasons. Moreover, it is argued that a critical realist philosophical approach has the ability to enhance the ICT4D researchers analytical capacity and the overall credibility of themselves and the ICT4D sub-discipline.

The specific features of critical realism - ontological, epistemological, methodological, axiological - were outlined. These features make the paradigm particularly relevant and suitable for ICT4D research, as well as differentiating it from other paradigms such as positivism and interpretivism. It was suggested that there is a generic and inbuilt ability of critical realism to address issues seen as concerns for ICT4D research. The paradigm engages with underlying structure which helps to expose causal mechanisms. It also facilitates use of theoretical frames that connect ICTs to development impact. It encompasses difference: reflecting the contingent and contextualised link between cause and effect seen in ICT4D practice and legitimising the views of different stakeholders on ICT4D phenomena. Methodologically, the paradigm triangulates, thus reducing the bias of individual ICT4D respondents, researchers or methods. Moreover, critical realism asks for reflexivity by pressing the ICT4D researcher for deeper insights into their work. And it seeks progressive social change by supporting ICT4D's intervention-orientation and its goal of delivering international development.

The particular value of critical realism to current trends in ICT4D research was also discussed. It is suggested that the paradigm supports the recent search for causality within ICT4D. In addition, critical realism supports the "political turn" in ICT4D by exposing the structures and mechanisms of power that underpin application of ICTs in development contexts, but still allowing space for consideration of human agency. Furthermore, the paradigm supports the "ethical turn" in ICT4D by seeking the outcome of a more just and equitable society, and by necessitating investigation of the social structures that underpin rights, ethics and justice.

The chapter concluded with an examination of the challenges to using critical realism in ICT4D research, one of the main challenges being the orientation of many ICT4D researchers towards alternative paradigms. Although there are many both general and domain-specific challenges it is concluded that delivery of critical realism's utility will require a number of enabling actions. These include commissioning of journal special issues and conference tracks, training and development activities for researchers such as workshops, as well as pressure from conference chairs, editors and reviewers for more explicit incorporation of research paradigms within the methodology sections of papers. All of this requires the IS and ICT4D research communities to be proactive in taking action that will enable this emergent research paradigm to flourish (Heeks & Wall 2018).

Chapter 5: Research Design and Methodology

5.1 Introduction

The previous chapter examined research paradigms in IS and ICT4D research. Critical realism was discussed in this context, and its suitability for ICT4D research was considered. This chapter will build on that work in a number of ways. Firstly, the research domain and field of contribution of this research is presented in order to provide context. This is followed by a detailed description of critical realism and Margaret Archer's (1995) morphogenetic approach. This includes description of some of the main components of the paradigm including events, mechanisms, and retroduction. The research framework is presented in section 5.4 before the chapter concludes with a brief summary.

5.1.1 Philosophical Foundations and Academic Location of the Research

As mentioned in Chapter 1, this research examines an mHealth project in the Bonthe District of Southern Sierra Leone. Sierra Leone and the many problems facing both the country and the public health systems were discussed in section 1.1.2 above, with the mHealth case in Bonthe District being outlined in Chapter 2. It was also mentioned in Chapter 1 that this research spans a number of different fields and sub-fields and may be considered to be located primarily within the IS field and more specifically within the sub-fields of ICT4D, M4D and mHealth in developing countries. This research is also located within the field of health informatics and HIS, part of which is located within the more expansive field of global health. The research may therefore be considered to be interdisciplinary. The interdisciplinary nature of this research correlates with the position taken by a variety of scholars (e.g. Naudé 2016, Thapa 2014, Walsham 2012) who suggest that ICT4D should be interdisciplinary, multidisciplinary, and transdisciplinary.

The interdisciplinary nature of this research is important as it has been claimed that techno-centric approaches have largely dominated the field of ICT4D (e.g. Wall, Vallières et al. 2013), and a more interdisciplinary approach is necessary if we are to address the challenges currently facing the implementation of ICT4D and mHealth in developing countries (Walsham 2012). Techno-centric approaches focus on the technological aspects of ICT4D, and thus tend to ignore the social, cultural, and political aspects of the technology. This research does not adopt such a techno-centric approach, but instead opts for a socio-technical perspective. This means that all the technologies in the Sierra Leone mHealth case, including the mobile phones, the solar chargers and other associated infrastructure are considered to be components of a larger health information infrastructure including paper forms, the networks, the pre-existing data flow processes (Purkayastha 2010), social factors, market-based incentives, regulatory frameworks, and local cultures (mHealth Alliance 2012). Such an approach fits with the "4D" (for development) component of ICT4D as the field is oriented towards intervention, practice, and engagement. Consideration of such socio-technical processes may also empower individuals and communities, leading to greater social change and an improved quality of life. This would substantiate the widely held belief that mHealth is a tool for human development (Chigona, Nyemba et al. 2012).

The adoption of such a socio-technical perspective views the use of IS as an inherently social process. Such a perspective facilitates a view of IS as a contextualized social phenomenon. This reflects the view of Orlikowski & Iacono (2001) who identify hardware and software as components of a more complex socio-technical ensemble that includes people and work processes as well as institutional and cultural factors. Orlikowski (2001) suggests that when people use a technology, they draw on the properties comprising the technological artifact. Technological artifacts may be considered to be clear-cut manifestations of technology. The properties include those inscribed by the designers, and those added on by users through previous interactions. People also draw on their skills, power, knowledge, assumptions, and

expectations about the technology and its use, influenced typically by training, communication, and previous experiences (Orlikowski 2000).

Thus, technology implementation in this mHealth case should not be viewed as simply the transfer of hardware and software such as mobile phones and other infrastructure. An information system may be understood as a social system and thus cannot be transferred physically in the same way as software applications or a piece of hardware. All technology is embedded in a structural, social and cultural context, making the transfer of just the technology itself problematic. This is recognized by Braa et al. (1995) who posit that technology is not simply an isolated artefact by itself, but it also involves the social and cultural use of the technical artefact. This means that implementers of IS and ICT4D are likely to have to negotiate a multiplicity of interacting socio-technical factors that are both within and outside of their control (Manda & Msosa 2012). Indeed, the assumption that such technologies will simply fit into the specific environment present in any given developing country and be easily adopted by the user has been described as fallacy (Shozi, Pottas et al. 2012). This is because any mHealth implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technological and ideological factors.

Also, of relevance is the primary objective of any mHealth initiative which should be to provide solutions to specific problems that prevent the health system from delivering health interventions that are already known to be effective (Labrique, Vasudevan et al. 2013). It has been argued that amidst the mounting pressure to scale interventions beyond the pilot phase, the importance of strong evidence, proven cost-effectiveness and a sound public health agenda must not be neglected in the interests of corporate growth or the desire to increase a market share of mobile subscriptions (Wall, Vallières et al. 2014). Where the impetus and funding for mHealth projects in these contexts can often originate from a top-down approach, the adoptability and therefore the sustainability of mHealth programs is implicitly threatened. As

such, mHealth projects must be deeply rooted within the technological, environmental, and social contexts within which they are deployed (Wall, Vallières et al. 2014). The best way to ensure this happens is to develop research frameworks which incorporate a socio-technical perspective. The research framework developed for this research (presented in section 5.4 below) adopts such views and takes these socio-technical perspectives into account.

5.2 Critical Realism

This section reviews the main features of critical realism including its ontological realism combined with its epistemological relativism; its iterative, pluralist and reflexive methodology; and its emancipatory values. Critical realism may be seen as a philosophical approach, or research paradigm, which combines transcendental realism with critical naturalism in an attempt to interface between the physical and natural sciences and the social sciences. According to Heeks, Ospina, & Wall (2019) research paradigms can be understood as a kind of continuum with positivism at one end and interpretivism at the other. Ontologically, critical realism situates itself in the middle-ground between positivism and interpretivism (Heeks 2019), and according to Carlsson (2009) may be viewed as an alternative to the different strands of positivism and constructivism currently dominating IS research.

Critical realism developed from the work of Roy Bhaskar (e.g. 1975, 1979, 2008) who is credited with popularising the paradigm throughout the 1970s and 1980s. According to Fleetwood (2014), Bhaskar's meta-theoretical perspective subsequently went on to influence sociology, social theory, and organization studies. Archer (2016) provides a useful overview of critical realism as a series of philosophical positions on a range of matters including ontology, causation, structure, persons, and forms of explanation. Further, Gorski (2013) proposes that critical realism is not itself a theory of society, but instead a philosophy of science and a theory of what science is and does. The paradigm emerged from what Archer calls the "post-positivist crises in the natural and social sciences"

in the 1970s and 1980s (Archer, Decoteau et al. 2016). Many agree with Archer, suggesting that critical realism was primarily developed as an answer to the so-called positivist crisis (e.g. Carlsson 2009), with the starting point being to argue specifically against empiricism and positivism (Mingers, Mutch et al. 2013).

There is widespread agreement that the critical realist paradigm is complex and difficult to understand. Thus, it is not surprising that many scholars have attempted to provide a simplified explanation. Among these is Fleetwood (2014, p. 182) who provides a useful four-point clarification of critical realism as follows:

1. Critical realism is a meta-theory rooted explicitly in ontology, with critical realist ontology being characterized by stratified, emergent, and transformational entities, relations, and processes.
2. Critical realism's influence goes beyond ontology because ontology influences aetiology, epistemology, methodology, choice of research techniques, mode of inference, the objectives one seeks, and the concepts of explanation, prediction, and theory one adopts. Fleetwood (2014) refers to this as the chain of metatheoretical concepts.
3. Critical realism highlights the existence of two rival ontologies in sociology. These are an empirical realist ontology (characterized by observed, atomic events) and an idealist ontology (characterized by entities constituted entirely by discourse).
4. Critical realism offers an interpretation, and critical evaluation, of empirical realist and idealist ontologies and their associated chains of meta-theoretical concepts.

In addition to the work of Archer and Fleetwood there is a wealth of other literature concerning critical realism (e.g. Bhaskar 1975, Bhaskar 1979, Mingers 2004, Mingers 2004, Bhaskar 2008) with many descriptions and definitions of the term being provided. Mingers (2013, p. 796) gives us one of the most widely used and accepted definitions of critical realism as being about "objects,

entities and structures that exist (even though perhaps unobservable) and generate the events that we observe". Additionally, Mingers (2013) attempts to present simplified descriptions of the paradigm in many of his writings. He suggests that critical realism initially developed as an argument against both the empiricist view of science as embodied in positivism and the idealist view of (social) science as embodied in the interpretivist philosophical approach. The critical realist argument begins with some accepted phenomenon and goes on to ask what the world must be like for this accepted phenomenon to occur. The paradigm adopts the view that these observed phenomenon and occurrences cannot be explained by empiricism or idealism alone. The reason for this is because they necessitate some form of realist ontology. In other words, some intransitive domain of object and events must exist, independent of our perceptions of them, which can indeed become objects of our knowledge (Mingers, Mutch et al. 2013).

Effectively, critical realism distinguishes clearly between epistemology/knowledge and ontology/existence. There are unobservable structures which are independent of human thought and exist independently of such thought. These unobservable structures cause observable events. This means that we can gain some understanding of the social world if the structures that generate the observable events can be recognised and understood. This brings us to the key feature of critical realism, i.e. the difference between structure and the events which generate that structure. A useful way to envisage the paradigm is by examining Bhaskar's (1975) stratified ontology of critical realism. This stratified ontology proposes that critical realism asserts that general elements of an independent reality exist, but our knowledge of specific structures and mechanisms is limited because of the difficulty of accessing them directly through levels of stratification. This stratification is presented in figure 5.2 below as three nested domains as proposed by Bhaskar (1975). An alternative diagrammatic representation of critical realism from Mingers (2004) is presented in figure 5.3. This representation of critical realism is given as it has been claimed that Bhaskar's

representation in figure 5.2 can give the false impression that we can experience both the Real and the Actual. Mingers representation in figure 5.3 clarifies this by representing the Real and the Actual as nested within each other, thus making it impossible to experience both.

	Domain		
	Real	Actual	Empirical
Mechanism	X		
Events	X	X	
Experiences	X	X	X

Figure 5.1: The Stratified Ontology of Critical Realism as proposed by Bhaskar (1975, p. 13)

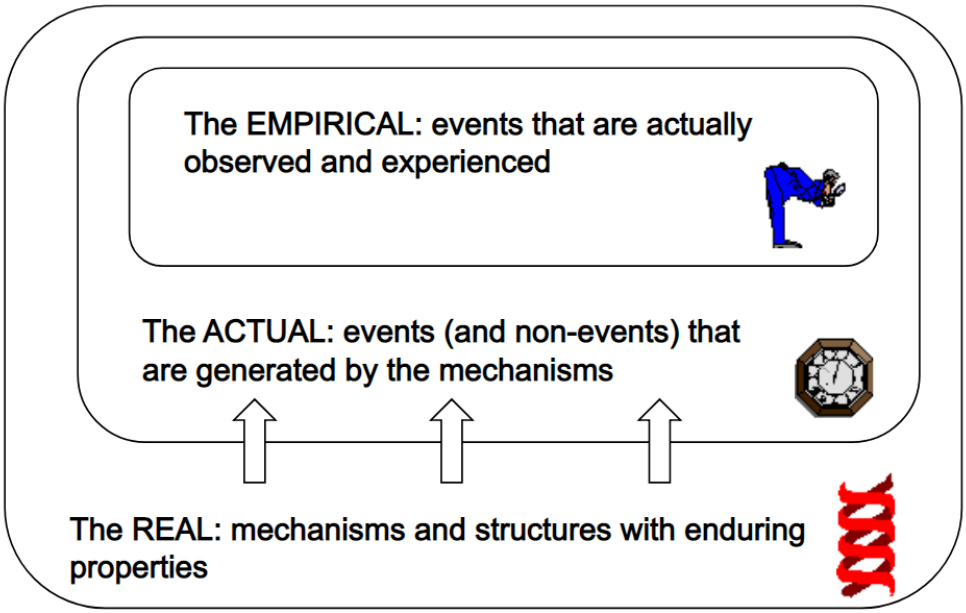

Figure 5.2: Stratified Ontology of Critical Realism as proposed by Mingers (2004)

At the core of critical realism is the premise that researchers seek mechanisms, but mechanisms reside in the domain of the Real and are thus independent of human knowledge or our ability to perceive them. The Actual domain contains events which are generated from both exercised and non-exercised

mechanisms. The domain of the Empirical contains the events that we as humans are able to experience. The domain of the Empirical thus encompasses human experiences and observations of the events generated within the Actual domain, with these experiences being not objective but shaped by their context. Events are specific happenings resulting from causal mechanisms being enacted in some social and physical structure within a particular organizational context, with mechanisms being seen as causal structures that generate observable events. Events and mechanisms are important in this context and are discussed in greater detail in section 5.2.1 which follows.

It has been claimed that critical realism can add to IS research by opening up a particular methodological space that lies between empiricism and interpretivism (Mingers 2004). This may be because the critical realist accepts an ontology which includes observable entities and underlying structures which are similar to positivists and interpretivists (Bhaskar 1998), but "leverages elements of both to provide new approaches to developing knowledge" (Wynn & Williams 2012, p. 787). For this and other reasons, critical realism has been proposed as a way to transcend a number of inconsistencies between the stated philosophical assumptions and the actual practice of IS research under both positivism and interpretivism (Smith 2006).

According to (Mingers, Mutch et al. 2013) there are a number of specific strengths and advantages associated with critical realism and these have been comprehensively discussed in Chapter 4. In addition to that already discussed, a stated strength of the paradigm is that "critical realism defends a strongly realist ontology that there is an existing, causally efficacious, world independent of our knowledge" (Mingers, Mutch et al. 2013, p. 795). The critical realist paradigm makes this defence against both classical positivism and the other forms of constructivism. Secondly, critical realism "recognizes that our access to this world is in fact limited and always mediated by our perceptual and theoretical lenses" (Mingers, Mutch et al. 2013, p. 795). This is an important strength of critical realism as it accepts that knowledge is always

local and historical (epistemic relativity), but not that all viewpoints must be equally valid (judgmental relativity). Additionally, "critical realism accepts the existence of different types of objects of knowledge (physical, social, and conceptual) which have different ontological and epistemological characteristics" (Mingers, Mutch et al. 2013, p. 795). This means that the critical realist paradigm requires the use of a range of different research methods and methodologies to access them which critical realism supports.

There are also some disadvantages associated with relying on the critical realist paradigm and many of these have already been outlined in Chapter 4. These mainly involve claims that critical realism is difficult to understand and operationalise (Smith 2018), but it has also been claimed that critical realism lacks methodological precision and direction. This may be because critical realism itself is a philosophy as opposed to being a method (Yeung 1997, Danermark, Ekström et al. 2002). Despite this however, critical realism does guide the research process in that the objects defined by critical realism subsequently frame ontological, epistemological and methodological development (Dobson et al. 2011).

5.2.1 Events and Mechanisms

Fundamental to the critical realist paradigm are the concept of events and mechanisms. It is worth noting at this juncture that mechanisms are frequently referred to as generative mechanisms and this phrase is used interchangeably with the word mechanisms throughout this PhD text. The literature provides many definitions and examples of both events and mechanisms. Williams et al. (2013, p. 939) describe events as "specific happenings resulting from causal mechanisms being enacted in some social and physical structure within a particular organizational context". Events are identified by key informants during interviews, through observations, and from archival data and each event should be "validated across multiple respondents and at multiple points in time" (Williams & Karahanna 2013, p. 939). Williams (2013, p. 939) in their examination of federated information technology governance structures

within an organisation, identify a number of events including the formation of groups, appointment of new IT leadership, approval of a new governance model by the Chief Operating Officer in an organization, the changing of the IT council mission, the establishment of an exploratory group, and presentations to management.

Although Bhaskar has called the generative mechanism the "lynchpin" of critical realism (Groff 2004, p. 138, Bhaskar 2013), there has been little discussion of the exact nature of mechanisms and how such mechanisms can be identified. This raises the important question of how do we know such hypothetical mechanisms actually exist (Mingers, Mutch et al. 2013). Mingers (2013) suggests that at one level we can never really know for certain since critical realism accepts that knowledge is always fallible.

In addition to this uncertainty around the existence of mechanisms and whether or not they actually exist, it is claimed that the concept of a mechanism in critical realism is be poorly understood, with Volkoff & Strong (2013, p. 821) suggesting that "despite their importance, however, there has been little discussion of exactly what mechanisms are, and how IS researchers can identify the generative mechanisms of interest". There would also appear to be a lack of consensus on the exact definition of mechanism, with Raduescu & Vessey (2008, p. 38) claiming that causal mechanisms are "ill-defined". This would seem to be borne out by Astbury & Leeuw (2010) who identify 24 different definitions of mechanism in the literature, with Volkoff & Strong (2013) identifying 9 different definitions specifically from the social sciences literature. Despite this seeming confusion, a number of useful definitions of mechanism are provided in this body of work. Henfridsson & Bygstad (2013, p. 911) define generative mechanisms as "causal structures that generate observable events", and Bygstad (2010) provides a similar definition of a generative mechanism as "a causal structure that can trigger events ... (whether a mechanism is triggered depends on context, i.e. other mechanisms)". Astbury & Leeuw (2010) also provide a definition, referring to

mechanisms as “the underlying processes or ‘‘hidden causal levers’’ that account for how and why a program works to bring about desired changes in the reasoning and behaviour of participants” (Astbury & Leeuw 2010, p. 375).

These definitions of mechanism are helpful, but according to Volkoff & Strong (2013, p.821) “we still lack a concrete sense of what a generative mechanism looks like”. They provide a number of specific examples of mechanisms from the literature, referencing work by Hedström & Swedberg (1996) who identify a belief-formation mechanism in psychology whereby an individual’s personal belief in the value or necessity of performing an act is a function of the number of individuals who have already performed that act. They also highlight the mechanism underlying economic markets as the pursuit to maximize marginal utility.

From an ontological perspective, some degree of certainty around mechanisms is important. This is because critical realists perceive reality as emergent and stratified (Njihia & Merali 2013). This results from the stratified ontology of critical realism and effectively means that higher levels are emergent from, but irreducible to, lower levels, with each level having its own properties appropriate to it and different in kind from those of levels above and below (Bhaskar 1975). This means that access to reality is only achieved by moving through layers of the Empirical (that which is directly experienced), the Actual (the location of events and occurrences), and the Real (the location of the generative mechanisms that give rise to events and empirical observations) (Njihia & Merali 2013). The Real is not directly observable or accessible and can only be accessed through hypothesization of the mechanisms that would give rise to events and observations we can comprehend (Njihia & Merali 2013). Thus, the entire ontological structure of critical realism relies on some degree of certainty about the nature of mechanisms.

Moreover, “critical realism holds that things in social reality have causal powers” with causal explanation resulting from defining those things or

generative mechanisms (Njihia & Merali 2013, p. 883). Thus, causality is explained by the existence of generative mechanisms (Smith 2018), with causal explanation relying on definition of "these things with their causal powers" (Njihia & Merali 2013, p. 883). This is not the positivist certainty of x causing y, but a contingent causality that means mechanisms may lead to certain effects but only in the presence of particular contextual features. Indeed, from a critical realist perspective both positivist and interpretivist notions of causality are flawed. They only show part of the picture because ontologically they can only describe what can be observed. The critical realist notion of a generative mechanism, as a latent, unobservable causal power existing at the level of the real provides a concept that subsumes other research explanations (Mingers 2004).

Smith (2018) uses the example of a mobile phone to explain this. He suggests that a mobile phone, when combined with other technologies to form a mobile phone network, has causal powers. In other words, it is a potential generative mechanism with the causal power of making a phone call. Smith proposes that the person making the call is the source of a contextual mechanism, which possesses the ability to trigger the causal power of using the mobile phone network to make a call. It is also important to note that the causal powers of the mobile phone extend beyond the ability to operate in the ways a phone would be expected to operate. The mobile phone could also act in a variety of unexpected ways including as a doorstop or as a weapon. These unexpected uses should also be considered as generative mechanisms of the mobile phone.

Smith (2018) goes on to provide another example which illustrates how a mechanism might emerge from an ICT intervention in a developing country context. He gives the example of the One-Laptop-per-Child intervention, and suggests that the effects of this programme will, depending on the context, potentially trigger a range of mechanisms as follows:

- Children may explore the mathematics software (Mechanism 1).

- One child may find the content interesting (Contextual Mechanism 1), while another may find it boring (Contextual Mechanism 2).
- Concerned teachers and parents may restrict the use of the laptops at home (Contextual Mechanism 3).
- Teachers may show preference towards boys using the technology (Contextual Mechanism 4).

Smith (2018) proposes that any one, or any other combination of, these 4 mechanisms could occur. This is important as "each of these mechanisms will contribute to the aggregate effect of the intervention and the ideas and opportunities it introduces" (Smith 2018, p. 3 of 10).

5.2.2 Retroduction

Key to any critical realist-based methodology is what Bhaskar (1975) calls retroduction. Retroduction involves transcendental deduction from observed events to come up with the conditions for their possibility (Njihia 2008). Put more simply, retroduction requires the researcher to take "some unexplained phenomenon and propose hypothetical mechanisms that, if they existed, would generate or cause that which is to be explained" (Mingers 2004, p. 94). Put another way, in order to arrive at possible explanations for the phenomenon, the critical realist relies on analogies with already known phenomena and on pre-existing theories as cognitive raw materials (Belfrage & Hauf 2017). These pre-existing theories are called "proto-theories" (Collier 1994, p. 165), and can consist of any of the theories in common use within the IS field or other scientific theories.

It is suggested in the literature that the challenges in identifying mechanisms in a critical realist-based methodology are many (Thapa & Omland 2018). It is also suggested that the process of applying such retroductive reasoning in an attempt to identify causal mechanisms is "challenging" (Williams & Karahanna 2013, p. 947), as well as being "difficult, time-consuming and resource-intensive" (Reed 2009, p. 436). Indeed, Bygstad (2011, p. 2) argues that the

"limited amount of empirical research based on the critical realism perspective can be partly explained by the lack of a more explicit methodology for data analysis, to aid the researcher in the search for generative mechanisms." Furthermore, Bygstad (2011, p. 2) argues that the "limited amount of empirical research based on the critical realism perspective can be partly explained by the lack of a more explicit methodology for data analysis, to aid the researcher in the search for generative mechanisms." Despite this however, retroduction is the "essential methodological step in critical realist studies" (Mingers, Mutch et al. 2013, p. 797) and is therefore required in any critical realist-based research. There are a number of research frameworks to guide in the retroductive process, with many detailed descriptions of the application of such frameworks available in the literature. One such framework is Archer's (1995) morphogenetic approach on which this research relies. The morphogenetic approach is described in detail in section 5.3 which follows.

According to Easton (2010), the critical realist research process follows a retroductive movement methodologically. In order to identify generative mechanisms, critical realists ask the question "what must be true for events to be possible?" (Belfrage & Hauf 2017, p. 254). This is the literal meaning of retroduction, i.e. leaning backwards, or a "... mode of inference in which events are explained by postulating (and identifying) mechanisms which are capable of producing them ..." (Sayer 1992, p. 107). In addition, this is recognised by Easton (2010) who also claims that retroduction literally means "moving backwards", with this backward movement being a key component of the retroductive process.

Retroduction therefore involves moving back across the domains from the Empirical via the Actual to the Real and represents the way by which the domains are connected within active research (Heeks & Wall 2018). Additionally, this retroductive movement between observable phenomena and possible explanations is recognised by Sayer (1992), as well as by Lawson (1997, p.236) who suggests that "the process of retroduction involves moving from a

conception of some phenomenon of interest to a conception of a different kind of thing that could have generated the given phenomenon". This might potentially be a one-time movement, but more often involves an iterative cycle in which mechanisms are postulated from existing data, evidenced or otherwise through gathering of new data, and supported, revised or rejected iteratively during the analysis of that data (Easton 2010).

All of this movement across domains and other complexities should not confuse the primary purpose of retroduction which is to gain deeper knowledge of reality by seeking explanation. Indeed, it is claimed that one can take positivist and interpretivist research findings and reinterpret them through the process of retroduction, turning the findings into generative mechanisms (Smith 2018). Retroductive arguments move from a description of some phenomenon to a description of something which produces it or is a condition for it (Belfrage & Hauf 2017). This is important from a methodological perspective as seeking explanation requires that the researcher go back to the research site to collect more data until epistemological closure is obtained (Easton 2010). It is recognised that this process may be flawed and temporary (Easton 2010) but reaching an understanding of the nature of retroduction and how it works from a methodological perspective is vital for critical realist-based research.

5.3 The Morphogenetic Approach

This section outlines the main features and concepts associated with the morphogenetic approach. As stated in the previous chapter retroduction is key to any critical realist-based methodology (Bhaskar 1975). Although retroduction is said to be challenging, difficult, time-consuming and resource-intensive (Reed 2009, Williams & Karahanna 2013), there are a variety of research frameworks available in critical realism and the literature contains many detailed descriptions of how such frameworks have been applied. Critical realist research frameworks include:

• Margaret Archer's (1995) morphogenetic approach;

• Danermark's (2002) staged model;

• The Transformational Model of Social Activity (TMSA) (Bhaskar 1998);

• Pawson & Tilley's (1997) realistic evaluation framework (Context-Mechanism- Outcome (CMO) realist experiment);

• The Strategic Relational Approach (SRA) (Jessop 2005);

• Methodological Realism (Sayer 1992), and

• The Research Map (Layder 1993).

Raduescu & Vessey (2008) suggest that the most commonly used frameworks are Archer's morphogenetic approach (1995), Danermark's (2002) staged model, and Pawson & Tilley's (1997) realistic evaluation framework. As mentioned previously, the morphogenetic approach is adopted for this research. One of the main reasons for this is because the morphogenetic approach gives researchers a practical framework to explore layers of mechanisms in a sociologically robust manner. Njihia & Merali (2013, p. 884) provide a strong justification for the use of this approach as it "furnishes the analytic apparatus to tease out the relationship between structure, agency, and outcomes by making explicit the mechanisms that connect situated actions and systemic outcomes." This is particularly appropriate in the context of this research as Njihia & Merali use the morphogenetic approach for a study of ICT4D in Kenya.

The morphogenetic approach gets its name from a combination of the words "morpho" (shape, form, structure) and "genesis" (origin, beginning). This literally gives us "the shape of the origin" and can be taken to mean that society does not have a pre-determined or pre-set form. Instead, society is shaped through the actions of agents (Archer 1995). However, according to Njihia & Merali (2013) while society is not predetermined, it is also not totally contingent, with some relations being necessary to the social system while others are external and contingent to that system. This is important and it allows the morphogenetic approach to provide a method of conceptualizing

how the interplay between structure and agency can be analyzed over time and space (Njihia & Merali 2013). Furthermore, Njihia & Merali (2013) suggest that structure and agency shape and reshape each other through a process called emergence, with morphogenesis resulting when agents transform the social system, and morphostasis occurring when the actions of agents reproduce the existing social system.

The morphogenetic approach has a number of significant strengths when compared with alternative frameworks. One of the biggest advantages of using the morphogenetic approach is the existence of an extensive body of theoretical and empirical work by Archer (1995, 1996, 2000, 2003, 2007, 2012), with this approach having been used by used by many scholars including de Vaujany (2008), Dobson et al. (2013), Wong (2005), Njihia & Merali (2013), Mihailescu et al. (2013), Thurstfield & Hamblett (2004), Carter (2002), and Volkoff & Strong (2007). Thus, there is clear and comprehensive guidance on how to use the approach. A further compelling reason to use the morphogenetic approach is because it prioritises the role of agency, with Archer placing "considerable emphasis on agents in her morphogenetic cycle" (Raduescu & Vessey 2008, p. 36). This is because Archer recognises that agents create causation which has the potential to alter structure. The morphogenetic approach also seems particularly suited to the study of ICT4D as it provides a way "to gain better understanding of complex ICT4D contexts" (Njihia & Merali 2013, p. 886) and as such provides "a tractable, comprehensive approach within which we can model and theorize ICT4D change in complex contexts" (Njihia & Merali 2013, p. 883).

Moreover, it has been claimed that critical realism and the morphogenetic approach are particularly appropriate for use in ICT4D studies, with scholars such as Lemayian & Omwansa (2013) suggesting that the field of mHealth in developing countries is better researched by using approaches involving the use of critical theory and critical realism. One example of how critical realism and the morphogenetic approach have been used in the ICT4D field is the

attempt by Njihia & Merali (2013) to understand the evolution of ICT4D in Kenya. They suggest that the morphogenetic approach is appropriate for the study of ICT4D as it "should tell us with good reason why things are as they are now and where they could be heading, based on the causal tendencies of identified generative mechanisms" (Njihia & Merali 2013, p. 886). They go on to say that the "morphogenetic approach ... is a tractable, comprehensive approach within which we can model and theorize ICT4D change in complex contexts" (Njihia & Merali 2013, p. 883) and they demonstrate how such an approach "can open up the black box by explicating the deep structure of ICT4D contexts to generate causal explanations for observed trajectories" (Njihia & Merali 2013, p. 882). Thus, it can be claimed that a strength of this approach is its ability to highlight actual problems that may exist in any particular case. This is emphasized by Mingers et al. (2013, p. 795) who suggests that critical realism has the ability to offer "exciting prospects in shifting attention toward the real problems that we face and their underlying causes, and away from a focus on data and methods of analysis".

It is for these reasons that this PhD research adopts critical realism and the morphogenetic approach to reveal mechanisms that explain how the interaction of different structural, cultural and agency factors have influenced the mHealth project in Sierra Leone. This approach is expected to provide a sophisticated and nuanced account of the mHealth case. It is claimed that the approach adopted "offers exciting prospects in shifting attention toward the real problems that we face and their underlying causes and away from a focus on data and methods of analysis" (Mingers, Mutch et al. 2013, p. 795). Allen et al. (2013, p. 835) proposes that such an approach can aid in "fostering explanation in terms of real structures, mechanisms, powers and tendencies, rather than mere description or crude prediction". Thus, there is potential for this research to generate knowledge which will benefit the mHealth project directly in a significant and tangible way by identifying the underlying causes of any problems. The research can also provide guidance on future plans to scale the mHealth project in Bonthe District, across all of Sierra Leone, and to many

other countries further afield. The identification of mechanisms will result in more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors. There will also be the potential to improve and enhance the health systems of Sierra Leone and beyond which will help many of the poorest and most disadvantaged people on the planet.

5.3.1 Morphogenetic/Morphostatic Cycles

As previously mentioned, retroduction is key to any critical realist-based methodology and it requires the researcher to take some unexplained phenomenon and propose hypothetical mechanisms that, if they existed, would generate that which is to be explained (Mingers 2004). This research relies on Margaret Archer's morphogenetic approach (Archer 1995) for retroduction, and the methodology associated with using the morphogenetic approach is described in this section.

It is important to start by emphasizing that the morphogenetic approach requires identification of discrete time periods called morphogenetic/morphostatic (M/M) cycles, each of which seeks to explain how change (morphogenesis) or reproduction (morphostasis) take place. Transformation/morphogenesis occurs where people and structures are transformed and structural reproduction/morphostasis occurs where people and structures are largely reproduced. The M/M cycles operationalize analytical dualism to explain how and why change happens.

M/M cycles can be used to analyse the relationship between structure and agency in any context. Analysis is done over discrete time intervals to identify emergent changes in structure, culture, and people, and their causal relationships. Three domains of social reality are recognized: Structural Emergent Properties (SEPs), Cultural Emergent Properties (CEPs), and People's Emergent Properties (PEPs). Structural, cultural, and people (agential) emergent properties are relatively enduring, and also irreducible to each other. These domains are evaluated in time over each analytical cycle. The M/M cycle

for structure and culture is shown in figure 5.3 below. Each M/M cycle begins at a time T1 that corresponds to prior conditioning by the existing configuration of components in social reality. The intermediate period T2 to T3 corresponds to the mediating action of agency through social or socio-cultural interaction. Emergent change leads to structural elaboration by time T4. As mentioned, structural elaboration can result in either reproduction (morphostasis) or transformation (morphogenesis). During analysis, these time periods are identified empirically from a historical account of events.

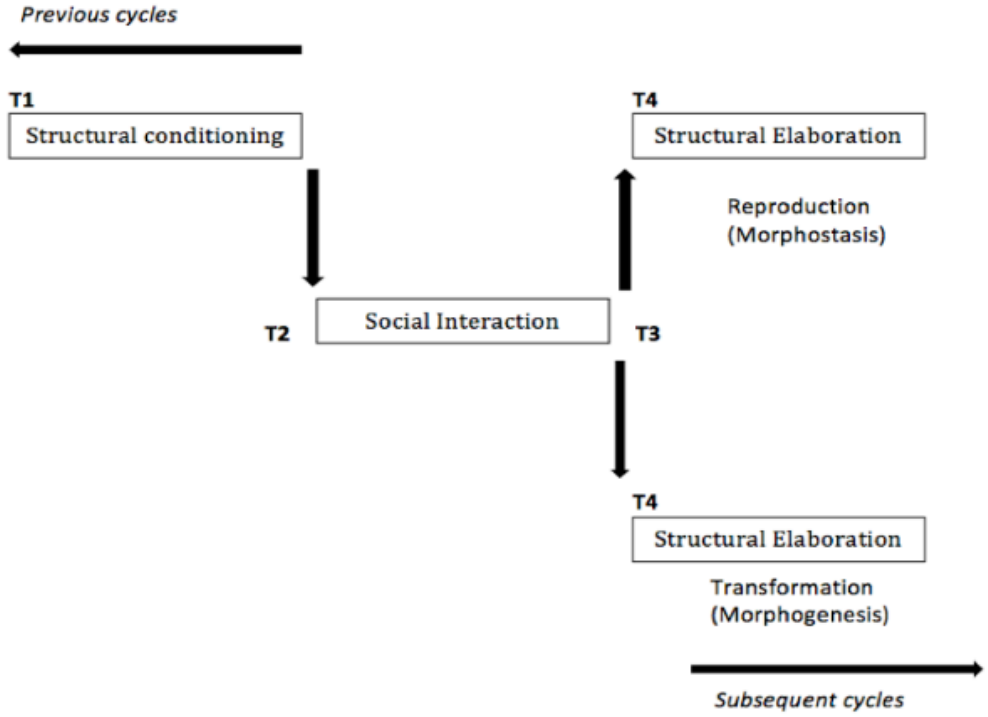

Figure 5.3: The M/M cycle for structure and culture

The M/M cycles for agency (people) is similar to the M/M cycle for structure and culture as shown in figure 5.3 above. These M/M cycles operate in a similar way to the M/M cycle for structure in so far as they begin at a time T1 that corresponds to prior conditioning. The intermediate period T2 to T3 corresponds to the mediating action of agency, with emergent change leading to cultural and agential elaboration by time T4. Archer (1995, p. 258) tells us that agents have a strong awareness of what they want, and they are also articulate and organised. Agents will seek access to resources, and this will

dictate whether they are successful or not. Resources in this instance could be expertise, assets, political power or influence. Agential success also depends on relations to other agents and the degree of interaction between them. Furthermore, Archer (1995) tells us that agency undergoes morphogenesis through conditioned social interaction as primary and corporate agents in different interest groups. Additionally, Archer tells us that decisions and actions are made for reasons important to agents but contingent upon systemic emergent properties and their powers (Archer 1995).

Thus, structural elaboration at T4 is bound to result in one of either morphogenesis or morphostasis. Morphogenesis is when change occurs, and morphostasis refers to overall stability of the social system. Whether morphogenesis or morphostasis occurs, it ultimately derives from agent interaction and reconfiguration. This is important as the M/M cycle theorizes the interplay between structure and culture with four possible pure combinations of morphogenesis/morphostasis and SEPs/CEPs (conjunctions or disjunctions) as follows:

- Conjunction 1: Structural and Cultural morphostasis. This represents a situation where structural and cultural elites need one another to survive and are both interested in holding on to the status quo. Conjunction 1 is highly likely to lead to a mutually beneficial social system.
- Disjunction 1: Structural morphogenesis, cultural morphostasis. This disjunction represents a situation where there is one dominant cultural agent. This can change for a variety of reasons including the introduction of new technologies, or new or altered political alliances. In this situation the stable cultural context will resist or dampen structural change, and this is likely to lead to cultural elaboration as new corporate agents arise in the cultural realm.
- Disjunction 2: Structural morphostasis, cultural morphogenesis. This is the opposite to the previous case with there is one dominant structural agent amidst a diversified cultural context. This poses a

challenge to the dominant structural agent to either change or stay the same by defending the current tradition. This disjunction is likely to result in structural elaboration in the form of social regrouping and a polarization of interests.

- Conjunction 2: Structural and cultural morphogenesis. This is the last possible combination and represents a situation where each has many organized and articulate groups with a high degree of interaction. Outcomes are highly contingent on the specific intersections between material and ideational interests in conjunction 2, with structural and cultural elaboration likely to be the result.

As time passes each M/M cycle can potentially link with another M/M cycle as shown in figure 5.5. In other words, M/M cycle 1 will end with T4 structural elaboration as represented in figure 5.4 above. This represents an end to M/M cycle 1, and a potential beginning for M/M cycle 2 which begins at its own T1 representing structural conditioning. M/M cycle 2 operates in a similar manner to M/M cycle 1 striating at T1 structural conditioning, before then moving to T2 social interaction, which results in T4 structural elaboration. Multiple M/M cycles can be linked in this manner.

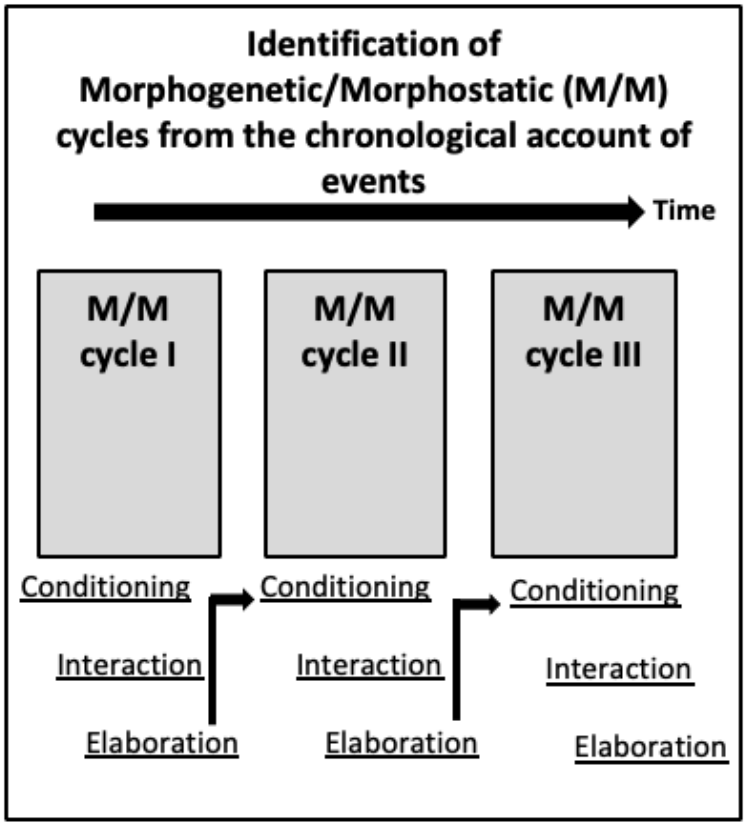

Figure 5.4: Different M/M cycles linked over time

The morphogenetic approach recognises that agents create causation which has the potential to alter structure. The makes the M/M approach particularly suitable for ICT4D research as it provides a tractable, comprehensive approach within which we can model and theorize ICT4D change in complex contexts (Njihia & Merali 2013). Thus, Archer's morphogenetic approach when applied to this research, allows theorization of how the interplay between mHealth structure and agency produce emergent use of the mHealth systems in Sierra Leone.

5.4 Research Methodologies in Critical Realism

As already mentioned a number of times in previous sections, this research relies on a qualitative, longitudinal case study methodology, with critical realism and the morphogenetic approach providing the philosophical perspective. This foundation is used to examine an ongoing mHealth project in Sierra Leone. The longitudinal aspect of this mHealth case study means that

the approach adopted is consistent with critical realism. Yin (2009) defines a case study as an empirical enquiry that investigates a contemporary phenomenon within its real-life context especially when the boundaries between phenomenon and context are not clearly evident. According to Yin (2009) case studies are the preferred strategy when "how" or "why" research questions are asked. This may be part of the reason case studies are considered to be the preferred strategy in social science when the investigator has little control over events within some real-life context. Many authors would agree with this, an example being Touray (2013, p. 5) who suggests that "the case study is a valuable method of research with distinctive characteristics that make it ideal for many types of investigation."

However, it is recognised that there are a variety of problems and shortcomings associated with a case study approach. Firstly, it is argued that case studies have a limited external validity or the weak potential to generalise findings from one case to another (Yin 1999). In addition, the relatively low power of the case study to generate theory is considered to be a problem.

Despite the stated problems and shortcomings associated with a case study approach, much of the critical realist-based literature suggests that a case study methodology provides a particularly good fit with a critical realist-based philosophical perspective. Such an approach has been used frequently in the literature (e.g. Bygstad 2010, Strong & Volkoff 2010, Dobson, Jackson et al. 2013, Njihia & Merali 2013). Furthermore, the case study approach in critical realism has been recommended by various authors including Wynn & Williams (2012) and Williams (2013) who establish the case study as the primary research design in critical realism. Indeed, Wynn (2012, p. 803) proposes the cause study as the "primary research design" for the critical realist paradigm. In addition, a study Easton (2010, p. 127) suggests that such a combination "seems ideally matched", and critical realism and a case study approach are "particularly well-suited" (Easton 2010, p. 119). Furthermore, a case studies methodology is also particularly suited to those using the morphogenetic

approach. According to Archer (1995) such an approach can describe any interplay of ideologies that seek endorsement through the various levels of society, people, their decisions, and their actions in narratives of the lived experience, for evaluation over morphogenetic cycles to produce analytical narratives.

A single case methodology is typical of critical realist research (e.g. Njihia 2013, Wynn 2012, Easton 2010) and there are many examples where one single case has been used, with this being particularly true in ICT4D studies (e.g. Njihia 2013, Avgerou, 2018, Thapa 2018). According to Wynne & Williams (2012) the most important reason to use a case study approach in critical realist-based research is that such an approach is effective in exposing the causal mechanisms which have produced a unique set of events in any particular case. As such, the results are not considered to be generalisable across multiple contexts and across other cases. Thus, the critical realist philosophical approach concentrates on one single case in a specific setting in an attempt to build an explanatory theory that matches the empirical facts as closely as possible. This is because the intensive study of one single case can result in an in-depth and contextually relevant analysis (Wynn & Williams 2012) and this is seen to be particularly true in critical realism. This is because the idea of generalisability has a particular meaning in critical realist-based research (Wynn & Williams 2012), with the ontological objective being not to generalise findings. Instead, the objective is to hypothesize the mechanisms that operate in that specific case only, and not to "expect identical or even highly similar outcomes if we were to replicate a given study in a different organizational, industry, regional, or cultural setting" (Wynn & Williams 2012, p. 804). Wynne and Williams go on to say "in essence, the generalisation within CR-based case study research is generalisation to theory" as opposed to generalisation to other cases (Wynn & Williams 2012, p. 805). This is important and emphasises the suitability, if not the necessity, of a single case study methodology for critical realist-based research.

Further justification for the use of a single case in critical realist-based research is given by Easton (2010) who suggests that a single case study must be able to stand on its own in research. Easton posits that "a critical realist case approach is particularly well suited to relatively clearly bounded, but complex, phenomena such as organisations, interorganisational relationships or nets of connected organisations" (Easton 2010, p. 123). This is important as research based on a critical realist philosophical approach falls within this category.

Despite the degree of agreement amongst authors as to the merits of using a case study approach in critical realism, many have argued that there is a lack of methodological clarity associated with the philosophical approach (e.g. Yeung 1997, Danermark, Ekström et al. 2002). Furthermore, it has been proposed that there exists an associated lack of clear guidance on how exactly to put critical realism into practice (Fletcher 2016). Despite these claims, there are a number of critical realist-based research frameworks, referred to as "operational guides" by some (e.g. Heeks 2019, p. 6), to assist the researcher. In addition to the research framework developed for this research as depicted in diagrammatical form in section 5.4 below there are three other methodologies which have recently received attention:

1. Bygstad's (2011) four-step methodology which involves description of events, identification of entities and associations, abduction (theoretical re-description), and retroduction.
2. Bygstad's (2016) six-step methodology. This is the same as the four-step methodology but includes the additional analysis of mechanisms (affordances), and assessment of explanatory power of mechanisms.
3. Mingers (2013) DREI methodology. DREI comes from: Describe the events of interest; Retroduce explanatory mechanisms; Eliminate false hypotheses; Identify the correct mechanisms. This methodology assumes the intransitivity of real structures. This effectively means that they will always have the potential for effects that are out of our control. According to Mingers (2013) the approach means that we should eliminate alternative explanations by testing in some way for their potential effects.

According to Mingers (2013) critical realism is eclectic in terms of research methodology. He suggests that as underlying structures may have a variety of material, social, and cognitive forms, we need a variety of epistemological methods to access them. Heeks (2018) would seem to agree with this by suggesting that given the transitive relation between the empirical and the actual, critical realism requires pluralism of methods. This makes critical realist-based methodology daunting for any early-stage researcher. This is made even worse as there are few papers which provide a practical demonstration of critical realism-based methodology, with this being particularly true of the IS and ICT4D bodies of work. One recent example of the use of Bygstad's (2011) four-step methodology is illustrated by Thapa (2018) in his study of the Nepal wireless networking project (NWNP). Bygstad's (2011) four-step methodology involves the following 4 steps: 1. Description of events; 2. Identification of entities and associations; 3. Abduction (theoretical re-description); 4. Retroduction.

A closer examination of the four-step methodology as completed by Thapa (2018) is now given. The first step involves a description of events. This involves producing a description of events in the context of the NWNP. The identified events then become the object of enquiry. Events can occur in both the domain of the Actual and the Empirical layers. However, using this methodology it is only possible to describe the events that we as researchers are able to experience in the Empirical layer. Step 2 involves identification of entities and associations that characterize the phenomena being studied. The researcher must then collect data about these entities. It is important to note that this is not a mere collection of various entities, but an interconnected set of entities that act, enact, and interact to generate some events. Step 3 involves abduction (or theoretical re-description). This effectively involves interpretation of the data, or in other words a search for different theoretical perspectives and different explanations of the phenomena. A variety of theories can be used at step 3, with Thapa (2018) suggesting that theories commonly used in ICT4D to reach an in-depth theoretical understanding of the

case would be appropriate. These theories could include any theory commonly used in the IS and ICT4D fields including actor network theory, institutional theory or structuration theory. Step 4 involves retroduction. This is the identification and selection of generative mechanisms. Thapa (2018) suggest that retroduction is the key epistemological process, and also that step 4 is the most crucial step in the entire methodological framework.

Thapa (2018) suggests that step 4 which requires the researcher to hypothesize the mechanisms is not straightforward. The process may have to iteratively go through several rounds of step 1, step 2, and step 3 in an attempt to uncover mechanisms from empirical data, confirming it through adding further data and applying various theoretical lenses. Bygstad (2011) suggests that this process may involve forward chaining to understand intentions, or backward chaining to understand results. An example provided by Thapa (2018) is backward chaining when the researcher finds some an incidence where the intended goals were reached and therefore looks for the mechanisms that led to those goals being reached. The paper goes on to illustrate the working of the methodology. This is an important paper as it is one of the only that provides a detailed description of a critical realist methodology in action.

In additional to these three critical methodological approaches there is the research methodology adopted for this research. This is described in detail in the following section. The research framework uses Raduescu & Vessey's (2008, p. 12) 4-step methodology to produce analytical histories of emergence which provide the basis for inferences about causal mechanisms. This particular methodology has been incorporated into the research framework as shown in figure 5.6 below. This methodology was chosen as it is deemed to be appropriate for use with the morphogenetic approach.

It should be noted at this point that many existing studies in the wider IS field have used affordance theory in an attempt to identify and detect sociotechnical mechanisms. It should also be noted that the use of affordance theory is

growing rapidly in the field of ICT4D (e.g. Thapa 2019, Thapa 2018). According to Strauss (2019) affordance theory has its origins in ecological psychology, with the theory being originally proposed by Gibson (1977, 1986) in an attempt to understand the behaviour of animals in their natural environments. Strauss suggests that the noun affordance was coined by Gibson (1977, 1986) himself from the verb to afford, which means to provide. Despite the growing popularity of affordance theory in the IS field and its increasing use in ICT4D research it was decided that it would not form part of this research. Thus, it is beyond the scope of this research to discuss affordance theory in any detail. Further, it is also beyond the scope of this research to provide a detailed review of the work on affordance theory in either the fields of IS or ICT4D. Affordance theory is mentioned here only as it was very strongly considered for inclusion as part of the overall research framework, and because it is commonly used in the broader IS field when the subject of the research concerns the socio-technical artifact or the detection of socio-technical mechanisms.

As mentioned, after much consideration it was decided not to use affordance theory in this research. There are a number of reasons for this and these are now briefly discussed. Firstly, it was considered that the research framework as discussed in this chapter is robust and detailed enough to fully address the research questions in a comprehensive manner. Additionally, the research questions have been specifically designed around the philosophical and methodological research framework developed for this research. Also, although affordance theory is being more commonly used in critical realist studies - most notably by Volkoff & Strong (2013) and Thapa (2018, 2019) it is by no means a requirement of all critical realist-based research. Indeed, in personal conversation with Margaret Archer (at the International Association of Critical Realism Conference 2017 in Turin) she advised that there would be no need for the addition of affordance theory to the philosophical, theoretical and methodological frameworks that had been developed for this research. Similar advice was also received from other well-known and widely published academics who are experts in critical realism. A further important factor that

was considered was that there are a number of studies in the ICT4D field - most notably the work of Njihia & Merali (2013) as published in MISQ - which utilise critical realism and the morphogenetic approach to provide mechanism-based explanation without relying on affordance theory. Taking all of this into consideration it was decided not to use affordance theory as part of the research framework as developed for this research.

The following section will now describe and discuss the overall research framework adopted for this research.

5.5 Research Framework

As discussed in the previous chapter, critical realism and Margaret Archer's (1995) morphogenetic approach are adopted by this research for a variety of reasons which have been discussed at length in previous sections. These reasons include the generic ability of critical realism to address issues seen as concerns for ICT4D research, as well as the claim that the field of mHealth in developing countries is better researched by using approaches involving the use of critical theory and critical realism (Lemayian & Omwansa 2013). Additionally, critical realism is an appropriate choice for this research as it is historically associated with underdeveloped economies (Njihia & Merali 2013) and is specifically driven by the value of emancipation (Heeks & Wall 2018, p. 4). These are essential components of any ICT4D-based research paradigm. Moreover, as a philosophy of science and social science, critical realism clearly provides a metatheoretical grounding for understanding complex causality (Mooney 2016) and this is also key to ICT4D research.

Additionally, it is important that the critical realist perspective adopted in this research has the potential to contribute to what Njihia & Merali (1995, p. 751) refer to as the "small but important group of empirical studies" in the IS literature using Archer's (1995) morphogenetic approach. This is worth aspiring to as there have been a number of calls for an increased use of critical realism in the IS field as critical realism is being used by relatively few scholars

in IS research (Dobson, Myles et al. 2007, Allen, Brown et al. 2013). This research will answer the calls made for more critical work in ICT4D research (e.g. Njihia 2013, Walsham 2007), as well as contribute to the general literature on critical realism and specifically to the body of knowledge in the IS literature deploying Archer's (1995) morphogenetic approach.

The overall objective is to use critical realism and the morphogenetic approach to reveal mechanisms that explain how the interaction of different structural, cultural and agency factors have influenced the mHealth project in Sierra Leone. The morphogenetic approach will be used to "unpack these complex interactions, underlying factors and relationships, without conflating structure and agency, to identify significant causal mechanisms and how they work" (Njihia & Merali 2013, p.887). The focus is on exposing the mechanisms which have caused the events unique to this mHealth case and the specific factors which have combined to generate these mechanisms. Specifically, the research seeks an answer to the research question why did the mHealth project in Sierra Leone evolve the way it did, and what are the mechanisms that determined this outcome? This approach is expected to provide a detailed understanding of the mechanisms influencing users of the mHealth systems. In addition, a detailed theoretical explanation of these mechanisms will be provided. Such mechanism-based explanation will lead to a greater understanding of why this mHealth project evolved the way it did and of the mechanisms that determined this outcome. A second objective is to show how the critical realist-based research framework developed for this research can be applied to the mHealth case in Sierra Leone. This includes a consideration of the relevance of critical realism as a philosophical paradigm for ICT4D and mHealth research, and an examination of whether or not this research framework is appropriate, detailed enough, and methodologically suitable for this mHealth case.

The overall research framework developed for this PhD research is presented in figure 5.6 below. It is claimed that such a critical realist-based approach

"offers exciting prospects in shifting attention toward the real problems that we face and their underlying causes and away from a focus on data and methods of analysis" (Mingers, Mutch et al. 2013, p. 795). Allen et al. (2013, p. 835) proposes that such an approach can aid in "fostering explanation in terms of real structures, mechanisms, powers and tendencies, rather than mere description or crude prediction". This research framework provides potential for the research to generate knowledge which will benefit the mHealth project directly and in a significant and tangible way by identifying the underlying causes of any problems. The identification of mechanisms will result in more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors.

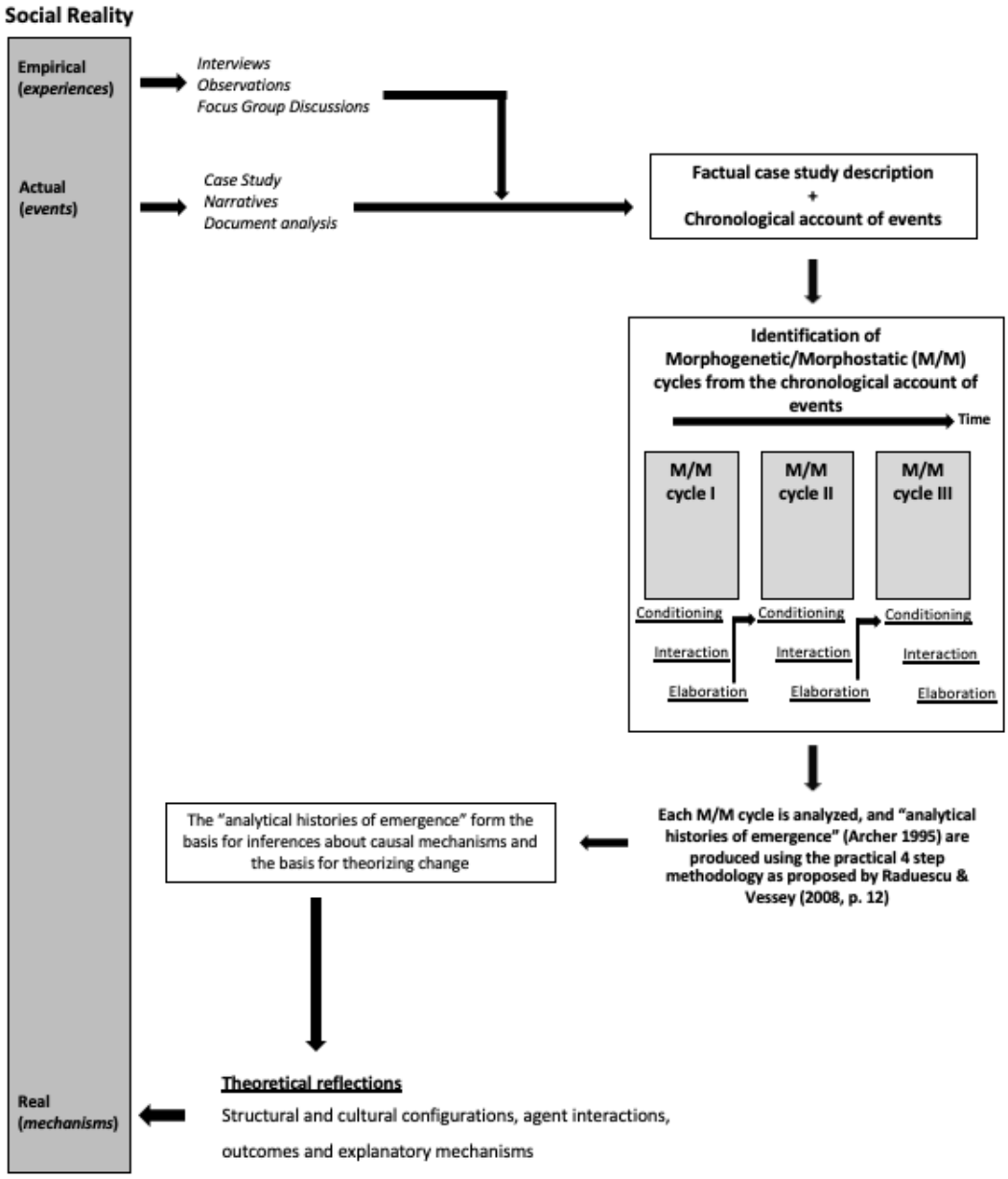

Figure 5.5: The research framework developed for this research

The left hand side of the research framework consists of critical realism's three domains of social reality: the Empirical, the Actual, and the Real. The data which can be collected from the Empirical and Actual domains consists of interviews, observations, focus group discussions and a variety of documents. This data is then analysed and used to prepare a detailed factual case study description and a chronological account of events. This gives rise to identification of discrete M/M cycles which are identified empirically. Each of

the discrete M/M cycles seeks to explain how change (morphogenesis) or reproduction (morphostasis) take place.

The morphogenetic approach has three stages as follows (Archer 1995, Archer 1996):

- Stage one: The researcher identifies relevant antecedent social structural and cultural relations.
- Stage two: The researcher examines the activities of agents that are constrained and facilitated by the identified antecedent social structural and cultural relations.
- Stage three: The researcher examines the effect of the agential activities on the antecedent social structural and cultural relations. This effect may be to re-produce social structure and cultural system unaltered (morphostasis) or to modify or transform them (morphogenesis).

Analysis is done over discrete time periods using the three domains of social reality for SEPs, CEPs and PEPs. Each domain is evaluated in time over each analytical cycle. As described in the previous section each M/M cycle begins at a time T1 that corresponds to prior conditioning by the existing configuration of components in social reality. The intermediate period T2 to T3 corresponds to the mediating action of agency through social or socio-cultural interaction. Emergent change leads to structural and cultural elaboration by time T4. During analysis, these time periods are identified empirically from the historical account of events.

For theorization of the mechanisms to occur, each of the M/M cycles should be analysed using the 4-step methodology as proposed by Raduescu & Vessey (2008, p. 12) to produce analytical histories of emergence (Archer 1995). The 4 steps in the methodology are as follows:

- Identify the internal and necessary relations within and between social structure; that is identify the structural emergent properties

via the transcendental argument. This is done by asking questions about what needs to be the case, what needs to be present for X to be such it is, and not what people think, tell, or believe it is.

- Look for causal influences exerted by social structures on social interaction.
- Look for causal relationships between various types of agents at the level of social interactions.
- Identify how social interaction elaborates upon the composition of social structures by modifying the current internal and necessary structural relations and introducing new ones as in the case of morphogenesis. The congruence between both sets of powers (structural and people's causal powers) results in transformation. Alternatively, if the social interaction reproduces the existing internal and necessary structural relations then morphostasis applies. This effectively means that the two sets of powers are incongruent, and change does not occur.

The analytical histories of emergence will form the basis for inferences about causal mechanisms, i.e. they will form the basis for retroduction. According to Njihia & Merali (2013) analytical histories of emergence are retroductive, corrigible accounts of sociological transformation over time, which can never be final because we can always improve on our explanations as more or better data becomes available. According to Njihia & Merali (2013, p. 886) such "analytical history of emergence ... should tell us with good reason why things are as they are now and where they could be heading, based on the causal tendencies of identified generative mechanisms". It is only at this stage can theoretical reflection, or retroduction, take place. This involves consideration of structural and cultural configuration, and the interactions of the various agents involved and outcomes. In other words, this process allows generative mechanisms to be hypothesized. The retroductive process involves a search for explanatory theory which will be able to explain mHealth in this case. According to Dobson et al. (2013, p. 971) this "requires a non-traditional

approach to research as theories are frequently examined and discarded based on their explanatory power".

The methodology associated with the research framework, as well as data collection and analysis, is described in the following chapter.

Chapter 6: Data Collection & Analysis

6.1 Introduction

This chapter presents details of the data collection processes for this research. Most of the data was collected in Sierra Leone in July 2018 and consists of 25 semi-structured interviews, 7 focus group discussions, a large variety of documents, and unstructured observation. Collected data was analyzed using qualitative data coding techniques and NVivo software.

The chapter begins with a description of the ethical arrangements for the research which involved obtaining formal ethical approval from both TCD and the MoHS in Sierra Leone. The chapter then continues with description of the field investigations and research site for the research, before moving on to discuss the data collection processes in more detail. A description of the data analysis that occurred is then provided, before the chapter concludes with a brief summary.

6.2 Ethical Considerations and Research Conduct

Ethical approval has been received from both TCD and the MoHS in Sierra Leone for this research (see Appendix 7 & 8). This section will outline details of those ethical approval processes.

It is important to note that prior to any ethical approval applications being made careful consideration was given to ethical implications through every stage of the research design. Particular attention was paid to ethical considerations when choosing the data collection methods and the structure and conduct of the semi-structured interviews and focus group discussions. Risks to participants were carefully considered at all stages of the research process, and all data collection methods, participant information sheets, and informed consent forms were very carefully designed to minimize risk to all participants involved. Participants were never asked to discuss or disclose any

personal or health related data, and no health data of any sort which was collected by the mHealth systems or the mobile application was accessed in any way for this research.

Both the participant information sheets (see Appendix 9) and the informed consent forms (see Appendix 10) included a statement that the participant had the right to contact the Ethics and Scientific Review Committee in the MoHS in Sierra Leone for any reason. Contact details for the Ethics and Scientific Review Committee were given on both the participant information sheets and the informed consent forms. Additionally, it was stated on both the participant information sheet and the informed consent form that the subject's participation in this research was voluntary, and refusal to participate would not have involved any penalty or other loss of benefits that the subject was otherwise entitled to.

It was also made clear there were circumstances when the participants participation in the research could have been terminated by the principal investigator without regard to the participants consent. It was clearly stated in the participant information sheet that the subject's participation could have been terminated by the principal investigator if they engage in any illegal or illicit behaviour or make any illegal or illicit behaviour known to the investigator or research team. It was also stated that if the participant had made illicit activities known, these would have been reported to appropriate authorities. The subject's participation could also have been terminated by the principal investigator if they did not wish to be electronically recorded during the interview or focus group discussion. Participants had the right to stop electronic recording at any time, and could have at any time, even subsequent to participation in this research, have had such audio recordings, and any written transcripts resulting from these recordings, destroyed. All participants were informed of this prior to their participation in this research, and this was also stated on both the participant information sheet and the informed consent form.

The monitoring, privacy and confidentiality of all data collected continues to be of extreme importance to this research. All audio, video and any other electronic recordings are kept securely under lock and key at all times and both password protected and encrypted. All electronic recording devices and equipment were password protected and kept secure and in the possession of the lead researcher while any recorded audio, video, or other data was on the device. All audio, video and any other electronic recordings and data was removed from the electronic recording device immediately after being recorded. All such data was copied from the electronic recording device to 2 separate external hard drives. Each external hard drive was encrypted with Apple FileVault which uses XTS-AES 128-bit encryption protocols. One of these hard drives was stored in TCD in a secured and locked filing cabinet or safe box in the offices of the lead researcher. The other hard drive was stored in TCD in a secured and locked filing cabinet or safe box in the offices of the research supervisor. No electronically recorded data of any sort was kept or stored outside TCD at any time. No electronically recorded data of any sort was uploaded to the cloud or backed up online at any time. All passwords and encryption keys continue to be kept by the lead researcher and will be made available to the research supervisors upon request. No one else has access to the passwords and encryption keys. These data monitoring, privacy and confidentiality procedures are clearly stated in the participant information sheet.

The method of selecting interviewees and focus group participants for this research is also described in detail in the participant information sheet. Selection was equitable for all persons targeted for interview. The participant was selected to participate in an interview because they currently are, or at some time in the past were, involved in some capacity with the mHealth project. Each participant was selected based on the lead researcher's knowledge of this mHealth project, and may also have been selected because they were recommended by the Director of Global Health Programmes in World Vision Ireland who provided the principal investigator with the

participant's contact details (if they are not contact details that the principal investigator already had through prior interactions with that person). All persons recommended by the Director of Global Health Programmes in World Vision Ireland was asked to participate in this research. It was clearly stated in the participant information sheet that all subjects participation was voluntary and that refusal to participate would not involve any penalty or loss of benefits that the subject was otherwise entitled to. It was also stated that the participant had the right to omit any responses to individual questions without penalty or loss of benefit. In addition, the participant information sheet states that the participant could withdraw their consent and cease their participation in this research at any time without penalty or any loss of benefit to which they may otherwise be entitled.

In order to mediate any potential risks to participants the consent process was implemented as follows:

- During the last week of June 2018, all eligible subjects/participants for this research were contacted by either the principal investigator or World Vision Sierra Leone and asked if they would be interested in learning more about participating in this research study.
- If they were interested, they were told about the research and asked if it would be ok to contact them again in approximately one week's time regarding an information session about the research.
- During the first week in July 2018, the appropriate participant information sheet was given to all potential participants.
- Anyone who responded (including CHWs and health centre workers) was then asked to attend their nearest health centre for an information session on this research study.
- During the information session participants were told about the research study, the research process, purpose, and procedures. They were fully informed about all aspects of their participation. They were also informed about the provisions for confidentiality, and that their participation in the study would be voluntary. It was

again made clear that refusal to participate in the research did not involve any penalty or other loss of benefits that they were otherwise entitled to. Potential risks and discomforts were also explained, and potential participants were reminded that they maintained the full right to discontinue their participation in the research study at any time should they choose to do so.

- They were also informed that they had the right to contact the Ethics and Scientific Review Committee in the MoHS in Freetown if they had any issues whatsoever with the study, or if they sustained any research-related injury. The Ethics and Scientific Review Committee contact details (address, email and phone numbers) were also given at this time.
- Potential participants were then given the opportunity to ask questions.
- If they were still interested at this point they were then given a copy of the appropriate participant information sheet. This was available in English and both local languages (Kiro and Mende). Each potential participant was given a week to consider their participation.

If any potential participant could not physically attend an information session it was made clear that they could have contacted the principal investigator or any other appropriate person in World Vision Sierra Leone or World Vision Ireland for the information given at the information session.

After one week, participants were once again contacted to ask if they were still willing to participate in this research study. At this time they were given another opportunity to ask questions. They were then asked again if they were still interested in participating in the research study. Any participant still willing to participate was then asked to take part in either a semi-structured interview or focus group discussion. Every attempt was made to organize this at a time convenient to the participant.

Prior to the participants participation in the semi-structured interview or focus group discussion (this was usually on the day of the semi-structured interview or focus group discussion) the participant was given another opportunity to ask questions. If they did have any questions to ask, the research procedures were explained to them again at this point. It was again made clear that participants would be electronically recorded, and that they may stop electronic recording at any time. Additionally, they may at any time, even subsequent to participation in the research, have such audio and/or video recordings, along with any transcripts made from these recordings, destroyed. At this point they were again asked if they were still interested in participating in the research study. If they were, they were asked to sign an informed consent form and they were assigned a random participant number. If they were not willing to participate, their participation in the research was terminated at this point.

At the end of the semi-structured interview or focus group discussion the participant was given another opportunity to ask questions. At all times it was made clear that no coercion was involved at any stage of the process. This includes the informed consent process and the data collection process.

If requested by any participant, they would have been fully de-briefed at the end of their participation in this research. Also, if requested, participants would have been given an explanation of the study. It is interesting to note that although no participant requested to be formally de-briefed, the majority of participants had questions after they completed either the semi-structured interview or the focus group discussion. These questions mainly involved asking about the purpose of the research and whether or not the research could help improve their delivery of health services. Participants were also very interested in asking questions about the lead researcher, where he was from, his background and various other details of his life in Ireland.

All interviews were held in English, and all focus group discussions were conducted in Mende or Kiro. A trained local research assistant conducted the

focus group discussion. The research assistant was also responsible for transcribing all recorded interviews and focus group discussions. All semi-structured interviews and focus group discussions were completed before the end of July 2018. The focus Group discussions were translated and transcribed into English before the end of July 2018. All semi-structured interviews were transcribed before the end of October 2018.

6.3 Field Investigations and Research Site

According to Shaffir (1990) "fieldwork must certainly rank with the more disagreeable activities that humanity has fashioned for itself. It is usually inconvenient, to say the least, sometimes physically uncomfortable, frequently embarrassing, and to a degree, always tense" (Shaffir & Stebbins 1990, p. 1). This statement is bound to be at least particularly accurate in the context of ICT4D research where the environment is likely to be both resource-constrained and far from the researcher's home and place of work. When combined with Smith's (2018) assertion that if it appears that ICT4D and social science research is simple (particularly when using the critical realist paradigm) then you are probably doing it wrong, fieldwork would seem like an uninviting prospect.

For this research field investigations were carried out at the location of the mHealth implementation in Bonthe District, Sierra Leone. A total of three field trips to Sierra Leone have taken place. All three trips visited the World Vision Sierra Leone offices in both Freetown and Mattru Jong in Bonthe District. A variety of the health centres in Bonthe District were also visited, and meetings took place with many of the health workers and CHWs affiliated to these health centres. The visits also allowed meetings with key personnel at the MoHS in Freetown to occur.

The first two field trips took place in January/February 2013 and October/November 2013. Each field trip was of approximately three to four weeks duration. These initial trips provided an opportunity to become familiar

with the mHealth project, the health systems in Sierra Leone and the ethical, social, cultural, political and environmental conditions under which this research was to be carried out. The field trips also provided a unique opportunity to observe first-hand how the mobile phones and mHealth application were actually being used by the CHWs and health workers. Over the course of the first two field trips, a total of 18 of the rural health centres in Bonthe District were visited, with a number of the health centres being visited more than once. This provided an opportunity to observe and talk to a variety of health workers including nurses, maternal and child health (MCH) aides, vaccinators and CHWs. There was also an opportunity to meet with Dimagi personnel who were responsible for developing, localizing and installing the mHealth application, and testing the mobile phone and solar charger hardware. Various meetings were also attended in both Bonthe District and Freetown where a many of the key stakeholders were present including World Vision Project Managers, World Vision Development Facilitators, various other World Vision personnel, the District Health Officer for Bonthe District, the District Health Sister for Bonthe District, Professors and researchers from the University of Sierra Leone, and various other personnel from the MoHS in Sierra Leone. Project planning meetings and training days where CHWs were trained in the use of the mobile phones and the mHealth app were also attended. All of these meetings were important as they facilitated commencement of the process of creating a network of contacts amongst the key project participants and stakeholders.

The experience gained from these first two field trips in 2013 was invaluable and proved to be instrumental in making decisions on the research objectives, the research questions to be asked, and the appropriateness of the philosophical and methodological approaches chosen for this research. It was vital to take the time to become familiar with the social, political, cultural, human and technological environments within which this mHealth case operated, and this helped to make a decision about the philosophical and ontological foundations to be applied to this research (as discussed in section

5.1.1.). It was also important to gain practical experience of conditions in the field in Sierra Leone. Furthermore, these visits allowed the time and space to commence the process of building and maintaining connections and networks of stakeholders. This facilitated an opinion on what the research questions needed to ask and what the research objectives needed to achieve. This was required in order to construct an appropriate philosophical, theoretical and methodological framework which would be achievable within the ethical, social, cultural, political, and physical environment as well as time frame in which the research was to be carried out.

The third and most recent field trip to Sierra Leone took place in July 2018. The majority of the research data was collected during this trip, with 20 of the 25 semi-structured interviews (Appendix 1) and all 7 of the focus group discussions (Appendix 2) taking place. Most of the documents were also collected during this third research trip. The research was conducted strictly in line with the ethical requirements imposed by both TCD and the MoHS in Sierra Leone, with all interviewees and focus group participants asked to give their informed consent in writing before the commencement of the interview or focus group discussion. Ethical considerations for this research are detailed in the previous section of this chapter. All interviews and focus groups were based on an interview or focus group guide (Appendix 3 & 4) and were recorded electronically. Notes were also taken during the course of the interviews and focus groups. All interviews were conducted in English and transcribed. Interviews typically lasted between 60 and 90 minutes. All focus group discussions were conducted in the local language of Mende. A local Sierra Leonean research assistant carried out all focus group discussions, and he was also responsible for transcribing all focus group discussions into English. Focus group discussions typically lasted between 60 and 80 minutes.

Unstructured observation of the CHWs and their use of the mobile phones was also carried out during the July 2018 field trip. In addition, there was unstructured observation of various other health workers in all health centres

visited. Observation of the testing of the mobile hardware and software and various training sessions and meetings was also carried out. Details of all observations were recorded using pen and paper in a written field journal.

A variety of documents in connection with the mHealth project were collected both before and during the field visit in July 2018. Many of these documents were identified and requested during the interviews and at meetings with project stakeholders. Documents collected include mHealth project reports and technical reports, a wide variety of training documents, manuals and material, various policy documents guiding CHWs in the use of the mobile phones, meeting minutes, a variety of other MOTECH and CommCare documents, as well as many other documents including unpublished academic papers and working papers.

In addition to the work carried out during the field trips, other work has also been carried out from Ireland with a total of 5 of the semi-structured interviews being conducted from Ireland (see Appendix 1). All of these interviews were conducted by Skype. Additional ongoing work includes keeping in frequent contact with key people in both World Vision Ireland and World Vision Sierra Leone. This is so that new documents and reports of relevance to the mHealth can be collected, and to keep appraised of any changes or important occurrences in the mHealth project. Finally, a detailed and reflective field journal was completed daily. Observations, thoughts and ideas were all recorded, with great care being taken to complete the field journal on a daily basis.

6.4 Data Collection

As outlined in the previous sections data collection methods consisted of semi-structured interviews, focus group discussions, document analysis, and unstructured observation. The data collected responds to what is required by the research framework as presented in figure 5.4 above. In other words it corresponds to critical realism‘s three domains of social reality by collecting

data from interview, observation, focus group discussion and a variety of documents. All interview transcripts, focus group transcripts and other interview notes were entered into NVivo data analysis software for analysis. This is now discussed in more detail in the following sections and subsections.

6.4.1 Semi-structured Interviews

In-depth, semi-structured interviews are considered to be the best and most effective way to collect rich, qualitative data for this research. The main purpose is to obtain the interviewees views on the phenomena under investigation. This approach requires interviewees to answer open-ended questions and is widely used in a variety of academic fields, including the academic field of healthcare by healthcare professionals in their research (Jamshed 2014). It is claimed that interviews are the most common means of collecting data in qualitative research (Jamshed 2014), and the approach has many advantages and strengths. According to Bernard (2014) one of the main advantages of semi-structured interviews is that the interviewer is in control of the interview process and has the freedom and flexibility to follow new leads as they emerge. Furthermore, Bernard suggests that this way of collecting data is best used when the researcher may have only one chance to conduct the interview with the interviewee. The semi-structured interview also allows for electronic recording and transcription of the interview.

Details of the ethical considerations concerning the semi-structured interviews has already been outlined in section 6.2. Ethical approval was received from both TCD and the MoHS in Sierra Leone for this research (see Appendix 7 & 8), and this ethical approval guided all aspects of the semi-structured interview process. The ethical approval also dictated the rationale for the identification and selection of interviewees, with this being described in detail in the participant information sheet (see Appendix 7 & 8). The aspiration was to interview every person who was involved in any significant way with the mHealth project. In order to select every one of these people, reliance was placed on the knowledge of 3 key persons; namely, Nichola Dunne (Programs

Officer with responsibility for the mHealth project, World Vision Ireland), Magnus Conteh ((Former) Director, Global Health Programmes, Strategic Partnerships and Innovation at World Vision Ireland), and Joseph Musa (mHealth Project Manager, World Vision Sierra Leone). These 3 people have detailed and extensive knowledge of the mHealth project from its inception to the current day. Each of these 3 people were asked to provide a list of all key persons involved with the mHealth project. The 3 lists were collated, and there was a total of 40 different people listed between the 3 lists. It should be noted that there was significant correlation of names between the lists. All 40 people were contacted in line with the procedures as laid out in the ethical approval procedures as already detailed in Section 6.2. A total of 25 people responded that they were willing to participate in the interview process. A second attempt was made to contact the 15 people who did not respond, but none of these 15 people were available for interview for a variety of reasons. The 25 people who responded positively to the request for interview were interviewed. This methodology is considered to have led to an equitable selection for all persons targeted for interview. It also meant that no interviewee sampling was required as everyone who was available (100% of the population) was interviewed.

It was clearly stated in the participant information sheet that all subjects participation was voluntary and that refusal to participate would not involve any penalty or loss of benefits that the subject was otherwise entitled to. It was also stated that the participant had the right to omit any responses to individual questions without penalty or loss of benefit. In addition, the participant information sheet states that the participant could withdraw their consent and cease their participation in this research at any time without penalty or any loss of benefit to which they may otherwise be entitled.

For this research an initial interview guide was developed, and this was tested in a small number of mock interviews. The initial interview guide was short, but it evolved after detailed review of how the guide performed in the mock

interviews. A variety of sections and questions were added, and a number of new interviewer prompts were also included. In addition, the interview guide was adapted for different types of interviewee to ensure important data was captured. This also ensured that relevant questions that related to the interviewee and their area of knowledge in the mHealth case were asked. The interview guide constantly evolved over the course of the interviews, with additional questions and prompts being added. These additions were based on data which arose in previous interviews and were frequently added in an attempt to allow the current interviewee to verify points that had been made by previous interviewees in previous interviews. A sample interview guide is presented in Appendix 3.

In total 25 interviews were conducted with each interview lasting between 60 and 90 minutes. A detailed list of interviewees is presented in Appendix 1. A total of 20 of these interviews were conducted in person in Sierra Leone during the field trip in July 2018. The remaining 5 interviews were conducted between March and July 2018 by Skype from Ireland. Selection was equitable for all persons targeted for interview as detailed in section 6.2 above, and all interviews were conducted in accordance with the ethical approval received from both TCD and the MoHS in Sierra Leone as previously outlined. Each interviewee was selected for interview because they were a key person who had significant involvement with the mHealth project. Each participant was selected either based on the lead researcher's knowledge of this mHealth project or because they had been recommended by the Director of Global Health Programmes in World Vision Ireland.

Everyone targeted for interview agreed to be interviewed. This means that all of the key people involved with the mHealth project were interviewed for this research. Interviewees included the National Director of World Vision Sierra Leone, the (former) Director of Global Health Programmes, Strategic Partnerships and Innovation at World Vision Ireland, the ICT Manager in World Vision Sierra Leone, the mHealth Project Manager in Sierra Leone, the District

Medical Officer in Bonthe District, both the former and existing Digital Health and M+E Health Specialist for the mHealth project in Bonthe District, and the mHealth project manager in Bonthe District. In addition, an opportunity arose to interview key people within the MoHS in Freetown including the CHW Hub Coordinator, and the Co-Chair of eHealth Coordination Hub.

All interviews were audio recorded in accordance with the ethical approval requirements as detailed in section 6.2 above. Detailed interview notes supplemented each interview. These notes were taken with pen and paper during the interview. All interviews were transcribed into Microsoft Word before the end of October 2018. In total, this resulted in approximately 550 pages of interview transcripts and over 100 notebook sized pages of handwritten interview notes.

6.4.2 Focus Group Discussions

Focus group discussions are group interviews where a moderator guides the interview allowing a small group to discuss topics raised by the interviewer (Morgan 1997). Focus group discussions are used frequently in social science research and are seen as an effective way to collect data. Focus group discussions have many advantages (Morgan 1996), one of the main advantages being that focus groups not only explore what people have to say but they provide insight into complex behaviours and motivations (Morgan & Krueger 1993). All focus group discussions as carried out by this research were conducted in line with the principle for conducting focus groups as laid out by Morgan (1996, 1997).

A total of 7 focus group discussions took place on 24, 25 and 26 July 2018. These are detailed in Appendix 2. The largest amount of focus group participants was 14 in Junctionla MCHP, with the lowest number of participants being 5 in both Yargoi CHC and Gbangbaia CHP.

All focus group discussions were guided by a focus group guide which can be viewed in Appendix 4. The focus group discussions were conducted in accordance with the ethical approval received from both TCD and the MoHS in Sierra Leone.

All focus group discussions were conducted in the local language of Mende. A local Sierra Leonean research assistant carried out the focus group discussions, and he was also responsible for transcribing all focus group discussions into English. Focus group discussions typically lasted between 60 and 80 minutes. All focus group discussions were audio recorded in accordance with the ethical approval requirements as outlined in section 6.2, and subsequently transcribed into Microsoft Word before the end of July 2018. In total, this resulted in approximately 70 pages of focus group discussion transcripts.

6.4.3 Unstructured Observation

Observation has a long tradition in the social sciences (Punch 2013), and this includes both structured and unstructured observation. Unstructured observation is generally taken to mean the observation and recording of behaviour in a holistic way without the use of a pre-determined guide. Unstructured observation is usually adopted in exploratory studies, with the main purpose being to provide a richer and more direct account of behavioural phenomenon (Taylor, Sinha et al. 2006)

According to Punch (2013) quantitative research is likely to use highly structured observation whereas qualitative research is more likely to rely on unstructured observation. Unstructured observation does not use predetermined categories and classifications of data, but instead makes observations in a more open-ended way. Unstructured observation relies on the data being observed as a naturally unfolding stream of actions. Punch (2013) suggests this is because categories and concepts for describing and analysing the observed data will emerge later in the research. This is likely to be during the data analysis phase.

Unstructured observation of the CHWs and other health workers was carried out during the research field visit in July 2018 in accordance with the ethical requirements as already outlined. The CHWs and health workers were observed carrying out their normal duties and their use of the mobile phones was also observed. Observation of the testing of the mobile hardware and software and various training sessions and meetings was also completed. Additionally, observation of the workings of the DHMT and other World Vision staff occurred. Details of all observations were recorded using pen and paper in a written field journal. Observations, thoughts and ideas were all recorded, with great care having been taken to complete the field journal on a daily basis. Great care was taken to record all observations in as much detail as possible. This resulted in over 85 notebook sized pages of unstructured observation handwritten notes.

6.4.4 Document Analysis

According to Bowen (2009) document analysis is an important social research approach as well as a key tool in most schemes of data analysis and triangulation. The methodology has many advantages including being cheaper and more time efficient that other forms of data collection. Furthermore, documents are stable and "non-reactive" (Bowen 2009, p. 31) as well as being robust, easily verifiable, and highly reliable. Thus, documents are unlikely to be affected by researcher bias or other influences.

O'Leary (2017) provides a useful set of guidelines for document analysis. This is as follows:

- Gather relevant texts.
- Develop an organization and management scheme.
- Make copies of the originals for annotation.
- Assess authenticity of documents.
- Explore document's agenda, biases.
- Explore background information (e.g. tone, style, purpose).

- Ask questions about document (e.g. Who produced it? Why? When? Type of data?).
- Explore the content of the document.

O'Leary (2017) suggests two approaches for step 8 where the content of the documents is explored. Firstly, she advises adoption of the interview technique which involves treating the document like an interviewee who holds relevant information. The researcher effectively asks questions of the document, and then highlights answers within the text. The second approach requires the researcher to note occurrences where the use of particular words, phrases and concepts is recorded. According to O'Leary (2017) this approach allows the researcher to effectively determine what is being searched for, and then organise according to the frequency of appearance of the searched for item. In addition to the work of O'Leary in this area, Bowen (2009) suggests that thematic analysis of documents is a useful research technique. This approach takes emerging themes and makes them into categories used for further analysis, sometimes leveraging software such as NVivo.

The documents gathered for this research were initially organised and explored in line with O'Leary's (2017) 8 guidelines. A wide variety of documents connected to the mHealth project were identified and collected. These documents included, but were not limited to:

- mHealth project and technical reports.
- Training documents, manuals and material.
- Policy documents guiding CHWs in the use of the mobile phones.
- Workflow reports.
- Minutes of various meetings.
- Various MOTECH and CommCare documents.
- Various memorandums of understanding (e.g. for use of the mobile phones by the CHWs).
- Various feedback and other evaluation forms.
- A variety of documentation from Dimagi including:
    - CommCare platform overviews.

- Use case guides.
- Academic and other presentations.
- Both published and unpublished academic papers and working papers.

These documents are considered to be important to this research as they provide the timeline upon which interview data was based in order to build as complete a picture of the mHealth project as possible. The collected documents were used to build the chronological account of events and the factual case study description.

6.5 Data Analysis

This section and the sub-sections which follow provide detail of the data analysis that took place for this research. The research is focussed on the mHealth project in Sierra Leone between mid-2012 up to the current date and beyond to the completion of AIM-Health+ in 2021. As previously discussed, the data collected for this research consists of semi-structured interviews, focus group discussions, a variety of documents and various reports, and unstructured observation. The data analysis which was carried out is now described in the sections which follow.

It was decided that two separate levels of data analysis would be required. The first level was a descriptive level of data analysis which produced the factual case study descriptions and the chronological account of events. These two documents have been adapted to present the story of mHealth in Bonthe District as presented in Chapter 2. This involved the use of NVivo for thematic analysis of documents and the other interview, focus group, and observation data. The detailed factual case study description of the mHealth case and a chronological account of events gave rise to identification of 3 distinct M/M cycles which were identified empirically. Each of the M/M cycles seeks to explain how change (morphogenesis) or reproduction (morphostasis) take

place. Analysis of the 3 M/M cycles was completed over discrete time periods using the 3 domains of social reality for SEPs, CEPs and PEPs.

In order for theorization of the mechanisms to occur, each of the M/M cycles was analysed using the 4-step methodology as proposed by Raduescu & Vessey (2008, p. 12) to produce analytical histories of emergence. In addition, the analytical histories of emergence were derived from a second separate level of data analysis conducted at the analytical level. Development of the analytical history of emergence proceed iteratively with constant comparisons to the interview, focus group, observation and document data.

Data analysis is now described in more detail in the following sub-sections. The analysis of the M/M cycles and the analytical histories of emergence are discussed in Chapter 7.

6.5.1 Factual Case Study Description and a Chronological Account of Events

There is a significant amount of data available on the first mHealth pilot project between 2012 and 2014. This is because many of the people interviewed and who took part in the focus group discussions were part of that project. Additionally, there are many documents, reports and both published and unpublished research papers relating to the mHealth project. There is less data available on how the phones and mHealth app were used during the period of Ebola between May 2014 and March 2016. Many of the people interviewed were working away from the mHealth project during that time, and thus there are less documents and reports available. This may be because the mHealth project was severely restricted during that period with scarce resources being allocated elsewhere. There was also a focus on many of the Ebola-related projects which were in operation. In addition, there is significantly less data available on the current iteration of the mHealth project, AIM-Health+ and mHealth2. This is for the obvious reason that that the mHealth2 pilot commenced just a few months ago in September/October 2018. There is expected to be a lot of documentation over the coming years as research

reports and academic papers are written, but currently there is a dearth of data available.

As required by the research framework presented in figure 5.6 above, the first step is to prepare a detailed factual case study description of the mHealth case and a chronological account of events. Even though there is little guidance provided in the literature on the use of NVivo in critical realist research, it was decided to use NVivo for data analysis. The literature does contain a small number of critical realist studies which have discussed methodology in detail. However, few of these studies "have explicitly discussed methods of data analysis (e.g., coding)" (Fletcher 2016, p. 11), or described how software such as NVivo has been used for data analysis in critical realist studies. This lack of guidance makes data analysis using NVivo a daunting prospect for any early stage critical realist researcher attempting research of this type.

Thapa (2018) uses NVivo in his study of the NWNP which uses Bygstad's (2011) four-step methodology. This is a useful addition to the literature but unfortunately Thapa does not provide detailed methodological guidance on how data was analysed or how NVivo was used. In addition, Fletcher (2016, p. 11) used NVivo for data analysis in her critical realist-based study of Canadian farm women's experiences with agricultural. She identifies that although critical realism is a useful philosophical framework for social science research, "little guidance is available on which precise methods - including methods of data collection, coding, and analysis - are best suited" to applied critical realist research (Fletcher 2016, p. 1). Fletcher (2016) identifies this lack of literature on critical realism as a challenge to the process of coding data. She suggests that descriptions are "vague at best" (Fletcher 2016, p. 11), and what literatures there are concentrate on a grounded theory approach. Finally, Njihia (2013) uses NVivo for data analysis in his study of ICT in Kenya, but again detailed methodological guidance on data analysis using NVivo is lacking and could be more comprehensive.

This lack of guidance on data analysis using NVivo in the literature makes a clear and comprehensive data analysis methodology essential for this research. In an effort to provide methodological certainty and clarity this research uses NVivo as the primary software tool for data analysis and relies on the principles of thematic analysis as outlined by Braun & Clarke (2006) for guidance.

NVivo is commonly used to analyse data in qualitative research (Buchanan and Jones 2010), with quantitative methodologies having long utilised computer assisted software for data analysis. As already stated, the data analysis methodology adopted for this work is based on the principles of thematic analysis as outlined by Braun & Clarke (2006). This process requires that the data collected is grouped into categories of meaning, where relationships between the categories are derived from the data itself through a process of inductive reasoning. This process is known as coding.

According to Glaser & Strauss (1967) the coding process begins by recognising what are called data incidents. These incidents are then coded into categories. Data analysis then usually commences with an open coding process in an attempt to generate broad thematic categories or concepts which are to be obtained from the raw data. Categories can change as analysis progresses and data incidences are compared and put into categories. Braun & Clarke (2006) provide a useful six-phase guide outlining the phases and steps which are required to be taken in this analytical process. The six phases are as follows:

1. Becoming familiar with the data. This effectively involves reading and re-reading the transcripts (Maguire and Delahunt 2017). It also involves importing the data into NVivo. Maguire (2017) advises that the researcher should be very familiar with the entire body of data before this is done. She suggests that initial ideas can be written down, as well as other notes and impressions.
2. Generating initial codes (often referred to as open coding). This is the phase where the data begins to be organised in a meaningful and systematic way (Maguire and Delahunt 2017). In other words, this is the phase where the data is first coded. Effectively, the data is deconstructed by assigning codes with

clear definitions that are clearly understood. Open coding in this context means that there are not pre-set codes. Instead, codes are modified and developed as the process progresses.

3. Searching for themes. This phase involves developing categories or preliminary themes. This is done by a close examination of the codes to see if they group into logical themes. All of the codes should be allocated into one or more of these logical themes. This phase may also include re-naming and combination of themes or categories if appropriate.

4. Reviewing themes. This phase involves reviewing, modifying and developing the preliminary themes as identified in the previous phase (Maguire and Delahunt 2017). This is completed in order to arrive at a more detailed understanding of the aspects under investigation. Maguire (2017) suggests the next step is to think about whether the themes make sense in the context of the entire dataset. She offers the following questions to consider Maguire (2017, p. 3358): "Do the themes make sense? Does the data support the themes? Am I trying to fit too much into a theme? If themes overlap, are they really separate themes? Are there themes within themes (sub-themes)? Are there other themes within the data?"

5. Defining and naming themes. This phase is often referred to as the data reduction phase and involves consolidating codes in a final refinement of themes to create a final framework of themes. Again, Maguire (2017) offers guidance here by suggesting that we ask what are the themes saying, and if there are sub-themes how might they interact with the main themes?

6. Writing analytical memos involves ensuring the content of each category is accurately summarised against higher level themes. This phase also involves a final writing up of the analysis.

This process was followed as closely as possible when coding and analysing the data for this research. The aspiration is to have this research guided by a clear and concise deductive, directed coding process (Hsieh and Shannon 2005).

It was decided that two separate levels of data analysis would be required. The first level was a descriptive level of data analysis which produced the factual case study descriptions and the chronological account of events. This involved the use of NVivo for thematic analysis of documents and the other interview, focus group and observation data. The second separate level of data analysis was at the analytical level and was completed to arrive at the analytical history of emergence. This is discussed in more detail in the following sections.

The first level of thematic data analysis started with open coding using a list of codes drawn up based on the research framework and key critical realist concepts. This resulted in 80 free nodes. These were grouped into emergent categories in an effort to search for themes. All themes, concepts and ideas were examined, and many themes were combined and renamed at this point. All were subject to change and were added to when appropriate (Gilgun 2011). Hierarchical relationships were also identified at this point, and a variety of node sets, deeper thematic nodes, and relationship nodes were derived from the free nodes. As more documents and interview transcripts were analyzed the accounts got richer. Eventually it was recognised that there was a diminishing return on thematic reach until the point where no new themes were emerging. Theoretical saturation was considered to have been reached at this point indicating that both the detailed factual case study description of the mHealth case, and the chronological account of events were substantively completed as fully as possible.

As there is so little guidance on critical realist-based data analysis using NVivo it was decided to add an additional layer of analysis at this point. The factual case study and chronological account of events were provided to multiple key stakeholders in World Vision Ireland and World Vision Sierra Leone for validation and corroboration. The World Vision stakeholders provided feedback that the documents were an accurate representation of what happened and did not add anything significant to either the detailed factual

case study description of the mHealth case or the chronological account of events.

Both the detailed factual case study description of the mHealth case and the chronological account of events have been used to present an adapted version of the story of the mHealth project in Bonthe District as presented in Chapter 2.

6.5.2 Morphogenetic/Morphostatic Cycles

M/M cycles can be used to analyse the relationship between structure and agency. Analysis is done over discrete time intervals to identify emergent changes in structure, culture and people, and their causal relationships. A total of 3 domains of social reality are recognized in M/M cycles involving structure, culture and people as previously described in section 5.3.1. Structural, cultural, and people (agential) emergent properties are relatively enduring and irreducible to each other. As can be seen in figure 6.1 these domains are evaluated in time over each analytical cycle, with each beginning at a time T1 that corresponds to prior conditioning by the existing configuration of components in social reality. The intermediate period T2 to T3 corresponds to the mediating action of agency through social or socio-cultural interaction. Emergent change leads to structural elaboration by time T4. Structural elaboration can result in either reproduction (morphostasis) or transformation (morphogenesis).

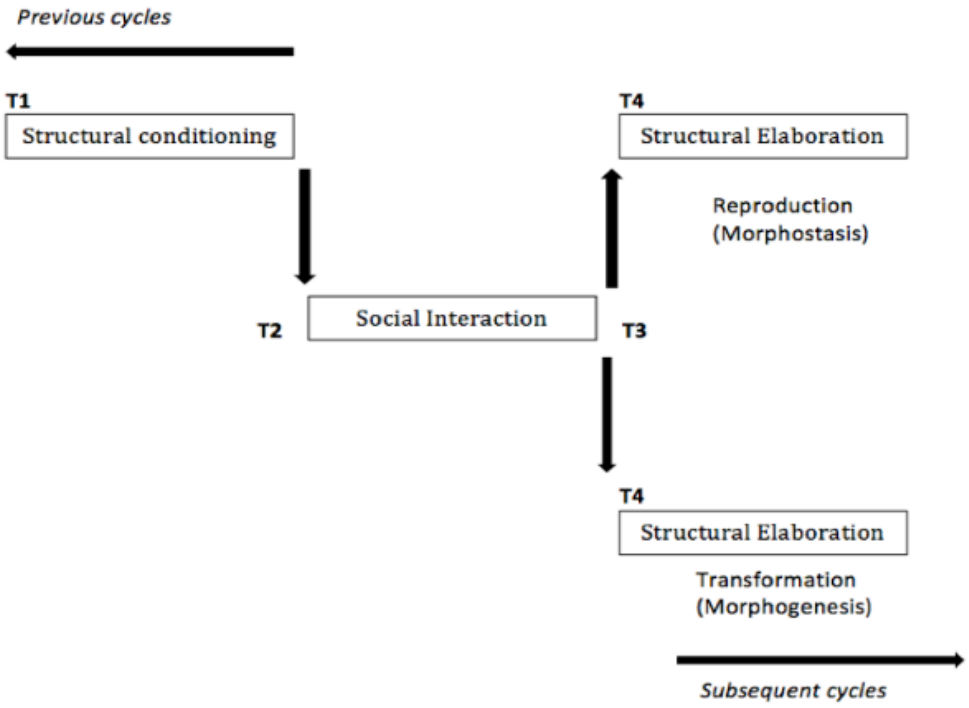

Figure 6.1: The M/M cycle for structure and culture

Each of the discrete M/M cycles seeks to explain how change (morphogenesis) or reproduction (morphostasis) take place.

The morphogenetic approach has three stages as follows (Archer 1995, 1996):

- Stage one: The researcher identifies relevant antecedent social structural and cultural relations.
- Stage two: The researcher examines the activities of agents that are constrained and facilitated by the identified antecedent social structural and cultural relations.
- Stage three: The researcher examines the effect of the agential activities on the antecedent social structural and cultural relations. This effect may be to re-produce social structure and cultural system unaltered (morphostasis) or to modify or transform them (morphogenesis).

Analysis is done over discrete time periods using the 3 domains of social reality for SEPs, CEPs and PEPs. Each domain is evaluated in time over each analytical

cycle. As described on the previous section each M/M cycle begins at a time T1 that corresponds to prior conditioning by the existing configuration of components in social reality. The intermediate period T2 to T3 corresponds to the mediating action of agency through social or socio-cultural interaction. Emergent change leads to structural and cultural elaboration by time T4. During analysis, these time periods are identified empirically from the historical account of events.

Using this approach, and relying on the data analysis as described in the previous section, 3 M/M cycles were identified as follows:

1. The “mHealth planning and pilot cycle” - mid-2012 to April 2014
2. The “Ebola virus cycle” - May 2014 to March 2016
3. The “mHealth2 cycle” - March 2016 to December 2021

These M/M cycles were identified empirically from the detailed factual case study description of the mHealth case and the chronological account of events (see previous section 6.5.1). Each M/M cycle represents appreciable change in the social system. The M/M cycles identified are now described.

The first M/M cycle has been called the “mHealth planning and pilot cycle”. This M/M cycle took place between mid-2012 and May 2014. The cycle commenced with the planning for the mHealth component of the AIM-Health project in mid-2012. The AIM-Health programme was a five-year initiative which was planned to be implemented between January 2011 and December 2015. This cycle includes all of the planning, design and implementation of the mHealth app and thus begins in mid-2012 when the planning phase of the mHealth project commenced. Also included is the pilot mHealth project itself when the Nokia C2-01 mobile phones and mHealth app were given to CHWs in Bonthe District for testing in January 2013. The mHealth pilot itself officially commenced in Bonthe District in January 2013 with the Nokia C2-01 mobile phones and mHealth mobile application given to 102 CHWs. Another 115 CHWs received a Nokia C2-01 mobile phones which was set up on a closed user group, but without the mHealth mobile application. The remaining 116 CHWs received neither a mobile phone nor mHealth application. There were plans in

place to scale up the mHealth project to provide all 333 CHWs with mobile phones set up on a closed user group and with the mHealth application. These plans included a further scale up to all 24 of World Vision's ADPs in Bonthe District which was planned for late 2014, which was to be followed in 2015 by a scale up to all World Vision ADPs in Sierra Leone.

The second M/M cycle occurred during the period of the Ebola epidemic in Sierra Leone. This M/M cycle has been called the "Ebola virus cycle" and it took place between May 2014 and March 2016. This was a period of great turbulence and disruption which resulted in 3,955 deaths in Sierra Leone. It was also a chaotic time for the mHealth project which saw many key people leaving the project or being redeployed to other Ebola-related projects. This meant the capacity of the mHealth management team in Bonthe was greatly reduced during this M/M cycle. Key people who left the mHealth project included the AIM-Health Project Manager and the Digital Health M&E Technical Specialist. During this time many of the CHWs continued to use the original Nokia C2-01 mobile phones and mHealth app when making household visits, registering pregnant women and making referrals. In addition, a different cohort of CHWs were given Nokia ASHA Java based mobile phones as part of an Ebola community mobilization project run jointly by World Vision and the DHMT in Bonthe District. As part of the Ebola project the CHWs were trained to use the mobile phones to provide information on Ebola to the community, take sick people to the health centre, and report suspected Ebola cases. Although the activity of the CHWs was restricted during this time, data continued to be collected on the original Nokia C2-01 mobile phones that still existed and had a functioning mHealth app installed. This happened even though many of the original Nokia C2- 01 phones had been broken, damaged or stolen.

The third M/M cycle identified has been called the "mHealth2 cycle". This M/M cycle commenced immediately after the Ebola crisis ended in March 2016 and is currently ongoing with the expectation that it will run until the end of the

AIM-Health+ project in December 2021. The "mHealth2 cycle" covers the post-Ebola period in Sierra Leone and includes planning for the next iteration of the AIM-Health project which is to be called AIM-Health+. AIM-Health+ is expected to run for a duration of five years between 2017 and 2021 and has an mHealth component called mHealth2. The "mHealth2 cycle" saw the return of key people to the mHealth project throughout 2017, and new Samsung J2 Android mobile phones - with a new mHealth android app installed - given to approximately 300 CHWs in the Imperi and Sherbro Island Districts of Bonthe District in August 2018. Also included in this M/M cycle is the training received by the CHWs at this time and the potential reconfiguration of their work as a result of their use of the new Samsung J2 mobile phone. This cycle also includes the establishment of the CHW Hub and the eHealth Hub. Also included is the appointment of a CHW Focal in the DHMT in Bonthe District.

These M/M cycles are hereafter referred to as M/M I, M/M II, and M/M III respectively.

For theorization of the mechanisms to occur, each of these M/M cycles will be analysed using the 4-step methodology as proposed by Raduescu & Vessey (2008, p. 12) to produce analytical histories of emergence (Archer 1995). The 4 steps in the methodology are as follows:

- Identify the internal and necessary relations within and between social structure; that is identify the structural emergent properties via the transcendental argument. This is done by asking questions about what needs to be the case, what needs to be present for X to be such it is, and not what people think, tell, or believe it is.
- Look for causal influences exerted by social structures on social interaction.
- Look for causal relationships between various types of agents at the level of social interactions.

- Identify how social interaction elaborates upon the composition of social structures by modifying the current internal and necessary structural relations and introducing new ones as in the case of morphogenesis. The congruence between both sets of powers (structural and people's causal powers) results in transformation. Alternatively, if the social interaction reproduces the existing internal and necessary structural relations then morphostasis applies. This effectively means that the two sets of powers are incongruent, and change does not occur.

The practical application of this process is described in detail in the following chapter.

6.6 Summary

Although extremely challenging in the context of a severely resource-constrained environment such as Sierra Leone, all fieldwork progressed as planned in most instances. Without exception, everyone involved with the mHealth project was helpful, friendly and very interested in the research. In some cases, interviews and focus group discussions had to be rescheduled or ran many hours late, but all interviews and focus group discussions yielded rich data which was considered to be accurate and detailed. Many of the focus group discussions were difficult to get to as they were organised in remote regional health centres. In addition, one of the focus groups was mistakenly scheduled for the wrong day which meant that the CHWs turned up a day early. They were kind enough to reschedule to the following day when the mistake was detected.

In addition, there are likely to be other practical problems when collecting data in developing countries such as Sierra Leone. These include dealing with different languages, indifferent ethical, cultural, and social norms and

traditions. Also included is the likelihood of poor road infrastructure and power supply as well as non-existent Internet availability.

Despite this, it is believed that all data collected from interviews, focus groups, unstructured observation, and documents was accurate, honest and analysed in a robust and appropriate manner during data analysis.

Chapter 7: Research Findings and Discussion

7.1 Introduction

This Chapter will provide analysis of each of the 3 M/M cycles as identified in Chapter 6. Each of the 3 M/M cycles will be analysed using the 4-step methodology as proposed by Raduescu & Vessey (2008) to produce analytical histories of emergence. The chapter will go on to discuss the mechanisms hypothesized before concluding with a revisiting of the two research questions posed by this research.

The 3 M/M cycles to be analyzed in the following sub-sections are as follows:
M/M I - The "mHealth Planning and Pilot Cycle"
M/M II - the "Ebola Virus Cycle"
M/M III - The "mHealth2 Cycle"

7.1.1 M/M I - The "mHealth Planning and Pilot Cycle"

The first M/M cycle is identified as the "mHealth planning and pilot cycle" which took place between mid-2012 and May 2014. This will henceforth be referred to as M/M I. M/M I is now analyzed using the 4-step methodology as proposed by Raduescu & Vessey (2008). Put simply, the first step in Raduescu & Vessey's methodology is to identify structural emergent properties via the transcendental argument. This involves asking questions about what needs to be the case, what needs to be present for X to be such as it is, and not what people think, tell, or believe it is. Then, causal influences which might lead to causal relationship between agents are sought. Following that either morphogenesis or morphostasis is hypothesized as follows: where key players converge ideologically, cultural or structural elaboration is hypothesized; where institutional reconfiguration in the face of pressures occurs, structural elaboration is hypothesized.

The analysis process for M/M I began by examining the introduction of the mHealth project, including the associated mobile phone hardware and mHealth mobile application. The question concerning what needed to be present for the mHealth project to be implemented was first addressed by looking at the infrastructure available to World Vision in Bonthe District. The focus was on the human people needed to make the mHealth project actually work. Most important in this were the CHWs who already had a strong vocation towards helping their communities, and who were willing to use what they saw as the new mobile technologies if these technologies could enable them to perform their jobs more effectively. Thus, the mobile phones and the potential of the CHWs to do their jobs more effectively was seen as a causal influence in this case. This also created a new causal relationship between the 3 groups of agents: the World Vision mHealth management team, the DHMT and the CHWs. This is hypothesized to have resulted in cultural transformation or morphogenesis of the CHWs social system as these 3 players clearly converged ideologically around the potential value of the mHealth systems.

This hypothesization of cultural transformation or morphogenesis of the CHWs social system is particularly relevant because the CHWs could use the new mobile technologies in a variety of ways which had the potential to reconfigure their social structures. The social structures reconfigured and elaborated included the CHWs working structures, the CHWs family structures, and the overall status of the CHWs in the community. This all resulted from the CHWs being in possession of a mobile phone and a solar charger and their ability to use this mobile hardware in a variety of ways for both work and in their personal lives. Very importantly, this included the way the CHWs used the phones to essentially create communities of practice amongst themselves. It also includes the increase in status they enjoyed as a result of having a new tool kit - the mobile phone and the mHealth application - which enabled them to serve their communities more effectively. Thus, significant cultural transformation or morphogenesis is hypothesized.

The other people of importance were the World Vision mHealth management team in Bonthe. The mHealth management team was made up of the mHealth Project Manager who played the role of project champion in this case as he strongly believed that the mobile technologies being implemented as part of the mHealth case would improve health outcomes. Also, of relevance is the technical mHealth Program Coordinator who was responsible for all technical aspects of the mHealth project in Bonthe. He also acted as a project champion in this case. This led to a variety of causal influences including these two people having a strong motivating effect on others around them, in addition to rallying people to the mHealth cause. Moreover, there were many causal relationships resulting from the role played by the mHealth project manager and the mHealth technical manager which modified and elaborated on social structures by creating a new environment which advocated the benefits and potentialities of mHealth. This resulted in transformation or morphogenesis of both structural and cultural structures around the mHealth project in Bonthe.

Additionally, the mHealth project resulted in a reorganization and expansion of the technical capacity of World Vision Sierra Leone as a whole. This resulted from a variety of factors including the establishment of the mHealth management team in Bonthe District which included new technical expertise in the form of the new mHealth Program Coordinator, as well as new collaborations with research institutions such as TCD and UoSL which brought a new technical skillset. Again, this is seen as having created new causal relationships between agents which had the effect of promoting technology and the mHealth project as a strategy which could improve health outcomes. It also resulted in both key players converging and institutional reconfiguration in World Vision. This interaction again resulted in transformation of the cultural structures around the perception of mHealth and the use of technology. As a result of this both cultural and structural elaboration is hypothesized.

Power, influence and control issues are also of relevance here. The introduction of new technology-based systems is likely to be resisted by people who have long-established manual ways of doing things. This was evident in both World Vision and the DHMT in Bonthe where the introduction of the mHealth systems were feared in some quarters. This fear is likely to have come from a loss in power and influence as new people were introduced who had different ways of doing things. In addition, the traditional ways of collecting and accessing data would be largely unavailable as the data was now being stored on a server in Freetown and not in paper form. The introduction of new personnel as well as increasing technical capacity, had an effect on the existing agents within World Vision Sierra Leone, diluting their direct power and influence in Bonthe District. The new mHealth management team could also be seen to have diluted the power of the existing DHMT which was headed by the DMO and the District Health Sister. Both the DMO and the District Health Sister wielded considerable power over health assets and resources in Bonthe District. The existing good relationships between World Vision and the DHMT in Bonthe meant that a direct power battle was avoided, but it is recognised that many in the DHMT were not convinced of the benefits of technology in general and the new mHealth programme in particular. This was in direct opposition to the views of the CHWs who wanted mHealth infrastructure and believed it would positively reconfigure their work practices. Overall, this did not lead to key players converging nor significant institutional reconfiguration of the DHMT. Thus, neither morphogenesis nor morphostasis can be seen to have taken place and no significant cultural or structural elaboration is hypothesized.

Another theme of significance was the newfound bargaining power the CHWs possessed as a result of the introduction of this technology. This did not result in significant causal influences as the CHWs were highly reluctant to use the technology as a bargaining chip to get additional benefits for themselves or their communities. All key players did converge ideologically, but this led to a strengthening of both cultural and social structures where the existing social

and cultural beliefs and structures of the CHWs were reinforced. Thus, the social structures were reproduced and morphostasis is hypothesized.

This completed the analysis of M/M I. According to figure 7.1 below M/M cycles are linked over time. Thus, M/M I effectively leads into M/M II, and M/M II leads in to M/M III. M/M II is analysed in the following section.

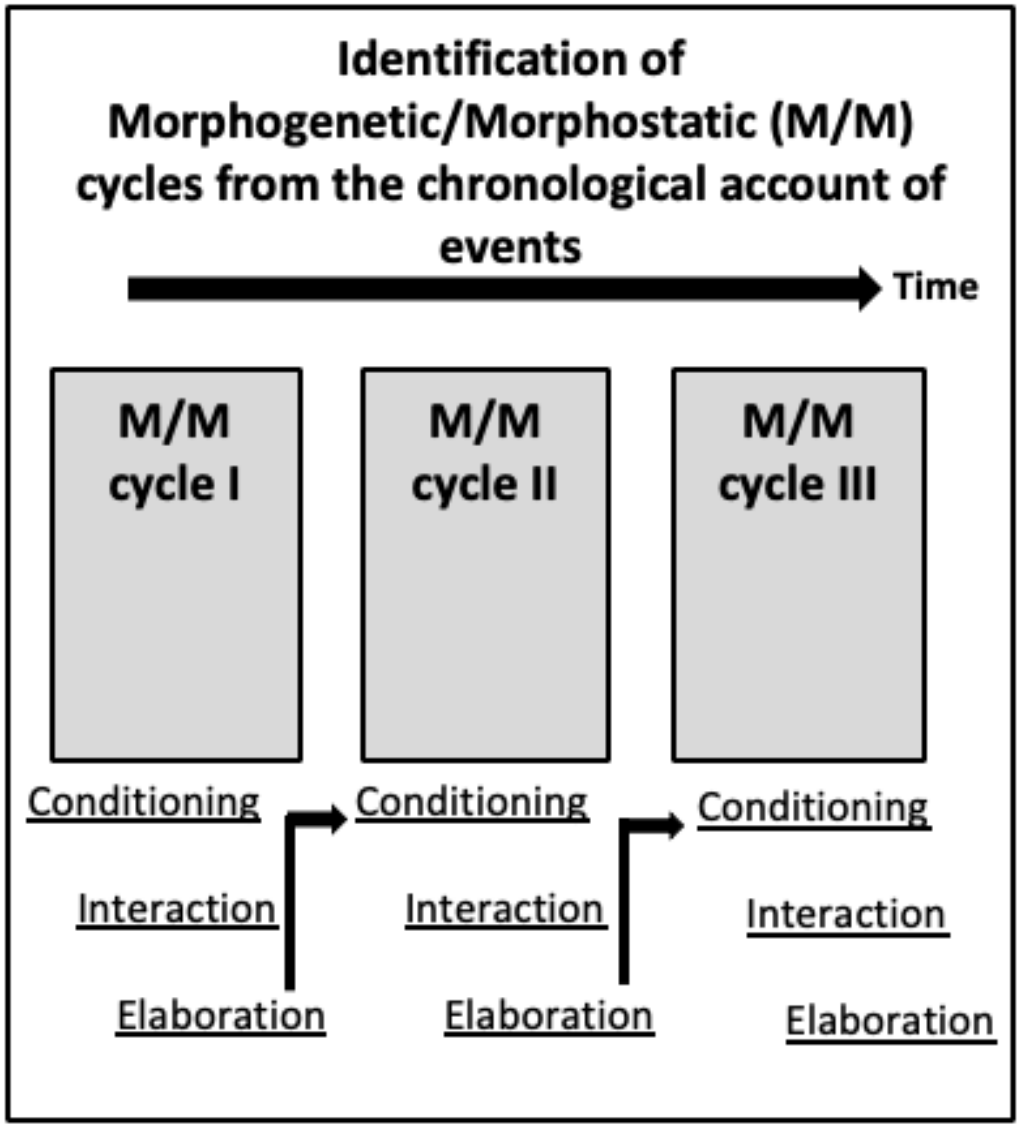

Figure 7.1: Different M/M cycles linked over time

7.1.2 M/M II - the "Ebola Virus Cycle"

The second M/M cycle occurred during the period of the Ebola epidemic in Sierra Leone. This M/M cycle is identified as the "Ebola virus cycle" and it took place between May 2014 and March 2016. This M/M cycle will henceforth be referred to as M/M II. M/M II is now analyzed using the 4-step methodology as proposed by Raduescu & Vessey (2008) in a similar manner to how M/M I was analysed in the previous section.

M/M II was dominated by the Ebola virus outbreak. M/M II also effectively marked the end of the first AIM-Health mHealth project, and it runs right up to the beginning of planning for the AIM-Health+ and the mHealth2 implementation in March 2016. M/M II saw an almost total deconstruction of the mHealth management team in Bonthe with key people leaving the project or being redeployed. This cycle also saw a huge reconfiguration in the work of the CHWs, which resulted in high levels of innovation amongst the CHWs who began using their phones in unexpected ways on the Ebola mobilization projects. Of particular note is the high levels of vocation, belief and commitment shown by the CHWs at all times. Throughout M/M II they continued to work in the most difficult of conditions. Conditions were made worse as the mHealth mobile application stopped working at some point during M/M II.

The analysis of M/M II commenced by examining the structural emergent properties connected with CHW motivation. This was perhaps the most common theme to emerge from the data analysis over all 3 M/M cycles. Analysis at this stage involved asking what needs to be the case for CHW to be so highly motivated and so devoted to their communities. Causal influences identified included the CHW selection process. CHWs are always selected by their own communities, and thus are usually well known and trusted persons within those communities. Strong potential causal relationships thus exist between each CHW and their community. This results in social interaction which has the potential to alter social structures. An example of this is where

the CHWs frequently addressed the many myths that had built up around Ebola, including a belief that the health centres were deliberately infecting people with the Ebola virus. The CHWs challenged this myth and people in the community believed them. This allowed CHWs to continue to bring people to the health centres if they were sick. This represents the ability of the CHWs to alter social structure and create new ones, and thus morphogenesis was hypothesized.

Additionally of relevance in M/M II was the new ASHA phones which were given to the CHWs as part of one of the Ebola mobilization projects that operated during this time. This is similar to the situation that pertained in M/M I when the original CHWs were given mobile phones as part of the original mHealth pilot. Again, CHWs could use the new ASHA phones in a variety of ways which had the potential to reconfigure their social structures. These social structures were reconfigured and elaborated resulting from the CHWs being in possession of a mobile phones. This also includes the way the CHWs used the phones to create communities of practice during the Ebola outbreak. There was a definite ideological convergence of key players during this time, and even some evidence of institutional reconfiguration in the way the working practices of the CHWs were reconfigured. As a result of this, significant cultural transformation or morphogenesis is hypothesized.

A significant amount of training was given to the CHWs during M/M II. This involved training on Ebola, and the many Ebola-related initiatives in operation. The training also included CHWs being trained to use the mobile phones to provide information on Ebola to the community, take sick people to the health centres, and report suspected Ebola cases. There are a variety of structural emergent properties associated with this. Again, it comes back to the high levels of motivation of the CHWs resulting (at least partially) from the causal relationship existing between agents: or in other words the causal relationship between the CHWs and their communities. This has significant ability to

modify social structures and force institutional reconfiguration. Thus, morphogenesis was again hypothesized in this instance.

Many key people left the mHealth project or were redeployed during M/M II. This resulted in loss of capacity in the mHealth management team in Bonthe and the original mHealth project effectively coming to a complete standstill. Importantly, both people who had been previously recognised as mHealth project champions in the previous section were lost to the mHealth project. This had an effect on the project with existing causal relationships between agents being destroyed or at the very least severely interrupted. Social interaction was not now possible with these particular project champions and so the potential ability to either modify or reproduce social structures did not exist.

Closely related to this were the restrictions imposed on travel and association of people in M/M II. This slowed down the CHWs but did not prevent them from continuing to do their jobs. This happened even though social interaction was severely restricted during this time. What needed to be the case for this to happen? Again, the same causal influences and causal relationships as already described were present. Key players yet again converged ideologically as there continued to be a strong belief that mHealth and technology could help the CHWs do their jobs more effectively during M/M II. Indeed, this was magnified as there was a belief that the CHWs had the power to immediately save lives threatened by Ebola during this time. This had strong potential to modify social structure and thus structural elaboration and morphogenesis is hypothesized.

This concluded the analysis of M/M II. The following section presents analysis of M/M III.

7.1.3 M/M III - The "mHealth2 Cycle"

The third M/M cycle identified is known as the "mHealth2 cycle". This cycle took place in the post-Ebola period between March 2016 and December 2021. This will henceforth be referred to as M/M III. M/M III is now analyzed using the 4-step methodology as proposed by Raduescu & Vessey (2008) similarly to how both M/M I and M/M II were analysed in the previous sections.

The analysis process for M/M III began by examining planning for the next iteration of the mHealth project which is to be called mHealth2. A search for the structural emergent properties associated with the decision to implement a new mHealth project in Bonthe involved asking what needed to be the case for a proposal for the new mHealth project to be made. Causal influences here involved mHealth project champions in both World Vision Ireland and World Vision Sierra Leone wanting the new mHealth project to be introduced in the same area and managed by the same mHealth management team. Causal relationships between agents were present as the previous mHealth project manager was redeployed back to the mHealth2 pilot project. In addition, a new technical M+E specialist was appointed who had the responsibility for all technical mHealth infrastructure. Both agents were based with World Vision in Bonthe and both immediately took on the roles of project champion. As with M/M I, this led to a variety of causal influences including these two people again motivating and rallying others around them to the mHealth cause. In addition, causal relationships resulted from the role played by the mHealth project manager and the mHealth technical manager which modified and elaborated on social structures by recreating the environment which had originally advocated the benefits and potentialities of mHealth. This, once again, resulted in the hypothesization of transformation and morphogenesis of both structural and cultural structures around the mHealth project in Bonthe.

As already mentioned, the mHealth2 project saw new Samsung J2 Android mobile phones, with a new mHealth android app installed, given to

approximately 300 CHWs in August 2018. Structural emergent properties via the transcendental argument in this instance are similar to those recognised in both M/M I and M/M II and involve the vocation and high levels of motivation, vocation, and dedication amongst the CHWs. This led to a number of potential causal relationships which were similar to M/M I and M/M II. One difference detected was the willingness of the CHWs to leverage their power on this occasion. The CHWs knew the mHealth project depended on them and were thus in a position of power. This meant they could ask for additional financial and non-financial benefits. It is recognized that this applies to CHWs across all of Sierra Leone, but it is also relevant for the cohort of CHWs who are part of this mHealth project in Bonthe. CHWs in Bonthe are now paid total of approximately 750k SLL (Sierra Leonean Leones) or approximately 90 Euro per quarter. These payments commenced in 2018 and are in line with CHW national policy in Sierra Leone. This indicated causal influences and causal relationships between agents. Almost all of the key players converged ideologically in this instance indicating both structural and cultural elaboration. Thus, morphogenesis was hypothesized.

The M/M III cycle also includes the establishment of the CHW Hub and the eHealth Hub in the MoHS in Freetown. Additionally, two new post were created in Bonthe in line with national CHW policy. These were the post of CHW Focal and CHW Regional Representative. There is a CHW Focal appointed to each DHMT in Sierra Leone, and there are 4 CHW Regional Representatives in Sierra Leone. The structural emergent properties associated with this involve asking what needs to be in place for this to happen. Again, many causal influences and relationships potentially exist in this instance. One of the most important is the communications structure now available to the CHWs. This includes the COMMS model which facilitates two-way communication between the CHWs at local or community level, to the DHMT at district level, to the MoHS at national level. This model also works the other way from the MoHS back to the DHMT and ultimately back to the CHWs. This structure has the potential for many causal influences and causal relationships between

causal agents. All of the key players converge ideologically, and thus structural elaboration is hypothesized.

Also important is the belief that technology, and mobile technology in particular, has the potential to address many of the problems associated with the public health systems in Sierra Leone. Causal influences may also have involved the election of a new Government in Sierra Leone in March 2018. Additionally, there are also causal relationships existing between the MoHS and the CHW Hub (launched in 2016) and the eHealth coordination Hub (launched in Summer 2017). Also, of relevance is the national CHW policy launched in February 2017. All of this gives potential for the causal relationships existing between people in the MoHS to have a significant elaborating effect on social structures. This ties back to the issue of CHWs getting paid as outlined in the previous section as this was part of CHW national policy as decided by the MoHS and implemented by the CHGW hub. All of the key players converged ideologically on this and thus there was likely to be both structural and cultural elaboration in this instance. This gave rise to morphogenesis being hypothesized.

7.2 Mechanisms Hypothesized

As mentioned, when the research framework was being discussed in Chapter 5, analytical histories of emergence form the basis for inferences about causal mechanisms, i.e. they form the basis for retroduction. According to Njihia & Merali (2013) analytical histories of emergence are retroductive, corrigible accounts of sociological transformation over time, which can never be final because we can always improve on our explanations as more or better data becomes available. It is only at this stage can theoretical reflection, or retroduction, take place. This involves consideration of structural and cultural configuration, and the interactions of the various agents involved and outcomes. In other words, this process allows generative mechanisms to be hypothesized.

It may be worthy of mention again at this point that the concept of a mechanism in critical realism is poorly understood with Volkoff & Strong (2013, p. 821) suggesting that "despite their importance, however, there has been little discussion of exactly what mechanisms are, and how IS researchers can identify the generative mechanisms of interest". Despite this however, a number of useful definitions of mechanism are provided. Henfridsson & Bygstad (2013, p. 911) define generative mechanisms as "causal structures that generate observable events", and Bygstad (2010) provide a similar definition of a generative mechanism as "a causal structure that can trigger events". Astbury & Leeuw (2010) also provide a definition, referring to mechanisms as "the underlying processes or ''hidden causal levers'' that account for how and why a program works to bring about desired changes in the reasoning and behaviour of participants" (Astbury & Leeuw 2010, p. 375).

Despite these clear definitions however, it is frequently noted in the research that the challenges in identifying mechanisms in a critical realist-based methodology are many (Thapa & Omland 2018), and that the process of applying such retroductive reasoning in an attempt to identify causal mechanisms is challenging, difficult, time-consuming and resource-intensive (Reed 2009, p. 436, Williams & Karahanna 2013).

Taking all of this into consideration, retroduction was carried out in this research and 5 mechanisms in total were hypothesized. The mechanisms retroduced are now discussed.

The 5 mechanisms hypothesized are as follows.

1. The communications and technological infrastructure built around the mHealth project.
2. The motivation, vocation, and attitude of the CHWs.
3. The mHealth management team in Bonthe District and the manner in which key people became project champions for the mHealth project.
4. The mHealth infrastructure in its entirety.

5. The incentives given to the CHWs

Each of these mechanisms are discussed in more detail in the sub-sections which follow.

7.2.1 Mechanism 1 - The Communications and Technological Infrastructure Built around the mHealth Project

The first mechanism hypothesized involves the communications and technological infrastructure built around the mHealth project. This infrastructure consists of technology, people, and monitoring and reporting structures. Important components are the AIM-Health COMMS model (World Vision 2019), and the Citizens Voice and Action (CVA) group (World Vision 2012) both of which are implemented by World Vision. COMMS is a World Vision model which can best be described as a health-focused community group empowered to coordinate and manage activities leading to improved overall community health and strengthened civil society. According to World Vision, CVA mobilises and equips citizens to monitor government services, and facilitates an advocacy methodology that results in the improvement of inadequate government-provided services. One of the key purposes of CVA is in improving relationships and communications between citizens, government and service providers. Another important function of both the COMMS and CVA models is to establish a link with the local communities. This has been successful as according to the mHealth Program Manager "COMMS and CVA are embedded in the community" and "COMMS is the bridge between the community and the health centre".

This mechanism includes the appointment of both a CHW Focal in the DHMT in Bonthe, and a CHW Regional Representative for Eastern & Southern Sierra Leone. The CHW Focal is part of the DHMT and is also the direct link between the CHWs and the DHMT as can be seen in Figure 7.2. The role of both the CHW Focal and the CHW Regional Representative for Eastern & Southern Sierra Leone was identifies in all the focus groups and many of the interviews as being

critical to the success of the COMMS and CVA models. The pivotal role of the CHW Focal can be seen in Figure 7.2 below.

Another important component of this mechanism is the two-way communication structures that operate between the CHWs at community level and the MoHS at national level. This is represented in Figure 7.2 where it can be seen that the CHWs have a direct link up to the MoHS, and the MoHS has a direct link back down to the CHWs. This was identified as important and one of the Development Facilitators stated, "the CHWs really know the channels of reporting". The CHWs also know the separate components of these channels. A member of the mHealth Management Team stated that "CHWs are aware of CHW Hub, CHW national policy, CHW training, and the CHW Focal. Albert Vandy (the CHW Regional Representative) came and told them (the CHWs) about this".

CHWs attached to each of the health centres in Bonthe District have monthly meetings where the CHW in-charge also attends. These monthly meetings allow CHWs to raise issues that they see as important, and they can also expect to receive feedback on their performance. These monthly meetings are supplemented by quarterly meetings which are usually co-facilitated by the local CVA group and may be attended by a variety of stakeholders including representatives from World Vision, other health staff, other NGO groups, and local politicians and citizen representatives. The CHW Focal will also usually attend, and the CHW Regional Representative may also attend if he is available. The CHW Focal will then report back to the monthly DHMT meeting in Mattru Jong, Bonthe District. This meeting will be chaired by the District Medical Officer for Bonthe District, and also in attendance will be the District Medical Sister, representatives from World Vision and other NGO's in the area, the CHW Focal, the CHW Regional Representative, as well as other relevant stakeholders. This allows the concerns and performance of the CHWs to be communicated to the DHMT, in particular the DMO and the World Vision AIM-Health project manager, directly. A report from this monthly meeting is then

given to the CHW Regional Representative and may also be given directly to the MoHS in Freetown. This communication system also works the opposite way, i.e. from the MoHS and the CHW and eHealth hubs at national level back to the CHWs at community level. This allows effective two-way communication between the CHWs at community level and the MoHS at national level and is represented in Figure 7.2.

This mechanism has the important effect of attracting and motivating CHWs. This is because the CHWs know they will be monitored and trained in an efficient manner, and as a result they can do their jobs more effectively. This was supported by the mHealth Program Manager who when asked about what motivated the CHWs replied "Simple motivation and praise … include them, and not exclude them" in these models and communication systems. It was also mentioned by one of the Development Facilitators who stated that "the CHWs are motivated when they see what they are doing is successful … they want to understand what is happening … they want to be included". The communications and technological infrastructure built around the mHealth project thus allows problems to be addressed and work to be completed more effectively thereby strengthening the health systems as well as making the job of the CHW a more desirable one.

Photograph 7.1: COMMS meeting in Junctionla MCHP showing CHWs meeting with the World Vision Sierra Leone mHealth Program Manager, World Vision Development Facilitators, other health staff, local politicians, and citizen representatives (photograph taken during fieldwork 25 July 2018)

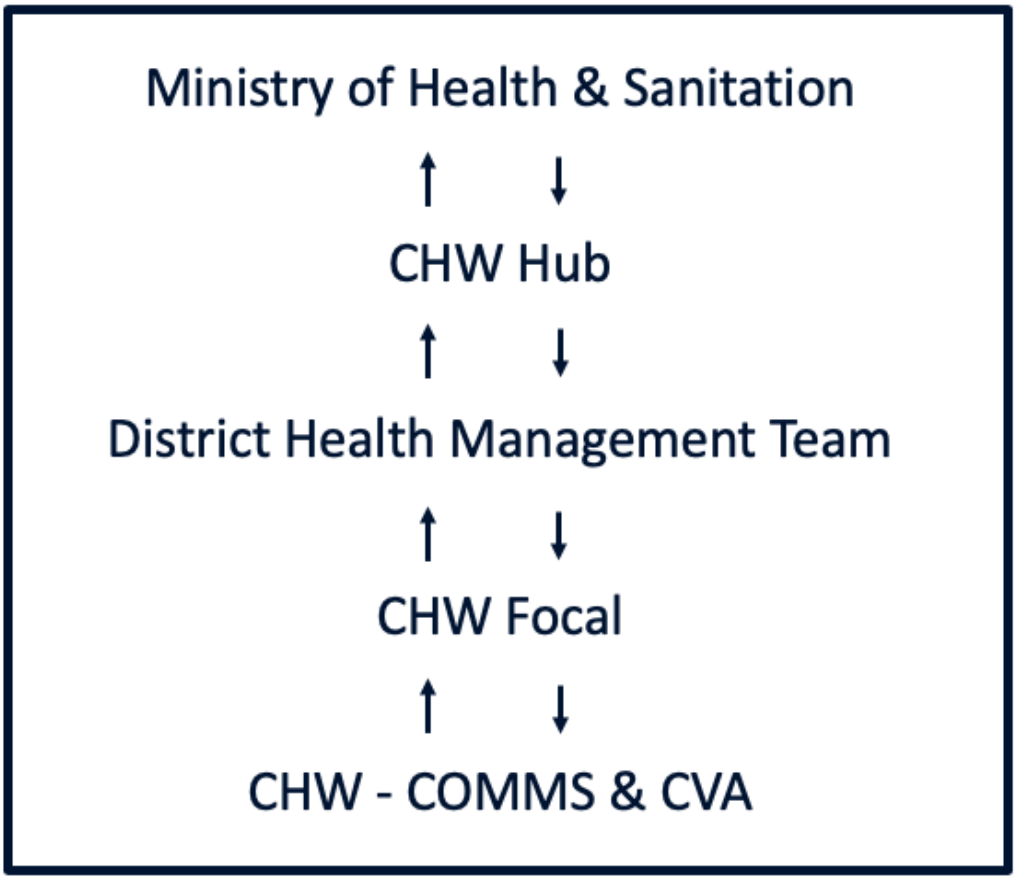

Figure 7.2: The COMMS and CVA model communications feedback and feedforward system

7.2.2 Mechanism 2 - The Motivation, Vocation, and Attitude of the CHWs

The second mechanism hypothesized involves the motivation, vocation, and attitude of the CHWs. This includes the dedication of the CHWs and the way they kept working through extremely difficult circumstances. The best example of this is the manner in which the CHWs kept working through the Ebola virus epidemic. One of the mHealth project commented that even "despite Ebola, CHWs continued to use the phones for the mHealth project". This was even though "there were a lot of problems with the mHealth app" during this time. Another Development Facilitator confirmed that the "CHWs used the phones and the mHealth app all through Ebola".

The ability and willingness of the CHWs to improvise around the phones and the rules of the mHealth project was also clear. This mechanism is typified by

the manner in which the CHWs worked throughout the Ebola crisis. They advocated for patients; they debunked myths about Ebola; they completed a variety of training; they put themselves in danger by interesting with suspected Ebola cases. This was emphasised by the mHealth Program Manager who stated that the CHWs "improvised in unforeseen ways" and used the phones in "very innovative" ways during Ebola. This included using the phones for "communicating with each other and for calling the Ebola emergency number when they came across suspected cases of the virus". It was also claimed that "the phones allowed the CHWs to meander through the community (during the Ebola crisis when there were strict rules in place which restricted the movement and gathering of people) and still work effectively because they had the phones". In addition, it was claimed by one of the mHealth management team that "the mHealth app was used as an "optic" during Ebola for the CHWs to visit pregnant women". This again may be seen as an innovative use of the phones facilitated by the vocational attitude of the CHWs when it would have been easier and safer for them to obey the rules and stay at home.

This mechanism also includes the altruistic nature of the CHWs and the manner in which they use the mHealth technology to complete their work. CHWs wanted to participate in the mHealth project for many reasons. Primary among these reasons was that they strongly believed that the mobile phones and mHealth application would positively reconfigure their working practices in a manner which would allow them to be more effective CHWs. In addition to this, the CHWs believed that the mobile phones gave them status in their communities. This matters to the CHWs as they are selected by their own communities for the position of CHW. The motivation and belief of the CHWs was summed up by the way they were described by almost all of the interviewees. The mHealth Program Manager provides an example of this when he said that "the CHWs have a passion for the work, and this passion is unique to the CHWs (as opposed to the people of SL in general)". This mechanism was supported very strongly by the interview data with words and phrases used including: "firefighters against Ebola"; CHWs believe it is correct

to “sacrifice yourself for your community”; CHWs “go the extra mile”; CHWs possess “passion for their people” and “love for their communities”; CHWs are the bridge between the DHMT and the community; CHWs are the “ears, eyes and nose” of the DHMT. One of the Development Facilitators sums this all up nicely by stating “they (the CHWs) really care … They are doing this job for themselves and their communities … They are doing this for their own people”.

It was also stated many times that CHWs want to learn in order to do their jobs better. Again, this would indicate high levels of motivation and interest in the work. The importance of training and education was emphasised many times during the interviews and focus groups. The mHealth project manager sums this up effectively by stating that “training and education (adult literacy, national CHW training, technology training)” is a huge motivating factor for the CHWs.

7.2.3 Mechanism 3 - The mHealth Management Team in Bonthe District and Project Champions

The third hypothesized mechanism concerns the mHealth management team in Bonthe District and the manner in which key people became project champions for the mHealth project. This facilitated others to believe in the mHealth project. It also facilitated a belief in the potential of ICT4D and mHealth in this case to improve public health outcomes. These project champions act as an hypothesized mechanism for both the original mHealth project and the current mHealth2 pilot project currently in operation. Included is the assumption that these project champions positively influenced the CHWs. This is supported by one of the Development Facilitators who made the claim that “support from people in World Vision and the DHMT really motivates CHWs … they really want this (support)”. It was also clear that the two main project champions were the mHealth Project Manager Joseph Musa, and the M&E Technical Specialist Joe G Miller. These 2 project champions were identified many times in both interviews and focus groups including by people in the World Vision head offices in both Ireland and Sierra Leone.

7.2.4 Mechanism 4 - The mHealth Infrastructure

The fourth mechanism hypothesized concerns the mHealth infrastructure in its entirety. This includes mHealth software, hardware, and overall infrastructure that has been put in place for both the original mHealth pilot and the current mHealth2 pilot project. Interview and focus group data suggests that the most important part of this mHealth infrastructure are the mobile phones given to the CHWs. This was clear from the focus group discussions where all groups expressed the importance of getting the mobile phones. The other infrastructure built around the phones (including the mHealth app, the connectivity and speed of Internet access, etc) was also mentioned by all focus groups as being very important. One of the Development Facilitators supported these assertions by stating that the CHWs are "very much happy" to get the phones. She went on to say that "they (the CHWs) have never seen that type of phone before" (Samsung J2), and that the phones "really matter" to the CHWs.

It was also stated by many interviewees and all of the focus groups that the mobile phone makes the work easier for the CHW and also that it makes them more effective. One of the Development Facilitators said that the "mobile phones lead to more accurate data and reports", with the mHealth Project Manager stating that "the phones make the CHWs work easier".

The phone also has other effects. It was stated by one of the Development Facilitators that the "phones create a strong relationship between the CHW and the health staff". This was also mentioned by the mHealth Project Manager who stated that "the mobile phones create a strong relationship between CHWs and health centre staff". He went on to say that "such a strong relationship facilitates positive change". This would support the mechanism hypothesized that the mHealth infrastructure in its entirety enables and facilitates the work of the CHWs.

This mechanism also encompasses the self-reinforcing adoption of mHealth mechanism which includes mHealth policy, good governance, supervision structures, inclusivity, and participatory design and decision making. This mechanism results from the way mHealth was adopted in this case, and includes the manner in which meetings were held, the development and design principles adopted for the mHealth app, and the training materials and methods adopted when developing and providing training for the CHWs. The mHealth Program Manager emphasised this when he stated that one of the most powerful motivators for the CHWs is the "training and education" programmes that are available to the CHWs especially the material available under the CHW national training programme. This mechanism also ensured that "the CHWs never lost interest in the phones even though the mHealth app stopped working (at some time during the Ebola crisis" according to the mHealth project manager. This may have been because "if the CHWs didn't use the phones there was nothing else" (as stated by one of the Development Facilitators).

7.2.5 Mechanism 5 - Incentives Given to the CHWs

The fifth mechanism hypothesized involves the incentives, both financial and non-financial, given to the CHWs. Examples of non-financial incentives can be seen in photographs 7.2, 7.3 and 7.4 where a variety of clothing, boots, backpacks, identification badges and bicycles are to be seen. Also included in this mechanism are the mobile phones given as part of the mHealth project. The mHealth Project manager stated that these non-financial incentives are very important as the CHW "might be the only person in that community to have a phone or any official form of identification" (i.e. a World Vision ID badge). He went on to say that such "non-financial incentives give the CHWs the respect of the community." This is a powerful mechanism as it has the potential to generate many events such as improved performance of the CHW and their increased participation in various training programmes. The mechanism may also result in greater degree of participation, respect and recognition of the CHW within the community.

One of the most important incentives is the CHW national training programme that all CHW have access to. The mHealth Program Manager emphasised this when he stated that one of the most powerful motivators for the CHWs is the "training and education" programmes (including adult literacy, national CHW training, technology + training) that are available to the CHWs. This also includes the material available under the CHW national training programme.

Other non-financial incentives given to the CHWs include bikes, t-shirts, badges, rain gear, and backpacks. One of the Development Facilitators emphasised the importance of t-shirts and identification badges as they are used by the CHWs as a "sign of identification". This is important as it distinguishes the CHW as a person of responsibility within their community, but also because in many cases CHW identification badges are the only form of identification in the possession of a CHW. Identification badges can also serve in lieu of a passport when traveling to many countries in West Africa. Other non-financial incentives on offer to CHWs include membership of saving schemes, and CHWs are now also given up to 30% of anti-malaria drugs to distribute to patients. This is an important incentive as such drugs may not have previously been available to CHWs, and thus patients may not have had access to these drugs for various administrative reasons within the Sierra Leonean public health system.

Furthermore, and of great importance are the direct financial incentives which are now given to all CHWs. These financial incentives are paid quarterly and amount to approximately 750k SLL (90 Euro) per quarter. This quarterly payment is broken down as 100k SLL per month with an additional 50K-80k SLL for expenses and travel per month. CHW peer supervisors get paid a slightly higher amount of 250k SLL per month. These payments were first given in 2018 and are now being paid in line with CHW national policy. According to one of the Development Facilitators the money that is being paid to the CHWs "has motivated them so much". This was also mentioned by the mHealth Program Manager who confirmed that "the financial incentives are a BIG motivation for

the CHWs". In addition, it came out strongly from all focus group discussions that this payment was a huge motivating factor for the CHWs.

Photograph 7.2: CHW Mohamed Amara from Mogwembo CHC showing some of the non-financial incentives he receives including t-shirt, backpack, identification badge, and rain gear (photograph taken during fieldwork 25 July 2018)

Photograph 7.3: CHW Isata Mannah from Yargoi CHC showing her CHW identification badge (photograph taken during fieldwork 26 July 2018)

Photograph 7.4: Bicycles ready to be given to CHWs and CHW Peer Supervisors in World Vision Mattru Jong (photograph taken during fieldwork 21 July 2018)

7.3 Interdependencies Among the Mechanisms Hypothesized

As detailed earlier in this chapter the 5 mechanisms hypothesized are as follows:

1. The communications and technological infrastructure built around the mHealth project.
2. The motivation, vocation and attitude of the CHWs.
3. The mHealth management team in Bonthe District and the manner in which key people became project champions for the mHealth project.
4. The mHealth infrastructure in its entirety.
5. The incentives given to the CHWs

Possible interdependencies between these hypothesized mechanisms are now considered. Although the topic of interdependencies that may or may not exist between generative mechanisms has been written about by a number of

scholars (e.g. Mingers 2017, Dalkin 2015) this topic has not received wide attention in the literature. Thus, it is difficult to make any claims about whether or not mechanisms have to be interrelated in general, or whether or not the mechanisms in the Sierra Leone mHealth case have the potential to be interrelated. Any consideration of this must begin by revisiting the ontological basis of critical realism. We must also start with a clear definition of the meaning of generative mechanism. According to Astbury & Leewu (2010, p. 368) generative mechanisms are ""underlying entities, processes, or structures which operate in particular contexts to generate outcomes of interest." If this definition is to be accepted it might be expected that there is likely to be various and complex interdependencies between the mechanisms hypothesized in any single case. Dalkin (2015) discusses work where possible interdependencies between mechanisms in a critical realist-based study on the impact of social networks in healthcare is examined. What she refers to as three separate "network mechanisms" were detected as follows: network navigation (identifying and connecting with relevant existing resources in a network), negotiation within networks (re-shaping relationships, roles, expectations, means of engagement and communication between network members) and collective efficacy (developing a shared perception and capacity to successfully perform behaviour through shared effort, beliefs, influence, perseverance, and objectives). It was posited that any interdependencies between these mechanisms is bound to be shaped by the environments in which they take place, and that these particular environments can be either enabling or disabling depending on the capacities they offer for carrying out illness management work and supporting behaviours beneficial for people's health in that particular case. This may be because mechanisms are hidden and we as humans cannot perceive them. Mechanisms are also highly sensitive to variations in context (Dalkin, Greenhalgh et al. 2015). This is important and has relevance for the mechanisms hypothesized by this PhD research and a consideration of any possible interdependencies between those mechanisms. Mingers & Standing (2017) also write about this topic. They highlight work by Hedström & Swedberg (1996) who argue that mechanisms are an appropriate

form of middle-range theory. They identified three types of mechanism as follows: situational mechanisms that link macro level (society or organization) to micro level (individual); individual action mechanisms that link desires and beliefs with action opportunities at the micro level; and transformational mechanisms that link individual actions into wider intended or unintended effects at the macro level. They suggest that there is potential for all of these three type of mechanism to be interrelated in some way. However, any such consideration must return again to the ontological origins of critical realism which dictates that mechanisms are hidden as well as being highly sensitive to variation in context in any particular case or combination of cases.

A number of other scholars have suggested that mechanisms are bound to be intrinsically linked at some level (e.g. Cartwright 1997; Shoemaker 1997). Mingers & Standing (2017) state that they believe this train of thought and argue that although the properties and powers of mechanisms are distinct, both come into being at the same time as characteristics of the particular thing or entity which is the subject of the research. In effect, they are arguing for two separate forms of causality: namely, event causality and generative (mechanism) causality. This means that in any situation where changes are occurring, there will be a series of linked events, one (or more) leading into the next. Mingers & Standing (2017) argue that this is the basis of critical realist causation as constant temporal conjunctions of events. They go on to argue that to examine further the interrelatedness of any mechanisms hypothesized in any single case, the characteristics and properties of the specific mechanisms hypothesized must be examined in terms of the events in that particular case. This is necessary in order to attempt to explain the particular event as following from the causal powers of the specific mechanisms hypothesized. They suggest that this is known as mechanism causality, and that this is very clearly distinct from event causality (Mingers and Standing 2017). Moreover, they suggest that any understanding of this relies heavily on being able to distinguish between the two: event causality is diachronic, the relationship is sequential in

time: and generative causality is synchronic, properties explain the behaviours at the same time.

This makes any consideration of the potential interrelatedness of the mechanisms hypothesized in the Sierra Leone mHealth case a complex and difficult task. It would seem obvious that the mechanisms are indeed linked with a high degree of interdependency and interrelatedness. However, this claim cannot be made with any certainty. As discussed in the previous paragraphs, any such consideration must take into account the extreme sensitivity of mechanisms to variations in context. This is important in terms of the Sierra Leone mHealth case as there are many and varied contexts at play. These include social contexts, ethical contexts, cultural contexts, and political contexts, as well as the many agential related contexts which exist in this case. All of these contexts vary considerably at any particular time and in any particular space in this case. Moreover, the ontological position taken by the critical realist philosophical approach that mechanisms are effectively hidden and thus we as humans cannot directly perceive them. This makes the task at hand even more challenging as we cannot be certain that the hypothesized mechanisms even exist. Finally, the complex interaction which is the basis of critical realist causation and the interrelatedness of any mechanisms hypothesized in any single case suggest that the characteristics and properties of the specific mechanisms hypothesized must be examined in terms of the specific events in that particular case. All of this taken together means that any detailed consideration of the interrelatedness of the hypothesized mechanisms in the Sierra Leone mHealth case would be an extremely challenging and difficult task. This question is thus considered to be beyond the scope of this PhD research.

7.4 Summary

This chapter presented the research findings. A total of 3 distinct M/M cycles were presented, and 5 generative mechanisms were hypothesized therefrom.

This provided a demonstration of the critical realist-based research framework which was developed for this research.

It should be noted however that the M/M cycles and hypothesized mechanisms are not without caveat. Any researcher relying on any critical realist-based framework cannot claim with any certainty that the mechanisms identified are the best or most appropriate. According to Thapa (2018) it cannot even be claimed that the mechanism exists. Despite this, the research framework and philosophical approaches used in this research have merit as the retroduction process can identify the best possible explanation of a situation that is consistent with the data provided in the same situation.

Chapter 8: Summary & Conclusions

8.1 Introduction

This chapter presents a brief summary and conclusions. The chapter begins by discussing the main outcomes and contributions of the research before concluding with a note on research gaps and limitations. The chapter concludes with recommendations for future research.

8.2 Main Outcomes of the Research

The main research outcomes involve providing detailed, theoretically appropriate answers to the research questions posed. This research has resulted in the presentation of a theoretically informed and empirically rich account of how 5 hypothesized generative mechanisms have acted to influence the use of mobile technologies in this particular mHealth case. The research has also delivered a clearer understanding of what theoretical concepts inspired by critical realism and the morphogenetic approach might facilitate an understanding of how mobile phones are being adopted and used in this case. Generative mechanisms have been hypothesized which serve to explain the events unique to this mHealth project and the ethical, social, cultural and political factors which have combined to generate them. This will provide mHealth and ICT4D implementors with a better understanding of how to implement, scale and sustain mHealth, particularly in Sierra Leone.

The research has also shown how a critical realist-based research framework can be applied to an mHealth case in Sierra Leone. This is an important research output as there is little research on the methodological aspects and procedures associated with critical realist-based research. Specifically, this research has demonstrated the practical application of a critical realist-based research framework and methodology to an mHealth case in Sierra Leone. The research has also succeeded in determining the relevance of critical realism as a philosophical approach for ICT4D and mHealth research. Moreover, the

research has succeeded in building new and innovative theoretical and methodological approaches and frameworks which are based on critical realist-based philosophical perspectives. The work has also successfully demonstrated the practical operation of these methodological approaches and frameworks.

It is also important that 5 actual generative mechanisms were hypothesized. This shows the research framework in operation, and additionally provides useful data to the people implementing this mHealth case. Findings from this research can contribute to theory building by describing the mechanisms in this mHealth case in conceptual terms which are then validated in other cases. This includes the objective of establishing whether the mechanism-based results arising from this research are generalisable to other mHealth cases and ICT4D projects in both similar and different social, cultural and political circumstances.

Another important outcome of this research is a better understanding of how mechanisms and context interact in this case. This will improve the design of mHealth programmes being implemented by governments and NGOs in developing countries as well as contribute to the existing knowledge of how these factors may or may not contribute to mHealth over time. This provides an opportunity to generate knowledge which will benefit the mHealth project in Sierra Leone directly in a significant and tangible way. The identification of mechanisms will bring to light the underlying causes of any problems and more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors will be made possible. This means the research has the potential to provide specific guidance and offer specific recommendations on future plans to scale the mHealth project in Bonthe District and ultimately across Sierra Leone.

Finally, this research has made an important contribution to a number of bodies of knowledge as outlined in section 1.2.3 above.

8.3 Contributions and Dissemination of the Research

There are a number of significant contributions arising from this research which are likely to be of interest to a variety of communities. These have already been outlined in section 1.2.3 but they are worthy of reconsideration at this point. These contributions are to the IS, ICT4D and mHealth bodies of knowledge. A contribution is also made to the literature on critical realism and in particular methodological approaches associated with the critical realist philosophical approach. A small contribution is also made to the body of work on Sierra Leone.

Perhaps most importantly, the research has contributed to the mHealth project in Sierra Leone in a significant and tangible way by providing a theoretically informed account of the mechanisms which have dictated why the mHealth project has turned out the way it has. The identification of these mechanisms has the potential to highlight any potential problems that might occur. The identification of mechanisms may also facilitate more contextually sensitive interventions that take into account the existence of structural, cultural and agency factors in the mHealth case. This is likely to be useful to World Vision and World Vision as they are currently planning to scale the mHealth initiative across all of Sierra Leone and a number of other countries in Africa.

The research will also provide guidance on how mHealth has evolved in different social, political and cultural contexts in this case and wider. This is because mechanism-based research which explains the formation of a socio-technical phenomenon in one setting can provide plausible hypotheses for investigation of similar phenomena in a similar setting (Avgerou, Masiero et al. 2018).

Other contributions of this research will be disseminated and shared as follows:

- The results arising from this research will be discriminated across a variety of national and international networks. SCSS in TCD will take primary responsibility for this.

- Research outcomes will also be shared directly with World Vision and the government of Sierra Leone through the MoHS, specifically the eHealth and CHW hubs in Sierra Leone.
- World Vision will be encouraged to host dissemination workshops to develop action plans based on the findings of the research.
- Internationally, the findings from this research will also be disseminated through World Vision's various networks and partner organisations.
- The research will be shared with the National mHealth Coordinating Committee in Sierra Leone whose mandate is to promote collaboration and best practice in mHealth.

This research will also contribute to training CHWs and other health workers in Sierra Leone. It will also be possible to make the research results more accessible to a wider, non-academic audience. This includes incorporating elements of this research into Sierra Leone CHW national training programme.

Perhaps most importantly, this research has the potential to contribute to improving the public health systems in Sierra Leone. Both the CHWs and the communities they serve will benefit greatly from improved and more effective health systems. Thus, knowledge created by this research has the potential to enhance the health systems of Sierra Leone which will help many of the poorest and most disadvantaged people on the planet. If the results of this research can be generalised to other mHealth and ICT4D projects outside of Sierra Leone, there is potential to have great impact and many of the world's poorest and most disadvantaged people could possibly benefit from improved systems, especially public health systems.

Finally, there have been 19 research outputs of various types arising from this research. These include journal articles, book chapters and conference presentations. These academic outputs are listed in Appendix 5 and will also be relevant to those in the academic fields of IS, ICT4D, mHealth, global health,

and international development. In addition, the research will be of interest to those in the critical realist community and others working in the areas of research ontology, epistemology and methodology.

8.4 Research Limitations and Practical Difficulties Associated with the Research

There are a variety of philosophical, methodological, and practical difficulties and limitations associated with this research. Firstly, philosophical and methodological limitations will be discussed. After that, the practical difficulties associated with this research will be presented.

The philosophical and methodological shortcomings of critical realism and the morphogenetic approach have been extensively discussed in previous sections of this research. Chief among the challenges associated with adopting critical realism for any type of research is the perceived complexity of the paradigm. This is a topic of much debate in the literature with many suggesting that critical realism is time-consuming, difficult to operationalize, complex, and often difficult to understand (e.g. Reed 2009, Fleetwood 2014, Smith 2018). In addition, many key concepts contained within the critical realist paradigm (e.g. mechanisms, retroduction) are vague and poorly understood. In addition, of great concern is the lack of methodological clarity. This was a huge factor in this research, and it was very difficult to gain any type of methodological certainty as there were few papers to be guided by. The well-worn phrase about critical realism being "a philosophy in search of a method" certainly rang true.

In addition to these practical difficulties, there are also many and varied philosophical criticisms of critical realism. Positivists would claim that critical realism lacks objectivity, and places limits on the generalizability of its findings. This would include the "provisional, fallible, incomplete, and extendable" nature of its explanations (Dobson 2009, p. 808). Interpretivists make the claim that the realism part of critical realism is misguided (Heeks & Wall 2018).

Another difficulty of note is the pre-existing orientation of many ICT4D researchers towards alternative, more established paradigms (Heeks & Wall 2018): namely, the philosophical duopoly that exists within ICT4D research. This means that students, supervisors and other researchers are unlikely to use the critical realist paradigm for their research as expertise does not exist, or where it does exist is likely to be at early stages of development. This is likely to create a negative cycle around the use of critical realism which will inhibit the use of the paradigm in academia. Furthermore, this will present a big obstacle for other ICT4D researchers working outside of academia who may be reluctant to invest time in coming to terms with what they might see as a highly complex and little-used philosophical paradigm that is associated with methodological uncertainty and unclarity. It was suggested above that these issues are not insurmountable. However, solving them will require journal editors and senior academics to actively encourage greater engagement with research paradigms in general, and the critical realist paradigm in particular. The likelihood of this happening is not certain.

As well as the philosophical and methodological shortcomings of the critical realist paradigm used for this research there were a number of practical difficulties associated with the research which are worthy of mention. Perhaps most importantly, it is both challenging and very ambitious for a researched from the Global North to attempt any level of understanding of mHealth in a severely resource constrained environment such as Sierra Leone. Technology and mHealth projects in such environments are highly likely to involve multiple interactions of ethical, structural, cultural, agential, political, social and technological factors. The task is made even more difficult when the researcher comes from a significantly different social and cultural background and the research site is located over 5,000 kilometres from the researcher's home and place of work in Ireland.

In addition, any researcher who is interested in ICT4D and mHealth in developing environments may find it very difficult to negotiate access to a suitable project at a stage where research at PhD level is appropriate or even possible. As discussed earlier in this section, there are currently many mHealth projects in operation around the world. However, many of these projects are not suitable as research sites for a variety of reasons: the project may be too small, the project may be at an inappropriate stage of development, the project is already the subject of research from other researchers and institutions, or the project may be based in a country that is not possible to travel to as a result of war or disease epidemic. Additionally, many ICT4D projects in developing countries do not allow access to external researchers for many reasons including the disruption the researcher might potentially cause, the additional costs the project implementer may have to incur, or the additional resources that may need to be deployed or redeployed when the research visits the research site. There are also likely to be institutional rules which may prohibit travel to what are perceived to be dangerous or unstable countries.

A further practical difficulty associated with research based in a developing country is the likelihood that there will be a significant amount of additional work involved for the researcher. This includes the work needed to establish the various collaborations required to carry out the research. This task may be made more challenging as many of these collaborations and networks are extensive and geographically dispersed.

In the context of this research it proved to be a significant challenge to convince both World Vision Ireland and World Vision Sierra Leone that this research would be useful and relevant to the mHealth project and also to their overall mHealth programme. World Vision required extensive information about the nature of the research and the research frameworks to be used, as well as the research questions and research methodologies to be applied. They also required details of how specifically the research would be disseminated across a variety of NGO and academic networks, and also how the research would be

fed back to their people, including the CHWs, in the field. When access to this mHealth project was agreed by all parties there were two separate ethical approval applications required. The first was from TCD and the second was from the MoHS in Sierra Leone. The ethics application process could best be described as detailed and arduous, with the completed ethical application to the MoHS in Sierra Leone weighing in at 75 pages and 24,959 words.

It is also worth mentioning the difficult conditions existing in Sierra Leone. This includes extremely poor infrastructure, security concerns, difficult travel conditions, a tropical climate and a non-existent power grid. Researchers working in more developed countries in Europe and North America tend to take public transport, power and light, as well as personal safety for granted, but the research environment is made far more challenging when the researcher does not have a source of electricity to power their laptop or a source of light to write notes by. An example of this is shown in photograph 1.3 below. The photograph is of the research assistant for this research, Hadji Kamara, working in Gbangbama CHC. The picture was taken in the late evening and he was forced to work in the CHC as this had the only source of power in the area. Approximately 2 hours after he started work a pregnant woman was brought to the health centre with what turned out to be a false labour. The woman was in great pain and didn't leave the health centre until the following morning. As can be imagined, these are not ideal circumstances in which to carry out any type of research. Other practical challenges of working in Sierra Leone include the difficulty of travel to the research sites (the health centres) in Bonthe District. The road network in Sierra Leone is slowly improving but is still in very poor condition and it takes a considerable amount of time to travel between health centres. In addition, there were frequently obstructions on the roads such as fallen trees and floods.

Of more serious concern is the fact that this research was severely interrupted by the Ebola virus epidemic which occurred in Sierra Leone between May 2014 and March 2016. Travel to Sierra Leone was severely restricted during that

time, and TCD would not approve research trips to any part of West Africa that had been affected by Ebola. It was also extremely difficult to contact any of the people involved in the mHealth project as communications were poorer than normal and many key World Vision staff were deployed to work on Ebola projects and were thus difficult to contact.

Lastly, it is difficult to find research assistants with the appropriate level of skills required to assist with research at this level in Sierra Leone. Any research assistant is required to have a good working knowledge of research practices and principles. In addition, they will be required to have good computer skills and an excellent knowledge of both English and various local languages. It is also difficult to communicate with stakeholders and research assistants from Ireland as they frequently won't have access to phone, Skype etc.

Despite these challenges, it is very rewarding to carry out research in developing environments. This is particularly true when the research being carried out has the potential to directly improve and enhance the health systems of an entire country and thus is likely to help many of the poorest and most disadvantaged people on the planet.

Photograph 8.1: Hadji Kamara (research assistant) working late into the evening in Gbangbama CHC. This was the only source of electricity to power his laptop (photograph taken during fieldwork 26 July 2018).

8.5 Recommendations for Future Research

There are a number of suggestions and recommendations for future research arising from this work. Firstly, additional consideration of the methodological approaches available to the critical realist researcher is required. Methodological guidance in critical realist-based research is lacking in the social sciences, and this is particularly true in the field of ICT4D and its associated sub-fields. Thus, more work on methodology in critical realism is recommended. This includes work showing new and innovative methodological approached beyond those described in this research.

More critical realist work in the social sciences and also in ICT4D research is also recommended. Additionally, the use of research paradigms which challenge the philosophical duopoly in ICT4D research (e.g. Heeks, Thapa et al. 2018, Heeks & Wall 2018) are needed.

A similar study to this research would be beneficial as it could strengthen and iterate or expand upon these research findings. Also, it would be desirable to see a similar study, using the same or a similar research framework, carried out in a different country to Sierra Leone. It would also be interesting to see the research framework and methodology used in this research applied to an mHealth case in a more developed country. This includes an assessment of whether or not this research framework is generalisable to other mHealth projects outside of Sierra Leone.

It is also suggested that the research framework used in this research should be further tested. Additionally, it would be worthwhile exploring the engagement of critical realism with some of the more common IS theories and the notion of affordance. One of the publications from this research has already suggested a critical realist-based research methodology based on activity theory. This work would be worthy of additional consideration.

Finally, more work on the morphogenetic approach is recommended. Theories suitable for use with the morphogenetic approach should also be explored and tested.

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Appendix 1: List of Persons Interviewed

	Name	Organization	Date of Interview	Location of Interview
1	**Frédérique Vallieres**	Assistant Professor, Centre for Global Health, Trinity College Dublin (Former) Lead researcher on the WHO-IRP implementation research platform for the mHealth project in Sierra Leone	15 March 2018	By Skype from Ireland
2	**Nick Nestle**	Senior Project Manager, Dimagi	27 March 2018	By Skype from Ireland
3	**Nicola Dunne**	Programmes Officer, World Vision Ireland, Dublin, Ireland	18 April 2018	By Skype from Ireland
4	**Magnus Conteh**	(Former) Director, Global Health Programmes, Strategic Partnerships and Innovation at World Vision Ireland, Dublin, Ireland	3 July 2018	By Skype from Ireland
5	**Agustine Trye**	(Former) mHealth Programme Coordinator, Bonthe District, World Vision Sierra Leone, Mattru Jong	3 July 2018	By Skype from Ireland
6	**Andrew Lasana**	(Current) Security Officer, World Vision Sierra Leone, Freetown (Former) Development Facilitator, Jong ADP, World Vision Sierra Leone, Mattru Jong, Sierra Leone	16 July 2018	WV National Office, Freetown, Sierra Leone
7	**Christian Bumboo-**	ICT Manager, World	16 July 2018	WV National Office,

	Johnston	Vision Sierra Leone, Freetown		Freetown, Sierra Leone
8	**Saffa Andrew Koroma**	Health and Nutrition Advisor, World Vision Sierra Leone, Freetown	17 July 2018	WV National Office, Freetown, Sierra Leone
9	**Alfred Kamara**	(Current) Education and Innovations Manager, World Vision Sierra Leone, Freetown (Former) World Vision Operations Base Manager for Bonthe District, World Vision Sierra Leone	17 July 2018	WV National Office, Freetown, Sierra Leone
10	**Julian Jackson**	Programme Effectiveness Director, World Vision Sierra Leone, Freetown (Formerly) DME Manager, World Vision Sierra Leone, Freetown, Sierra Leone	17 July 2018	WV National Office, Freetown, Sierra Leone
11	**Amara Koroma**	(Former) mHealth Programme Coordinator, World Vision Sierra Leone, Freetown	18 July 2018	WV National Office, Freetown, Sierra Leone
12	**Abdul Konomanyi**	ICT Manager and Co-Chair of eHealth Coordination Hub [Secondee from MoIC to MoHS], MoHS, Freetown, Sierra Leone	19 July 2018	MoHS Freetown, Sierra Leone
13	**Emeka Chukwu**	eHealth Strategy Development Consultant, MoHS, Freetown, Sierra Leone	17 July 2018	MoHS Freetown, Sierra Leone
14	**Mohamed Jalloh**	Deputy Director/Coordinator eGovernment, MoIC,	17 July 2018	MoHS Freetown, Sierra Leone

		Freetown, Sierra Leone		
15	**Ambrose Levi**	Deputy Director of Communications (Policy and Planning), MoIC, Freetown, Sierra Leone	17 July 2018	MoHS Freetown, Sierra Leone
16	**Alpha Philip Bangura (Jones)**	CHW Hub Coordinator, and National Coordinator for the National CHW Program [MoH/DPHC], Freetown, Sierra Leone	20 July 2018	MoHS Freetown, Sierra Leone
17	**James Nkemba Chifwelu**	National Director, World Vision Sierra Leone, Freetown, Sierra Leone	20 July 2018	WV National Office, Freetown, Sierra Leone
18	**Murana Mustapha Koroma**	District M+E Officer, DHMT Bonthe, Mattru Jong, Sierra Leone	23 July 2018	DHMT, Mattru Jong, Sierra Leone
19	**Charles Lissa**	(Current) Neglected Tropical Disease Focal, DHMT, Mattru Jong, Sierra Leone (Former) M+E Officer, DHMT, Mattru Jong, Sierra Leone	23 July 2018	DHMT, Mattru Jong, Sierra Leone
20	**Dante Musa**	CHW Focal, DHMT, Mattru Jong, Sierra Leone	23 July 2018	DHMT, Mattru Jong, Sierra Leone
21	**Prince Masuba**	District Medical Officer (DMO), DHMT, Mattru Jong, Sierra Leone	23 July 2018	DHMT, Mattru Jong, Sierra Leone
22	**Joe G Miller**	Digital Health and M+E Health Specialist, World Vision Sierra Leone, Mattru Jong, Sierra Leone	25 July 2018	Mattru Jong, Sierra Leone
23	**Elizabeth Matoe Yormah**	Development Facilitator, Imperi ADP, World Vision Sierra Leone, Mattru Jong,	26 July 2018	Gbangbama, Sierra Leone

		Sierra Leone		
24	**Christiana Kekura**	Development Facilitator, Sherbro Island ADP, World Vision Sierra Leone, Mattru Jong, Sierra Leone	26 July 2018	Gbangbama, Sierra Leone
25	**Joseph Musa**	(Current) mHealth Project Manager, Mattru Jong	26 July 2018	Gbangbama, Sierra Leone

Appendix 2: List of Focus Group Discussions

	Name	Number of Participants	Date of Focus Group	Location of Focus Group
1	**Mokaba MCHP**	6	24 July 2018	Mokaba, Sierra Leone
2	**Moriba Town CHC**	11	24 July 2018	Moriba Town, Sierra Leone
3	**Gbangbama CHC**	6	24 July 2018	Gbangbama, Sierra Leone
4	**Gbangbaia CHP**	5	25 July 2018	Gbangbaia, Sierra Leone
5	**Junctionla MCHP**	14	25 July 2018	Junctionla, Sierra Leone
6	**Mogwembo CHC**	10	25 July 2018	Mogwembo, Sierra Leone
7	**Yargoi CHC**	5	26 July 2018	Yargoi, Sierra Leone

CHC = Community Health Centre
MCHP = Maternal and Child Health Post
CHP = Community Health Post

Appendix 3: Sample Interview Guide

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Trinity College Dublin
School of Computer Science and Statistics

Interview Protocol and Sample Questions

Research Title:
A Critical Realist Framework for the study of Mobile Health (mHealth) in Sierra Leone

Lead Researcher:
Patrick Joseph Wall
Trinity College Dublin, School of Computer Science and Statistics

Supervisors:
Prof. David Lewis, Prof. Lucy Hederman
Trinity College Dublin, School of Computer Science and Statistics

Lead Researcher Contact Details:
Name: Patrick Joseph Wall
Phone: +353 (0) 86 83 56799
Email: wallp2@tcd.ie

Interview Protocol:
Participants who agree to the request for interview will be sent the Participant Information Leaflet, which provides more information on the research procedures and details the risks and benefits for the participant. Once the participant has received the information leaflet, they will be contacted within 7 days to confirm that they are still interested in participating in the research. If they are still interested the researcher will schedule the interview. The interview may take place in person, by telephone, or by Skype. In some cases, the participant may be asked to participate in a short follow up interview. This will only occur where there is a need to confirm prior findings and/or identify any changes that may have taken place since the initial interview. For any participants who are to be re-interviewed, the same interview guide and Participant Information Sheet will be used.
All interviews will be recorded electronically. Participants will be informed that

if they do not wish to have their interview recorded electronically, they will not be interviewed and will withdraw fully from the process. The participant will be informed of this in the Participant Information Leaflet and again before the interview commences.
Participants may stop electronic recording at any time, and may at any time, even subsequent to participation in this research, have such audio and/or video recordings destroyed.
Prior to the interview, the researcher will give the participant the opportunity to ask questions and will review the information sheet and declaration with the participant. If the participant still agrees to continue, the participant will be asked to complete the consent process before starting the interview. The consent process is described in detail in that document. The interviewee will be allowed to withdraw from the process at any time. The interviewee will also be allowed to review their contribution, and how the contribution is presented before any of the data is used.

Interview Questions:
A sample interview guide is shown below. Interviews will be semi-structured and will last for between 60-90 minutes.

General questions to all participants

1. Can you tell me about the history of the project? Prompt for any supporting documentation if available.

2. How did you get involved? Prompt for the names of anyone who got this participant involved.

3. Please describe your role in the project and exactly how you were involved in the mHealth project. Ask for official title (if any). Prompt for any supporting documentation if available.

4. Can you describe the work you completed? Ask for dates, job specs, contracts, etc.

5. What plans exist/existed for this mHealth programme? Any supporting documentation would be helpful.

6. What do you see as the main goals/objectives of the project?
7. Were there any changes in the mHealth project over the time of your

involvement? If so, what were these? Why do you think these changes happened? What produced this change? What effect did they have on the project overall? Prompt for supporting documentation if available.

8. Describe any mHealth policy that guided this mHealth project. Ask where these policies come from, and what these policies were specifically. Is any supporting documentation available?

9. What were the guiding principles and values for this project? Ask where these come from. Is any supporting documentation available?

10. Describe the policy development process. What guided the development and iteration of such guiding policies, principles and values?

11. Did such policies, guiding principles and values have any effect on your own involvement in this process? Did they in any way dictate the manner in which you worked? Tell me how.

12. Did they affect the mHealth project itself? What produced change? Prompt participant to explain how specific policies affected their own involvement. Prompt participant to explain how specific policies affected the mHealth project.

13. How was the policy translated into action plans/programmes? Ask for any supporting documentation if available.

14. Who are/were the stakeholders in this process? Who had most influence in the process?

15. Do you have any comment on how stakeholders were managed and coordinated? Any comment on stakeholder motivation and how different stakeholder motivation was managed?

16. Were you aware of any opposition to the project? If so, can you tell me more about this opposition? How was the opposition manifested? How was the opposition managed?

17. What were the main problems you encountered?

18. What you believe was successful about your participation in the project?

19. Can you give me an overview of the mHealth project as you see it now? Do you have any specific comment on how you think the project worked out? What are your overall opinions about the project now? Any supporting documentation would be helpful.

20. Do you have any personal experiences that you would like to tell me about which we have not covered thus far in this interview? This would include any significant events, personal experiences and/or motivations etc. Did you have to make any difficult decisions, or did you encounter any difficult situations?

21. Do you have any final comments on the mHealth project?

Question for participants who had direct involvement with the mHealth technology or the mobile app development

22. What technology was/is being used in the mHealth project? Ask for any supporting documentation that may be available.

23. What mHealth systems exist? Why were these particular systems decided upon? What was the process? Ask for any supporting documentation that may be available.

24. Tell me about the mHealth mobile application. Why was this particular app chosen? Were alternatives considered? Can you tell me more about the process involved? Any supporting documentation would be helpful.

25. What training was provided for using the systems & app? Who was training provided to and when? Ask for any supporting documentation and training materials that may be available.

26. How well did users and other stakeholders adapt to the new systems? How well did they adapt to the mobile app?

27. Do you think this mHealth project was a success or failure? Probe … ask participant to explain this in as much detail as possible. Why was the project either a success or failure? Was any action taken because of this success or failure?

Question for World Vision employees

28. Can you tell me about specific project dates? When did the project commence? When is it due to end?

29. What effect did the Ebola outbreak have on the project? Did this change any of the project dates? Did it change anything else? If so, what did it change and how? Did the Ebola outbreak have any specific effect on plans for scaling? Financing? Appetite for the project?

30. Was the mHealth project still operating during the Ebola outbreak? Probe for reasons as to why it was suspended or continued. If not, when was it suspended and/or re-started?

31. How did the mHealth project perform during the Ebola crisis? Were there any iterations, unexpected uses, branches/forks of the project? Did it change in any way as a result of the Ebola crisis? If so, how?

32. Tell me about the hardware and software used for the project.

33. How was the project financed? Did this method of financing have any positive or negative effect on the project? What is the business model for this mHealth project? "Who pays"?

34. Are there any plans for scaling the mHealth project? What are these plans? How will this scaling be carried out? Ask for any supporting documentation if available.

35. How will any scaling plans be financed? How will the project be paid for going forward? What is the business model for this mHealth project? "Who pays"?

36. Did the social/cultural/political/religious beliefs & practices of any stakeholders have any effect on this project? If so, what were these effects specifically? What do you think caused these effects? Concentrate on end-users (i.e. nurses, CHW's and patients). Probe … explain in as much detail as possible what these effects were.

37. How compatible were/are stakeholder social/cultural/political/religious beliefs/practices with the mHealth project and its aims/objectives? Tell

me in as much detail as possible about any conflicts, synergies, etc.?

38. Did any local adaptations evolve from these social/cultural/political/religious beliefs/practices? Tell me about this in as much detail as possible.

Do you have any final comments on how social/cultural/political/religious beliefs/practices may have had an effect on this mHealth project?

Appendix 4: Sample Focus Group Guide

Q	QUESTIONS
1	How long have you been a CHW?
2	Why did you become a CHW?
3	Why do you do this job?
4	Have you ever received incentives?
5	What did you receive?
6	Where you part of the original mHealth Project in 2013-14 (ttC project for maternal and child health)?
7	Did you receive a phone as part of your job as CHW?
8	When was the phone given?
9	What type of phone?
10	Do you still have the phone?
11	If not, what happened to the phone?
12	For how long did you use the phone before losing it?
13	Did the phone help you in you work?
14	How?
15	What were the problems encountered with/using the phone?
16	Have you received payment for this work?
17	When and how much?
18	Where there any problems with the payment?
19	What do you do if you have any problems as a CHW?
20	Who do you report o?
21	Has this been successful?
22	Have you ever received training as a CHW?

23	What was the training for?
24	How many times have you been trained?
25	Did the training help with your job?
26	How did the training help with your work?
27	Do you currently use mobile phone for your work?
28	Is this a personal phone or a phone given to you for the job? Who gave it to you?
29	How do you work with the phone?
30	Do you use a personal sim in the phone and why?
31	Did you work during Ebola?
32	What did you do during Ebola?
33	Were you trained, and by whom?
34	Did you use a mobile phone as part of your work during Ebola?
35	How did you use the phone?
36	Are you using mobile phones now? For why?
37	What is your main work now?
38	If not CHW, how do you compromise the CHW work?
39	Do you work as part of ttC project for maternal and child health?
40	Do you use a phone as part of this work?
41	Do you use a mobile app to do the work?
42	If yes, which phone and mobile app?
43	When do you use the phone and for what?
44	Do you use a paper-based system?
45	Which do you prefer between phone and paper and why?
46	What most supports you in your work?
47	What do you need for this work?

48	Why do you keep doing this work?
49	What are your biggest challenges as a CHW?
50	Have you heard about the CHW Hub?
51	What do you know about it?
52	Does the CHW hub has any influence on your work?
53	Have you heard about the eHealth Hub?
54	Do you know about the National CHW Policy?
55	What do you know about the policy?
56	Does it influence your work? And how? (CHW Training)
57	Do you know the CHW Focal?
58	How do they influence your work as CHW?
59	What else do you need to do your work?
60	Tell me how this will change what you do.

Appendix 5: Publications and Conferences

Peer Reviewed Journal Publications

Heeks, R. & Wall, P.J. (2018)
Critical Realism and ICT4D Research
Paper in the Special Edition of the *Electronic Journal of Information Systems in Developing Countries (EJISDC)* on Critical Realism and ICT4D

Heeks, R. & Wall, P.J. (2018)
Editorial - Critical Realism and ICT4D Research
Editorial in the Special Edition of the *Electronic Journal of Information Systems in Developing Countries (EJISDC)* on Critical Realism and ICT4D

Vallières, F., McAuliffe, E., van Bavel, B., Wall, P.J. & Trye, A. (2016)
There's no app for that: Assessing the impact of mHealth on the supervision, motivation, engagement and satisfaction of community health workers in Sierra Leone
Annals of Global Health, 82(5), 936-949

Peer Reviewed Conference Papers

Heeks, R., Ospina, A., Wall, P.J. (forthcoming - 2019)
Combining Pragmatism and Critical Realism in ICT4D Research: An e-Resilience Case Example
Information and Communication Technologies for Development: 14th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2019, Dar es Salaam, Tanzania, 1-3 May 2019

Wall, P.J., Lewis, D., Hederman, L. (forthcoming - 2019)
Identifying Mobile Health (mHealth) Generative Mechanisms in Sierra Leone: A Critical Realist Framework for Retroduction
Information and Communication Technologies for Development: 14th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2019, Dar es Salaam, Tanzania, 1-3 May 2019

Wall, P.J., Lewis, D., Hederman, L. (2018)
Causal Explanation of Mobile Health (mHealth) in Sierra Leone - A Morphogenetic Analysis
Paper presented at the Development Studies Association of Ireland (DSAI) Annual Conference 2018, Dublin, Ireland, 23-24 October 2018

Wall, P.J., Lewis, D., Hederman, L. (2018)
Mobile Health (mHealth) Innovation in Sierra Leone: A Critical Realist Study
IFIP WG 9.4 European Regional Conference on the Social Implications of Computers in Developing Countries, Tirana, Albania, 22-24 June 2018

Wall, P.J., Lewis, D., Hederman, L. (2017)
Information and Communications Technology for Development (ICT4D) - A Review of the Field and Future Priorities in a Changing International Context
Paper presented at the Development Studies Association of Ireland (DSAI) Annual Conference 2017, Dublin, Ireland, 23-24 November 2017

Heeks, R & Wall, P.J. (2017)
Critical Realism and Development Studies
In: DSA Annual Conference, University of Bradford, UK, Sept 6-8 2017

Wall, P.J., Deimling Johns, L., Lewis, D., Hederman, L. (2017)
Different Approaches, Different Mechanisms? Comparing the Mechanisms Identified by the Morphogenetic Approach and the Realist Synthesis Framework (MCO) Approach
In: 19th Annual Conference of the International Association of Critical Realism, University of Torino, Turin, Italy, 19-21 July 2017

Heeks, R. & Wall, P.J. (2017)
Critical Realism in Information and Communications Technology for Development (ICT4D) Research: An Emergent Paradigm
In: 19th Annual Conference of the International Association of Critical Realism, University of Torino, Turin, Italy, 19-21 July 2017

Heeks, R. & Wall, P.J. (2017)
Critical Realism and ICT4D Research
Information and Communication Technologies for Development: 14th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2017, Yogyakarta, Indonesia, May 22-24, 2017, Proceedings. J. Choudrie, M. S. Islam, F. Wahid, J. M. Bass and J. E. Priyatma. Cham, Springer International Publishing: 159-170

Wall, P.J., Khayyat, M., Lewis, D., Hederman, L. (2016)
Combining Critical Realism, the Morphogenetic Approach and Activity Theory: A Proposed Framework for the Study of Mobile Health (mHealth) in Sierra Leone
In: 18th Conference of the International Association of Critical Realism, University of Cardiff, UK, July 20-22 2016

Wall, P.J., Lewis, D., Hederman, L., McAuliffe, E. (2014)
A Critical Realist Perspective on Mobile Health (mHealth): A Case Study in Sierra Leone

In: 17th Annual Conference of the International Association of Critical Realism, Institute of Education, London, UK, July 18-21 2014

Wall, P.J., Vallières, F., Lewis, D., Hederman, L., Musa, J. (2013)
A Socio-Technical Approach to the Implementation of mHealth in Sierra Leone: A Theoretical Perspective
In: eChallenges e-2013 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds), IIMC International Information Management Corporation Ltd 2013
ISBN 978-1-905824-40-3, ISBN: 978-1-905824-40-3

Wall, P.J., Vallières, F., Nestle, N., Boombu-Johnson, C. (2013)
Technical Implications of Implementing mHealth Applications in Sierra Leone
In: eChallenges e-2013 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds), IIMC International Information Management Corporation Ltd 2013
ISBN 978-1-905824-40-3, ISBN: 978-1-905824-40-3

Vallières, F., McAuliffe, E., Bangura, A., Trye, A., Wall, P.J. (2013)
The Implications of mHealth for Human Health Resources in Bonthe District, Sierra Leone
In: eChallenges e-2013 Conference Proceedings, Paul Cunningham and Miriam Cunningham (Eds), IIMC International Information Management Corporation Ltd 2013
ISBN 978-1-905824-40-3, ISBN: 978-1-905824-40-3

Book Chapters

Gilmore, B., McVeigh, J., Wall, P.J. (2019 - forthcoming)
Studying Systems: Realist Methodologies for Systems Thinking in Global Health
Book Chapter in "Reading Across Systems Thinking for Global Health", Fiona Larkan, Hasheem Mannan, Frédérique Vallières (ed's). Oxford University Press

Wall, P.J., Vallières, F., McAuliffe, E., Lewis, D., Hederman, L. (2015)
Implementing mHealth in low and middle-income countries: What should program implementers consider?
CRC Press - Book chapter in "Mobile Health (mHeath): The Technology Road Map", Springer

Appendix 6: Awards

Yale University - International Scholar Honorarium for work on the Critical Realism Project 2017
Awarded by Yale University for the international scholar who completed research and produced publications outside of the USA for the Critical Realism Project website.

The Early Career Academics Grant - IACR (International Association for Critical Realism) Conference 2016
Awarded by the Society for the Advancement of Management Studies & Cardiff Business School, Cardiff University

eChallenges Conference 2013 - Runner-up Best Paper Award
Winner of the runner up paper award. The paper was entitled "A Socio-Technical Approach to the Implementation of mHealth in Sierra Leone: A Theoretical Perspective" authored by PJ Wall, Frédérique Vallières, Dave Lewis, Lucy Hederman (Knowledge and Data Engineering Group, Trinity College Dublin & Centre for Global Health, Trinity College Dublin) & Joseph Musa (World Vision Sierra Leone)

Appendix 7: Ethical Approval - Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

F.A.O. PJ Wall

School of Computer Science and Statistics Research Ethics Committee

2 August 2016

Dear PJ,

Following receipt of amendments, I am pleased to inform you that your application entitled "A Critical Realist Framework for the study of Mobile Health (mHealth) in Sierra Leone" has been approved.

Yours sincerely,

The School of Computer Science and Statistics Research Ethics Committee

Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

F.A.O. PJ Wall

School of Computer Science and Statistics Research Ethics Committee

14 February 2019

Dear PJ,

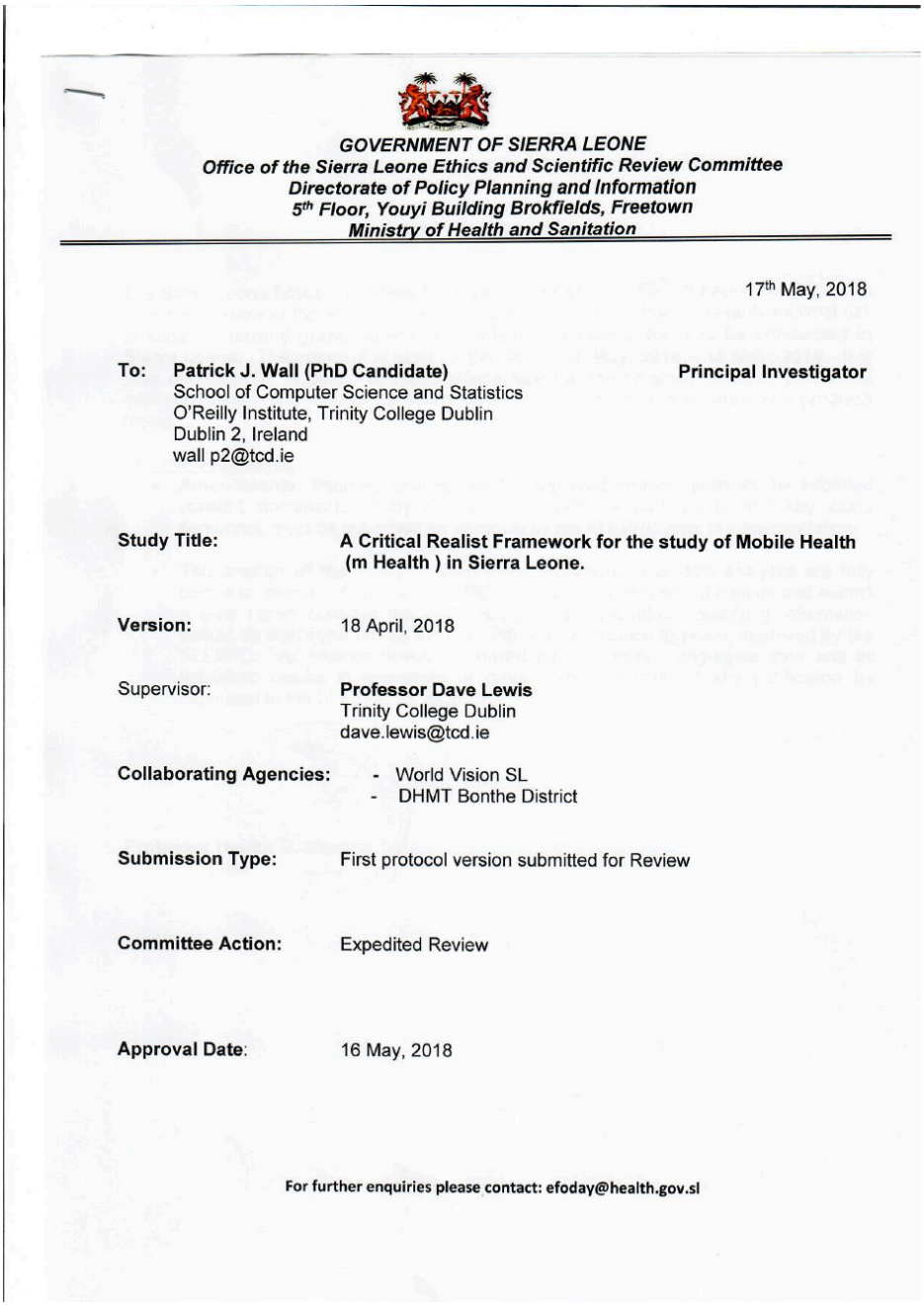
This letter is to confirm that your research ethics application entitled "A Critical Realist Framework for the study of Mobile Health (mHealth) in Sierra Leone" was granted approval by the School of Computer Science and Statistics Research Ethics Committee on the 2nd August 2016.

Yours sincerely,

Prof. Gavin Doherty,
Chair
School of Computer Science and Statistics Research Ethics Committee

Appendix 8: Ethical Approval - Ministry of Health and Sanitation (MoHS) in Sierra Leone

Ethical approval for this research has been received from both Trinity College, the University of Dublin and the Ministry of Health and Sanitation (MoHS) in Sierra Leone.



GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Policy Planning and Information
5th Floor, Youyi Building Brokfields, Freetown
Ministry of Health and Sanitation

17th May, 2018

To: **Patrick J. Wall (PhD Candidate)** **Principal Investigator**
School of Computer Science and Statistics
O'Reilly Institute, Trinity College Dublin
Dublin 2, Ireland
wall p2@tcd.ie

Study Title: **A Critical Realist Framework for the study of Mobile Health (m Health) in Sierra Leone.**

Version: 18 April, 2018

Supervisor: **Professor Dave Lewis**
Trinity College Dublin
dave.lewis@tcd.ie

Collaborating Agencies:
- World Vision SL
- DHMT Bonthe District

Submission Type: First protocol version submitted for Review

Committee Action: Expedited Review

Approval Date: 16 May, 2018

For further enquiries please contact: efoday@health.gov.sl

GOVERNMENT OF SIERRA LEONE
Office of the Sierra Leone Ethics and Scientific Review Committee
Directorate of Policy Planning and Information
5th Floor, Youyi Building Brokfields, Freetown
Ministry of Health and Sanitation

The Sierra Leone Ethics and Scientific Review Committee (SLESRC) having conducted an expedited review of the above study protocol and determined that it presents minimal risk to subjects, **hereby grants ethical and scientific approval for it to be conducted in Sierra Leone.** The approval is valid for the period, **16 May, 2018 – 15 May, 2019.** It is your responsibility to obtain re-approval/extension for any on-going research prior to its expiration date. The request for re-approval/extension must be supported by a progress report.

Review Comments:

- **Amendments:** Intended changes to the approved protocol such as the informed consent documents, study design, recruitment of participants and key study personnel, must be submitted for approval by the SLESRC prior to implementation.

- **Termination of the study:** When study procedures and data analyses are fully complete, please inform the SLESRC that you are terminating the study and submit a brief report covering the protocol activities. Individual identifying information should be destroyed unless there is sufficient justification to retain, approved by the SLESRC. All findings should be based on de-identified aggregate data and all published results in aggregate or group form. A copy of any publication be submitted to the SLESRC for its archive.

Professor Hector G. Morgan
Chair

For further enquiries please contact: efoday@health.gov.sl

Appendix 9: Participant Information Sheet - Interview

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Trinity College Dublin
School of Computer Science and Statistics

Participant Information Sheet - Interview Research Title:

A Critical Realist Framework for the study of Mobile Health (mHealth) in Sierra Leone

Lead Researcher:

Patrick Joseph Wall
Trinity College Dublin, School of Computer Science and Statistics

Supervisors:

Prof. David Lewis, Prof. Lucy Hederman
Trinity College Dublin, School of Computer Science and Statistics

Lead Researcher Contact Details*:*

Name: Patrick Joseph Wall Phone: +353 86 83 56799
Email: wallp2@tcd.ie

Expected Duration of the Research:

The expected duration of this research is June 2018 – March 2019.

This study is conducted in partial fulfilment of PJ Wall's PhD, to be awarded by the School of Computer Science and Statistics, Trinity College Dublin, Ireland.

Background to the research:

As the role of mobile health (mHealth) in clinical care, education, research, and training in the public health sector continues to gain momentum, many see considerable potential for mHealth in low- and middle-income countries (LMICs). However, the design, implementation and adoption of mHealth in

LMICs is beset with wide-ranging challenges and many mHealth projects have been unable to sustain or demonstrate any significant impact at scale. This is because any mHealth implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technical and ideological factors.

This research proposes to examine an ongoing World Vision mHealth project in Bonthe District, Sierra Leone. The purpose of the research is to find out why the mHealth project evolved the way it did. Specifically, the research seeks to find the mechanisms which may have caused the events unique to this mHealth case and the factors which have combined to generate these mechanisms. This research will utilize a research framework which defines mechanisms as the causal structures that can generate or trigger observable events. The research will rely on a variety of research approaches and methodologies in an attempt to reveal mechanisms that explain how the interaction of different structural, cultural and agency factors have influenced this particular mHealth project.

The procedures relevant to the participant within this particular study:

The lead researcher invites you to participate in this research project based on the fact that you are currently, or have been previously, involved with the mHealth project in some capacity. Your participation will involve a semi-structured interview which will last between 60-90 minutes. The topics covered in the interview will include, but are not limited to, a description of your involvement in the mHealth project, a description of the work that you completed, your experiences of the project, what dictated the manner in which you worked, any problems you encountered, what caused change in the project, what you believe was successful about your participation in the project, and your overall opinions about the project. In some cases, you may be asked to participate in a short follow up interview. This will only occur where there is a need to confirm prior findings and/or identify any changes that may have taken place since the initial interview. For any participants who are to be re-interviewed, the same interview guide and Participant Information Sheet will be used.

You may be electronically recorded as you participate in the interview. If you do not wish to be electronically recorded you will not be asked to participate and will withdraw fully from this process. If you agree to be electronically recorded

you may stop electronic recording at any time, and may at any time, even subsequent to participation in this research, have such audio and/or video recordings, or any transcripts taken of these recordings, destroyed.

You have the right to contact the Office of the Sierra Leone Ethics and Scientific Review Committee if you have any issues whatsoever with this study, or sustain any research- related injury. The Sierra Leone Ethics and Scientific Review Committee are located at the Ministry of Health and Sanitation, Directorate of Policy, Planning & Information (DPPI), Youyi Building, Fifth Floor, East Wing, Freetown, Sierra Leone. The contact telephone number is +23278 366493, and email is efoday@health.gov.sl.

Declaration of conflicts of interest:

The lead researcher declares that he has no conflicts of interest of any sort in connection with this research. The lead researcher is not aware of any conflicts of interest between any of the research team and this research.

How Participants have been selected to Participate in this Research:

You have been selected to participate in this research because you currently are, or at some time in the past were, involved in some capacity with this particular mHealth implementation. You have been selected based on the lead researcher's knowledge of this mHealth project. You may also have been selected because you were recommended by the Director of Global Health Programmes in World Vision Ireland. The Director of Global Health Programmes in World Vision Ireland provided me with your contact details if they are not contact details that I had already through prior interactions with you. Everyone recommended by the Director of Global Health Programmes in World Vision Ireland will be asked to participate in this research.

The voluntary nature of the participation:

Your participation in this research is voluntary, and without prejudice to your legal and ethical rights. Refusal to participate will not involve a penalty or loss of any benefits that you may otherwise be entitled to. You have the right to withdraw from the research process at any time without penalty or loss of any benefits that you may otherwise be entitled to. You also have the right to omit any responses to individual questions without penalty or loss of benefit. If you

are taking part in this research you will be asked for your consent, and this consent can be withdrawn by you without penalty or loss of any benefits that you may otherwise be entitled to at any time.

Anticipated risks/benefits of participation:

There are no anticipated risks to your participation in this research. However, please be aware that if you engage in any illegal or illicit behavior or make any illegal or illicit behavior known to the investigator, this will be reported to appropriate authorities, and your participation in this research may be terminated without regard to your consent.

Termination of participation:

As stated in a previous section, your participation in this research may be terminated by the principle investigator if you engage in any illegal or illicit behavior or make any illegal or illicit behavior known to the investigator. In such instances, all illegal or illicit behavior will be reported to appropriate authorities. It has also been stated that if you do not wish to be electronically recorded you will not be asked to participate in this research. If you agree to be electronically recorded you may stop electronic recording at any time, and may at any time, even subsequent to participation in this research, have such audio and/or video recordings, and any written transcripts resulting from these recordings, destroyed.

The provisions for debriefing after participation:

If requested, you will be fully de-briefed at the end of your participation in this research. If you so wish, you will also be given a brief explanation of the study.

Dissemination of the Research, and Publications arising from the Research:

Results, data and findings from this research will be published as PJ Wall's final PhD thesis. Additionally, results, data and findings from this research may be published in one or more peer-reviewed journals, conference proceedings, and a variety of other research publications and conferences. The results of this research will also be disseminated through a number of national and international networks. Primarily, Trinity College Dublin will be responsible for sharing research findings through their government and academic partnerships

both in Ireland and abroad.

Research outcomes will be shared directly with World Vision International, World Vision Ireland and the Government of Sierra Leone. This means that findings from this study may be used to better design programmes aimed at strengthening health systems, including making improvements to World Vision's mHealth programmes. The findings from this research will also be disseminated through World Vision International's networks and partner organisations. The research will also be shared with the National mHealth Coordinating Committee in Sierra Leone whose mandate is to promote collaboration and best practice in mHealth, and also the District Health Management Team in Sierra Leone.

By participating in this research, you agree that this data may be used for such scientific purposes, and that you have no objection that the data is published in research and scientific publications in a way that does not reveal your specific identity.

At all times your data will be treated with full confidentiality. There will be preservation of participant and third-party anonymity in analysis, publication and presentation of resulting data and findings. Any results, data and findings will be fully anonymous and no personal details about you will be revealed or identified as yours. If you name any third parties, these will be anonymized.

There will be provision for verifying direct quotations and their contextual appropriateness. If any direct quote from you is to be used, you will be contacted in advance and asked to give permission for the use of the quote. You will also be asked if the use of the quote is contextually appropriate and otherwise accurate. If you decline to give permission, the quote will not be used.

Should audio, video or any other electronic recordings be made at any time, these will not be made available to anyone other than the research team. Nor will any such electronic recordings be replayed in any public forum or presentation of the research. You may stop electronic recording at any time, and you may at any time, even subsequent to your participation in this research, have such audio and/or video recordings destroyed. At no time will any electronic recording be identifiable unless you give prior written

permission.

All audio, video and any other electronic recordings will be kept securely under lock and key at all times and both password protected and encrypted. All electronic recording devices and equipment will be password protected where possible and kept secure and in the possession of the lead researcher while any recorded audio, video, or other data is on the device.

All audio, video and any other electronic recordings and data will be removed from the electronic recording device immediately after being recorded. All such data will be copied from the electronic recording device to 2 separate external hard drives. Each external hard drive will be encrypted with Apple FileVault which uses XTS-AES 128-bit encryption protocols. One of these hard drives will be stored in Trinity College Dublin in a secured and locked filing cabinet or safe box in the offices of the lead researcher. The other hard drive will be stored in Trinity College Dublin in a secured and locked filing cabinet or safe box in the offices of the research supervisor. No electronically recorded data of any sort will be kept or stored outside of Trinity College Dublin at any time. No electronically recorded data of any sort will be uploaded to the cloud or backed up online at any time. All passwords and encryption keys will be kept by the lead researcher and will be made available to the research supervisors upon request. No one else will have access to the passwords and encryption keys.

The lead researcher must, at all times, act in accordance with all information provided in this and other documents.

Ethical Approval:

The lead researcher has obtained ethical approval for this research from the School of Computer Science and Statistics, Trinity College Dublin. Ethical approval has also been obtained from the Office of the Sierra Leone Ethics and Scientific Review Committee, Ministry of Health and Sanitation.

Appendix 10: Participant Informed Consent Form - Interview

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Trinity College Dublin
School of Computer Science and Statistics

Participants Informed Consent Form - Interview Research Title:

A Critical Realist Framework for the study of Mobile Health (mHealth) in Sierra Leone

Lead Researcher:

Patrick Joseph Wall
Trinity College Dublin, School of Computer Science and Statistics

Supervisors:

Prof. David Lewis, Prof. Lucy Hederman
Trinity College Dublin, School of Computer Science and Statistics

Lead Researcher Contact Details*:*

Name: Patrick Joseph Wall Phone: +353 86 83 56799
Email: wallp2@tcd.ie

Expected Duration:

The expected duration of this research is June 2018 – March 2019.

This study is conducted in partial fulfilment of PJ Wall's PhD, to be awarded by the School of Computer Science and Statistics, Trinity College Dublin, Ireland.

Background to the Research:

As the role of mobile health (mHealth) in clinical care, education, research, and training in the public health sector continues to gain momentum, many see considerable potential for mHealth in low and middle-income countries (LMICs).

However, the design, implementation and adoption of mHealth in LMICs is beset with wide-ranging challenges and many mHealth projects have been unable to sustain or demonstrate any significant impact at scale. This is because any mHealth implementation in such environments is bound to be shaped by a variety of social, cultural, political, environmental, technical and ideological factors.

This research proposes to examine an ongoing World Vision mHealth project in Bonthe District, Sierra Leone using qualitative case study methodologies. The focus is on exposing the mechanisms which have caused the events unique to this mHealth case and the specific factors which have combined to generate them.

Procedures to this Research:

The research objectives as outlined in the previous section will be achieved using a variety of research methods including semi-structured interview of a variety of participants, focus group discussions, analysis of documents connected with the mHealth project, review of archival data, and observation. As a person who is currently involved with, or at some time in the past has been involved with, the mHealth project in Sierra Leone I would like to invite you to participate in this study. Should you agree to participate, your involvement would consist of a 60-90 minute interview with the lead researcher. The topics covered in the interview will include, but are not limited to, a description of your involvement in the mHealth project, a description of the work that you completed, your experiences of the project, what dictated the manner in which you worked, any problems you encountered, what you believe was successful about your participation in the project, and your overall opinions about the project.

In some cases, I may ask that you participate in a short follow up interview. This will only occur where there is a need to confirm prior findings and/or identify any changes that may have taken place since the initial interview. If I ask that you be re-interviewed, the same interview guide and Participant Information Sheet will apply.

The interview will be electronically recorded. If you do not wish to be electronically recorded you will not be interviewed and will withdraw fully from

this process. If you agree to be electronically recorded you may stop electronic recording at any time, and may at any time, even subsequent to participation in this research, have such audio and/or video recordings and any transcripts taken of these recordings, destroyed.

There are no anticipated risks to your participation in this research. However, please be aware that if you engage in any illegal or illicit behavior or make any illegal or illicit behavior known to the investigator, this will be reported to appropriate authorities, and your participation in this research may be terminated without regard to your consent.

You have the right to contact the Office of the Sierra Leone Ethics and Scientific Review Committee if you sustain any research-related injury or have any issues whatsoever with this study. The Sierra Leone Ethics and Scientific Review Committee are located at the Ministry of Health and Sanitation, Directorate of Policy, Planning & Information (DPPI), Youyi Building, Fifth Floor, East Wing, Freetown, Sierra Leone. The contact telephone number is +23278 366493, and email is efoday@health.gov.sl.

Publications from this Research:

Results, data and findings from this research will be published as PJ Wall's final PhD thesis. Additionally, results, data and findings from this research may be published in one or more peer-reviewed journals, conference proceedings, and a variety of other research publications and conferences. The results of this research will also be disseminated through a number of national and international networks. Primarily, Trinity College Dublin will be responsible for sharing research findings through their government and academic partnerships both in Ireland and abroad.

Research outcomes will be shared directly with World Vision International, World Vision Ireland and the Government of Sierra Leone. This means that findings from this study may be used to better design programmes aimed at strengthening health systems, including making improvements to World Vision's mHealth programmes. The findings from this research will also be disseminated through World Vision International's networks and partner organisations. The research will also be shared with the National mHealth Coordinating Committee in Sierra Leone whose mandate is to promote

collaboration and best practice in mHealth, and also the District Health Management Team in Sierra Leone.

By participating in this research, you agree that this data may be used for such scientific purposes, and that you have no objection that the data is published in research and scientific publications in a way that does not reveal your specific identity Other provisions for protecting your identity and keeping all data connected with this research are outlined in the Participant Information Sheet.

Declaration:

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and
  this consent form (the Participant Information Sheet). I have had the opportunities to ask questions and all of my questions have been answered to my satisfaction and I understand the description of the research that is being provided to me.
- I agree that my data is used for scientific purposes and I have no objection that my data is published in research and scientific publications in a way that does not reveal my specific identity.
- I understand that if I make illicit activities known, these will be reported to appropriate authorities.
- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation, have such recordings destroyed (except in situations such as above). I may also request that all transcriptions of these recordings be destroyed.
- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the lead researcher, supervisors, and research team.
- I freely and voluntarily agree to be part of this research study, through without prejudice to my legal and ethical rights.

- I understand that I may refuse to answer any questions and that I may withdraw at any time without penalty or loss of benefits.
- I understand that my participation is fully anonymous and that no personal details about me will be recorded.
- I have received a copy of this agreement.

PARTICIPANTS NAME: _____ PARTICIPANT'S SIGNATURE: _____ Date: _____/_____/_____

Statement of Lead Researcher's Responsibility:

I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Lead Researcher Contact Details*:*

PJ Wall
Phone: +353 86 83 56799

Email: wallp2@tcd.ie

LEAD RESEARCHER'S SIGNATURE:

_____

DATE: _____/_____/_____

LEAD RESEARCHER COPY

Declaration:

- I am 18 years or older and am competent to provide consent.

- I have read, or had read to me, a document providing information about this
  research and this consent form (the Participant Information Sheet). I have had the opportunities to ask questions and all of my questions have been answered to my satisfaction and I understand the description of the research that is being provided to me.

- I agree that my data is used for scientific purposes and I have no objection that my data is published in research and scientific publications in a way that does not reveal my specific identity.

- I understand that if I make illicit activities known, these will be reported to appropriate authorities.

- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation, have such recordings destroyed (except in situations such as above). I may also request that all transcriptions of these recordings be destroyed.

- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the lead researcher, supervisors, and research team.

- I freely and voluntarily agree to be part of this research study, through without prejudice to my legal and ethical rights.

- I understand that I may refuse to answer any questions and that I may withdraw at any time without penalty or loss of benefits.

- I understand that my participation is fully anonymous and that no personal details about me will be recorded.

- I have received a copy of this agreement.

PARTICIPANTS NAME: _____ PARTICIPANT'S SIGNATURE: _____ Date: _____/_____/_____

Statement of Lead Researcher's Responsibility:

I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.)

Lead researcher Contact Details*:*

PJ Wall
Phone: +353 86 83 56799

Email: wallp2@tcd.ie

LEAD RESEARCHER'S SIGNATURE:

_____

DATE: _____/_____/_____

Appendix 11: Transcript of Semi-Structured Interview

Please note that this interview transcript has been anonymized in line with the ethical approval received from both Trinity College Dublin and the MoHS in Sierra Leone. The full list of persons interviewed for this PhD is given in Appendix 1. All interviews were fully transcribed. The code assigned to this interviewee is SI-1.

Interviewer: This is the interview with **SI-1** on 26th July, 2018. Okay, **SI-1**, thank you.

SI-1: Welcome.

Interviewer: You have been so helpful all week. I owe you so much. I couldn't have done any of this without you. I really do thank you so much. I want to start out by asking you some specific questions that I didn't ask anybody else because you're the man who will know more about this than anybody else, I'm just going to ask some specific questions. The two reports that you gave me earlier on the week, you said I could keep the smaller one, but you wanted the bigger one back?

SI-1: Yes, because we need to have it in file. I've actually not gone through it because I was there when those reports were written. I will also want to read it, but if you actually need it, if you want to take it home and then later come with it, I have no problem. You can use it, if you have no time to go through it now, you can take it home and then anytime you come in, you can bring so that we can just-- I will also go through it, and then maybe keep it in file.

Interviewer: Do you need it immediately?

SI-1: No.

Interviewer: Will I hold on to it then and bring it back?

SI-1: Yes.

Interviewer: What I can do is, I can give it to Nicola if she's coming back or somebody else's coming back a bit quickly, more quickly than me they can do that.

SI-1: No problem.

Interviewer: Is there a soft copy of that file anywhere?

SI-1: I have to ask Alieu if he has one. I only got hold of the hard copy.

Interviewer: Okay, no problem. Were there any other reports done on the mHealth project that you know of?

SI-1: Those are the two reports that I know of. I know that there were some reports, we have quarterly annual report from the project itself. Maybe I will ask the guy who was managing the project if he has any of those ones, then I will maybe send those ones to Amara.

Interviewer: If you can find that, that would be fantastic. Do you know if much of this data is on the World Vision website? Is there a specific part of it devoted to this mHealth project?

SI-1: I know there was some reports written by … I think it was a report that was written that covers all where the mHealth project was being implemented. There was one that was actually covering Sierra Leone which was done by Annette Gee. You know Annette?

Interviewer: Yes.

SI-1: Annette Gee might have a report that might cover some aspects of the mHealth in Sierra Leone. There's one that even has my photo on the cover page. Annette Gee may have some reports on that.

Interviewer: Okay, Annette Gee, all right. Can you tell me the dates that you worked? I want to get clear when you were actually on this project. When did you start working as the project manager?

SI-1: I actually started working on the eighth of September.

Interviewer: The eight of the night?

SI-1: Yes.

Interviewer: What year? 2012?

SI-1: There was a break. I had a break somewhere.

Interviewer: When did you start on the original?

SI-1: The mHealth? You mean the mHealth?

Interviewer: Yes, way back in 2012.

SI-1: I was the one that actually started the start-up workshop, before they have-- the project manager by then was, before he was recruited. I started way back in 2012, that was somewhere around July 2012.

Interviewer: You worked on?

SI-1: I worked on it for close to about six months, and the project manager was actually employed. He was only employed for-- He was recruited for a period of one year. I actually took over 2013.

Interviewer: Early in 2013?

SI-1: That was January because usually the project here start January, January of 2013.

Interviewer: You were project pm?

SI-1: Yes, and we went up to February of 2014.

Interviewer: Feb …

SI-1: Of 2014.

SI-1: And then I was asked to relocate to Gambia, March of 2014.

Interviewer: To EBODAC?

SI-1: Yes, EBODAC.

Interviewer: Can you spell that?

SI-1: E-B-O-D-A-C.

Interviewer: What does that stand for?

SI-1: It's Ebola Vaccine Deployment and Compliance.

Interviewer: Okay. Is there a V?

SI-1: No. There are two projects. There's one that is EBOVAC. The one that World Vision was actually operating is known as EBODAC. The EBOVAC is the Ebola Vaccine trial. World Vision is EBODAC, Ebola Vaccine Deployment and Compliance.

Interviewer: When did you leave that project to come back here?

SI-1: It was in the last week of August. Actually, the first week in September. That was when Nicola came. This guy died in the last week in July. He was laid to rest around the 13th of August 2017. I actually came over in September. I took over the project in September-- the first week in September 2017.

Interviewer: You were around EBODAC then from 2014 to 2017?

SI-1: Yes.

Interviewer: That's 14, 15, 16, 17. Three and a half years?

SI-1: Yes.

Interviewer: The job title is AIM-Health Project Manager?

SI-1: Yes.

Interviewer: AIM-Health Project Manager, okay. They were just some specific questions for you that I didn't ask anybody else. Currently, AIM-Health Project Manager. I was here for much of the initial pilot in 2013, 2014. Can you just clarify the exact dates for that? This is the original AIM-Health and mHealth One project?

SI-1: Yes.

Interviewer: What were the dates for that? I know there was planning through 2012. What happened then in 2013? Or do you remember the dates of the actual pilot?

SI-1: Well, what I can do is maybe-- I don't want to give you dates that are incorrect. I want to go back and look at my computer, and maybe I will be able to give you the exact dates as to how the projects--

Interviewer: You can email me.

SI-1: Yes, I can email that to you.

Interviewer: You have my email, because we've been--

SI-1: Yes, we have been communicating. I will email it to you.

Interviewer: All right.

SI-1: I don't want to give you wrong dates now.

Interviewer: That's okay. That's perfect. That will be really useful, **SI-1**. Thank you. Let's just talk very broadly for a moment then. AIM-Health started in 2012 to 2017?

SI-1: Yes.

Interviewer: Those are calendar years, aren't they?

SI-1: Yes.

Interviewer: 2012 to 2017 calendar. In 2012, I know Frederick was doing a lot of planning with you and the guys in head office in Freetown, then I think in early 2013 the mHealth One Project kicked off. That sounds about right. Isn't it?

SI-1: Yes. It was in 2013.

Interviewer: Yes. In 2013, yes. It went all the way through to 2013. It went into 2014.

SI-1: Yes, when there was actually Ebola outbreak.

Interviewer: Then Ebola happens in May 2014?

SI-1: Yes.

Interviewer: Just the period of 2013 to May 2014, that was when the mHealth project was running with no Ebola.

SI-1: Yes.

Interviewer: How was the project going at that stage? What did you think of the project? Was it producing good data? How was it working?

SI-1: It was very good at that time, because we had-- The project itself was a stand-alone project although it was implemented together with AIM-Health at that time. We have it as mHealth, and it has its own project manager by then.

Interviewer: Who was that then?

SI-1: That is Augustine Trye.

Interviewer: Of course, yes. Now, Joe G is his successor.

SI-1: Yes.

Interviewer: Okay. What did you think about that project? Did you think it was a good project?

SI-1: It was very good because we had a lot of good health outcomes out of that project because it was very evident by the reports that we even get from the CHWs. It was a pilot-like. There was one which was-- There were some phones which only had CUG, Closed User group, and there was the other one which was having the CommCare application.

Those ones that were having the CUG were very effective because they used to call the PHU staff in case there were any obstetric emergencies. They will easily attend to those emergencies in good time because, at that time, it was even very difficult to transport pregnant women, especially when maybe they have obstetric labor, from their communities to the health facility and to the referral hospital.

It was very good at that time because the community health workers, since they were having CUG, were able to communicate to the PHU staff directly and those PHU staff also can call the DHMT personnel so that they can make available transport facility to any case that is an emergency.

Interviewer: What about the CommCare app? Was that very effective also?

SI-1: It was also very effective because there were reminder messages that were sent to the CHWs to remind them on the visits of the pregnant women. Then it was also sent out if there was any danger signs that were detected on any pregnant woman. Those information can be sent to the PHU in charge who can also receive that information. It was like a referral sort of information that can be sent to the in charge.

The CHWs were reminded as to what they should do when the visit time is due because they can get the flashback of information to their phones. For example, if they visit a certain woman and they schedule a certain time for the visit, they can get the information flashing back in their phones reminding them to visit this pregnant woman. It was there to keep them informed and all of the visits that was done were actually scheduled on time.

Interviewer: Did the mHealth project lead to improved health outcomes?

SI-1: Sure.

Interviewer: Is that mentioned in the report? There's a baseline and then there's improved health outcomes from a follow-up study.

SI-1: Yes. In fact, that was a period when I think that there were, to some extent, two or three pregnant women were at least saved because of those phones because they were able to do a quick call. A lot of women were sent to the hospitals and they were urgent-- they were able to be attended to on time because of the use of the mobile phones.

Interviewer: Only two or three?

SI-1: There were more than that. I'm just mentioning it as an example, but there were more than that.

Interviewer: Now, I know you weren't here but during Ebola, from May of 2014 to March 2016 Ebola. Do you know anything about how to project run during Ebola?

SI-1: Yes, because these were the same community health workers that we are using for mHealth. They were trained in some infection prevention control measures. They were also trained on how they can do community sensitization on Ebola messages and they were also trained to do some observation, some signs that people can-- if an Ebola patient could show those signs so that they can report to the DHMT immediately.

The CHWs, since they were having the mobile phone, and it was also at that time still on CUG, they used to call. In case there were any suspected cases of any Ebola clients, they would be able to call the surveillance officers so that they can report, or if there were any deaths because at that time nobody was allowed to undertake any burial.

If there was any deaths that occurred, whether it was due to Ebola or it was due to any other cause, the CHWs were able to call the surveillance officers and they will go to those communities. Then they can do a swab and then they can take those swabs for medical examination for laboratory test.

Since they were having these phones, they were able to use these phones within that period. They were also now used as community mobilizers during the period of Ebola.

Interviewer: Community mobilizers?

SI-1: Yes.

Interviewer: Do you think that any of the … The original Nokia phones were being used, but was the CommCare app still being used during that time?

SI-1: It was also used because at that time there were [sic] this myth that Ebola was caused by health workers. The community health workers were able to still visit the pregnant women although, at that time, the optic of pregnant women to the hospital was a little bit hampered because of the Ebola. Having the fear that if they visit the hospital, the health workers can give them Ebola.

These community health workers, since they were living within the community, were still able to use the mobile phone to get some information from the mothers, then they can send us information out to the PHU. It was still used within that period so that pregnant women can still continue their follow-up to the PHUs.

Interviewer: The CommCare was definitely being used in that period?

SI-1: It was used in that period, yes.

Interviewer: I know that the CHW were given Nokia Asha phones during that period also.

SI-1: Yes.

Interviewer: Is it correct that World Vision bought those phones and they were distributed by DHMT?

SI-1: Yes, it's correct. The DHMT, we're only part of it because what we still do, they have to be part of the system, and they have to be with us when we are doing the distribution. We don't actually have to deliver the phones to them, but they will be part of the process. Like what we are planning to do now, we invite all of them and then we train them, but it is World Vision that we give the phones to. There should be a memorandum of understanding that should be signed by DHMT and then signed also by the CHWs. It has to be signed by the CHW, countersigned by the DHMT point person or even the district medical officer.

Interviewer: Do you remember how many Asha phones were given out of time?

SI-1: What I was told was-- because I was not here by then, I was in there. What I was told-- I asked this-- Maybe I will give you also that information. I asked Amara this afternoon and he told me that a total of 206 phones were given out.

Interviewer: 206 Ashas?

SI-1: It was not all Ashas, it included those C2, Nokia C2. There were some-- We have 106 that was given that was only with CUG. Then we have 106 that was given out with the Nokia CommCare application.

Interviewer: They were the C2s?

SI-1: Yes. They were C2s and then we have the Asha Nokia. We have 106 that was having only the CUG, then we have 106 that was was giving the conquer application.

Interviewer: You can find information on that—[crosstalk]

SI-1: Yes, I will confirm how many were Ashas and how many were the Nokia C2.

Interviewer: The CHWs kept working during Ebola, they used the phones particularly-- they were using a combination of the original C2s and the Ashas?

SI-1: Sure.

Interviewer: They had the CommCare app which they used as an excuse to visit pregnant women and keep registering, but they were really using that as a means of educating people against the myth that Ebola was being spread by the health workers?

SI-1: Sure.

Interviewer: That's interesting. Ebola finished in March of 2016; that was when the country was declared Ebola-free.

SI-1: Yes.

Interviewer: We can say March 2016 to now. Again, I know you weren't around then. I know your were on EBODAC at this stage, but are you aware of how the CHW used the forms after Ebola? They were using them in the pilot in 2013 and 2014. They used them in Ebola in 2014-15 up to March 2016. Then between March 2016 and now, how were the CHWs using the phones do you think?

SI-1: When I came back in 2017 September, many of the interviews that I have collected for myself shows that many of the phones weren't working again. Either the application was being distorted or they cannot send out any message now. That was the information I got after I came back in 2017 September.

Interviewer: So September 2017.

SI-1: Yes.

Interviewer: What was the reason the phones weren't working?

SI-1: Maybe it might be either they were not receiving now connection from Dimagi or many of the phones just-- because the community health workers at that time-- Many were either lost, or some of them may have misplaced the SIM, and some of them were even stolen because they are taken to these local charging centres to be charged and many of them were either stolen or some of

them they removed the SIM card from the phone. Whenever those ones we are like being interfered with, the whole system will get corrupted and they will not be able to use it again.

Interviewer: I believe then from speaking to other people that very little data was coming from the phones during that period. It's interesting, let me tell you that you're going to like this. We spoke to between 50 and 60 CHWs during the focus groups and one phone existed from that time. One person had a phone and she showed it to me and it was battered, scraped, damaged, broken. It was still working, but all the other CHWs had no phones from the original project; just one, and I took a picture of it because I knew this was a very scarce thing.

Then mHealth two project kicked off officially when?

SI-1: There was baseline between February and, is it July?

Interviewer: That was the baseline. When was the actual project started?

SI-1: The actual project started, from what I understood was-- because it's a five-year grant, so 2017, '18, '19, '20, '21. It was 2017 January

Interviewer: 2017?

SI-1: Yes, January of 2017.

Interviewer: January of 2017 for five years?

SI-1: Yes.

Interviewer: To bring it up to 2017, '18, '19, '20, '21?

SI-1: Yes.

Interviewer: Five years to December.

SI-1: Of 2021, yes.

Interviewer: '21. You came back then in September 2017?

SI-1: Yes.

Interviewer: You had missed the first little bit of the project, but you came back in--

SI-1: Yes.

Interviewer: During the post-Ebola time, you weren't here, but I know Christiana was here, and Amara was here. Overall, in the Bonthe office, in the Mattru Jong office there was a lot of change and a lot of people moving back and forward leaving.

SI-1: Yes

Interviewer: The management team was not stable at that point?

SI-1: No, in fact, yes. Especially for 2017, we had this programming where we have restructuring process taking place. When you even see Andrew now who was DF, at that time he was-- He actually moved from DF position. He was the admin logistic at the Mattru Jong office. Then he moved to Freetown now as a security officer. A lot of changes has occurred.

Interviewer: When you come back down from September 2017, things started to settle down a little better and more people came.

SI-1: Yes.

Interviewer: That's most of what I wanted there. We've got through most of that. We've talked about Ebola, we've talked about the Ashas, and the reconfiguration of work. When the CHWs were working during Ebola, a lot of people who I have spoken to have said that their work was very innovative. They did receive training, but the way that they worked, and the way that they use the phones was really clever, really smart, really innovative. Again, I know you weren't here during that time, but did you have anything to say about that? Do you think that that's true, or what did you think of the CHWs with the phones during Ebola?

SI-1: I want to go with them, because as you said, I was not actually around at that time now. From the information I have been receiving myself also is that it was very innovative. Even though they had some problems, a lot of challenges, because at that time we had this lock down, it can take like a whole, four, five days without people moving from one community to the other, it was a challenging period, but at that time, they were still able to maybe meander through and be able to look at any pregnant woman that needs attention or any child that needs attention and then they can use their phone also to call. That was some of the innovative ways that they use the phone during that period.

It was a difficult period because sometimes you have like four days, five days lock down, we call it lock down, where nobody was allowed to move from one community to the other, but still, they were are able to meander their ways through within the community. You can still move within the community, although, you cannot move from one community to other, which was a little bit difficult, especially when we have that lock down. You must be given some permission to move from one village to the other. They were still able to walk within the community they were assigned.

Interviewer: They could move around maybe almost without being noticed, because they're CHWs and they were using the phone for reporting, for advocacy, all of the things we've discussed in the last few months?

SI-1: Sure.

Interviewer: A lot of the phones were used in the pilot project mHealth one in Ebola, and then in the period after Ebola from 2016 through 2017, very few phones being used because they were lost, they were damaged, the CommCare app wasn't working. Because the CommCare app wasn't working, do you think that CHWs lost a bit of interest in the phones?

SI-1: I'm not sure, because even when we told them that we are still continuing with digital health, now the mHealth has been embedded into the AIM-Health clause. When we told them that we have to continue with the using of the CommCare application, for some of them, that was very interesting. Even today, some of the CHWs were asking, "When are we going to get our phones?" They have never lost interest. They've grown more interest. Also, when we now shown them the new type of phone that is being bought, and it will be given to them, they are very interested in using it.

Interviewer: They really want those phones.

SI-1: Yes.

Interviewer: Why do you think they really want those specific phones?

SI-1: It's because of the technology that the world is moving towards now. These ones have buttons, and these ones is soft touch that you can just touch and it move you to another platform. I think they are very much interested in that. They also want to move away now from using these ones to a soft touch phones.

Interviewer: They want to learn?

SI-1: Yes.

Interviewer: I think they see that as education and something that will provide their training and help them. They want to learn about the tech.

SI-1: Yes.

Interviewer: That's very strong. That's very strong, the CHWs. What were Ebola Common Centres?

SI-1: What were?

Interviewer: Ebola Common Centres? Somebody else mentioned that, but I might have got that wrong? Was there such thing as Ebola Common Centres?

SI-1: Oh, Command?

Interviewer: Command?

SI-1: Yes. Ebola Command Centres.

Interviewer: What were they?

SI-1: These were centres that where set so that they can monitor all of the activities that are related to Ebola in the district.

Interviewer: Under the DHMT?

SI-1: Under the DHMT.

Interviewer: They were then the centres which had the 117 emergency number?

SI-1: Yes, so that we're able to track all reports that are coming from various communities. They were able to track all the number of people that died during a given period, and they were able to give command. They were the only centre that were able to give command to people to bury their dead. They were able to look at all of the affairs that were happening within that period, so it's a command centre. It was actually manned by military guys. We have some of these military guys that came over to help the ministry of health and sanitation.

Interviewer: They had an overview on everything coming from the community level, coming from PHU level, and they could make decisions then and implement those decisions?

SI-1: Exactly.

Interviewer: Just before we move on to Ebola, we were talking about CHWs and the way they were using the phones. They got some training but were they innovative?

SI-1: Yes.

Interviewer: We also said. I like the way you used the phrase meandered. Did you say they meandered through the community?

SI-1: Yes.

Interviewer: I like that phrase. What do you think caused that innovation? What caused them to do that? What made them do it?

SI-1: I think it's the passion. They had the passion on the work they're doing. You remember even at that time they were not paid; now they're given incentive. Because they want to make sure that this was something that required the effort of everybody. If they would have maybe looked down on and disinterested in doing everything, who knew what it may have happened to themselves. Because they have passion and making sure that they bring an end to Ebola, they were able to use that type of innovation.

Interviewer: Okay. Anything else?

SI-1: Passion is really what I can say.

Interviewer: They have passion?

SI-1: Yes.

Interviewer: As we were discussing because I'm very interested in this. As we were discussing earlier over the last few days, do you think that this passion is unique to the CHWs or do you think it's the Sierra Leonean people who have this passion in them?

SI-1: I think it's very unique to the CHWs.

Interviewer: Why is that?

SI-1: One is how people value them within the community. They're being valued. They're being looked upon as people who are there now to look at their welfare related to health, so they're being valued. For example, many times if there are activities-- communal work that is being done within the community, they are exempted from doing those communal work. Because of that, they have taken it as a work that is being credible and accepted by the community. That's the reason why they have passion in it.

When we you compare to some health workers, although not all, but there are some health workers because they are not paid, sometimes time to go to work, but this community health workers continue to work. Even in the midst of not being paid, they continue to do the work. For the peer supervisors, sometimes even when they don't have-- there are no mobile, they're moving from community to community just to look at how the other community health workers are working.

Interviewer: That's the peer supervisors?

SI-1: Yes.

Interviewer: That's incredible. I wanted to move on to something that you know a lot about. You know a lot about many things, **SI-1**, but I think you know an awful lot about this next thing, the Comms model. Can you tell me about the Comms model? The first thing I suppose is the Comms model is a unique World Vision model. Is that correct?

SI-1: Sure.

Interviewer: Was it brought in in 2012 as part of mHealth one?

SI-1: Yes.

Interviewer: Okay. What is the Comms model?

SI-1: The Comms model is a type of model that is used for enhancing the seven eleven strategy for better health outcomes. It is there to making sure that it improves both community health in the community and then the health service that's being rendered at the health facility. It's like a bridge in between the community and the health facility. They are the ones that linked between-- They create linkages between the health facility and the community.

It's not a new structure. It's just the nomenclature that has changed. World Vision has now changed the name. Previously, we used to call them facility management committee. Their work at that time was particularly focused on the facility, just the facility. Because of nomenclature now that World Vision has improved, has come with known as the Comms, now they have some work that can be done within the community and then also associated with the health facility. They create the link between the community and the health facility.

Interviewer: When World Vision changed the structures, was it just the facility management committee or was there no committee that got reconfigured and changed?

SI-1: No. It was only that.

Interviewer: It was only that?

SI-1: Yes.

Interviewer: The facility management committee?

SI-1: Yes.

Interviewer: The citizens voice and action is also part of-- Citizen is part of that.

SI-1: When you look at the 360 behaviour change sample, if you have the 360 degrees behaviour change sample we have the ttc in the middle which has the community health workers and then just above the household level, on top of that you have the Comms model and above that you have the CVA. That makes the 360 degrees behavior change system. You have the community health workers at the middle doing the ttc and then just outside that, you have the Comms model, and then outside the Comms model you have the CVA.

Interviewer: Is there a diagram with that? There's a diagram [crosstalk]

SI-1: There's a diagram, yes.

Interviewer: Can you send that to me?

SI-1: Yes, I will send that to you.

Interviewer: What we saw yesterday, the CHW monthly meeting, that was in **[unintelligible 00:38:57]**, wasn't it?

SI-1:

Interviewer: That meeting happens once a month with the CHWs and it's attended by Comms, it's attended by CVA, it's attended by other stakeholders and some of the PHU staff. Does that meeting then report issues, performances, the work of the CHWs and does that then get discussed at the monthly Comms meeting and the monthly CVA meeting?

SI-1: Yes. What the Comms usually do is they … That is just one of the meetings that they attend at the PHU level. Then they also conduct community-level meeting where they have all the stakeholders. You have youths, you have the religious leaders, you have other stakeholders that are present. Many of the challenges or some of the things that we discussed with him, the CHW monthly meeting are also further discussed in the community meetings and the other stakeholders.

Interviewer: Then the community-- That's clear. Then, the Comms and CVA meetings, the community meetings, they report back to who? Who do they report to?

SI-1: They report to the PHU.

Interviewer: They report to the PHU?

SI-1: Yes.

Interviewer: Does the PHU have a monthly meeting?

SI-1: Yes.

Interviewer: That has a monthly meeting also?

SI-1: Sure.

Interviewer: That's a monthly meeting of the CHWs that reports to Comms and CVA?

SI-1: Yes.

Interviewer: They have monthly meetings to discuss other issues as well?

SI-1: What we do now is, we have what we call the Quarterly meeting. In the Quarterly meeting, all of these people now come together and we do what is known as the Comms Quarterly Debriefing meeting.

Interviewer: That's the PHU level meeting?

SI-1: Yes, that's one is on the PHU level.

Interviewer: Does each PHU have a meeting by itself, or the PHU is joined for one bigger meeting?

SI-1: No, each PHU has their own meeting, but they have separate dates for their meetings.

Interviewer: Okay, and they're held in the PHU?

SI-1: Yes.

Interviewer: will held in the PHU?

SI-1: Yes.

Interviewer: CHW comes in CVA, PHU?

SI-1: Yes.

Interviewer: Who does the PHU report to?

SI-1: To the DHMT.

Interviewer: What did you say was the name of the Quarterly PHU meeting?

SI-1: Debriefing. Quarterly Debriefing, D-E-B-R-I-E-F-I-N-G, Debriefing meeting.

Interviewer: Meeting, okay. The Quarterly Debriefing meeting, okay. Are World Vision involved in this as well? Do they report to just the DHMT or DHMT and World Vision?

SI-1: No, they report to both. Many times we are present in all of these meetings, the serial meetings, the Comms meetings, we are present there. We have the monthly DHMT meeting, which many times, I'm presenting those meetings.

Interviewer: That DHMT meeting is monthly?

SI-1: Yes.

Interviewer: Dante is there as well at that? He's one of the key people?

SI-1: Yes.

Interviewer: That's a monthly meeting. That involves World Vision, the CHW focal?

SI-1: Yes, other partners that's are also like Comm, doctors of African.

Interviewer: Okay, soother NGOs?

SI-1: Yes.

Interviewer: From there then, what's the next step up?

SI-1: It's important to the national because from the DHMT, it straights the reports on the national level.

Interviewer: National level?

SI-1: Yes.

Interviewer: That's MoHS?

SI-1: Yes.

Interviewer: Specifically then it goes to CHW hub and the **[unintelligible 00:43:07]** that we escort?

SI-1: Yes.

Interviewer: All right, that's the reporting structure from bottom up. If as CHW as a major issue, they can say that they're meetings, it goes to Comms, it goes CVA, ultimately it goes to the PHU, to DHMT, and World Vision and eventually, if it gets all the way through, it can go national level.

SI-1: Sure.

Interviewer: It's the bottom of a reporting system?

SI-1: Yes.

Interviewer: How does the information get back down from the national level? Does it just go back down through the same system?

SI-1: Yes, usually, the CHW will come down to the DHMT, and then they involve the DHMT. After, they'd move down to the PHU, and then the PHU go down the CHW's, and then we have the Comms and the CVA are all involved in there at community level.

Interviewer: Okay, Dante is involved in that with the CHW national representative of health for St. Albert funding?

SI-1: Yes.

Interviewer: Okay, I'm getting to know all these people in now very

SI-1: [chuckles]

Interviewer: Albert Fandi would attend some of those meetings also?

SI-1: Yes, many times he used to come and attend those meetings.

Interviewer: Which meetings will he attend? The DHMT meetings?

SI-1: Yes.

Interviewer: Albert, he--

SI-1: He doesn't really come every month, but he comes in the quarterly because I was doing the last Quarterly meeting, he was there. That was the first I actually met him.

Interviewer: The quarterly meetings are at the PHU level, but the DHMT meetings are monthly meetings?

SI-1: Yes, but after every three months, they also get their quarterly meeting. They meet every month--

Interviewer: Also quarterly.

SI-1: Yes.

Interviewer: Monthly meeting but also-- It's a lot of meetings.

SI-1: Yes.

Interviewer: The DMO is very active in that always that he knows--

SI-1: Many times, if he's there, he's the chair.

Interviewer: He's the chair, okay. Okay, and Dante would be also a very important person in that.

SI-1: Yes.

Interviewer: We've got through the CHW report and structure. It goes bottom-up but it also comes top-down. There's a two-way communication structure both up and down and national CHW policy, my understanding is that the new government are not looking at this. They're implementing existing policies, so they're not changing it. From 2016, it's all the way through--

SI-1: It's not changed because it was a policy that was designed from 2016 I think to 2021. Let me look at the--

Interviewer: It's okay. You can send it to me when you have the chance.

SI-1: Yes, I actually have the--

Interviewer: Is this your jacket here? Is this what you're looking for?

SI-1: No, the bag.

Interviewer: No, it's my bag.

SI-1: Okay, it's from 2016 to 2020.

Interviewer: Yes, I've got. Dante gave me one of those.

SI-1: You have one of these?

Interviewer: Yes.

SI-1: Okay.

Interviewer: That's 2016 to 2020.

SI-1: Yes.

Interviewer: That's the book.

SI-1: I will send the soft copy to you. I have the soft copy of it.

Interviewer: Will you? Thank you so much. That would be great.

SI-1: Yes, I'll send it to you.

Interviewer: That's 2016 to 2020?

SI-1: Yes.

Interviewer: To 20 too. Would it be fair to say that this policy is communicated back down to CHW level through the same system?

SI-1: Sure.

Interviewer: Okay, you think that's a good system?

SI-1: Yes, I think it's a good system because as long as you have information that's filtering from the lower level to the higher level than most from the higher level to the lower level, I think it's a good system.

Interviewer: Okay, that's fine. mHealth and PPU, we talked about that. Health structure, that's okay. Can you give me a list of all the DMOs starting with Francis Smart?

SI-1: Okay, we have Dr. Francis Smart.

Interviewer: Yes, who replaced him?

SI-1: Dr. Kargbo Labor.

Interviewer: Can you spell it?

SI-1: K-A-R-G-B-O L-A-B-O-R.

Interviewer: Yes, who was after him?

SI-1: After Dr. Kargbo Labor, we have Dr. Samuel Massaquoi.

Interviewer: Samuel S-A-M-

SI-1: U-E-L.

Interviewer: -U-E-L, yes.

SI-1: Massaquoi.

Interviewer: M-A-S-

SI-1: - S-S-A-Q-U-O-I.

Interviewer: - Q-U-O-I yes.

SI-1: Now, we have Dr. Masuba.

Interviewer: Okay, what's his first name?

SI-1: I have to call. I just know his name is Dr. Masuba.

Interviewer: Okay, he's the current guy. M-A-S-U-B-A.

SI-1: B-A, yes.

Interviewer: All of those you think were good DMOs?

SI-1: Yes, they were good DMOs because-- I've worked with all of them. I worked with Dr. Smart. He wasn't there really after-- During the Ebola is was Dr. Kargbo Labor that was there during the Ebola and then after Dr-- You have Dr. Samuel Massaquoi who just came after. I've worked with each one of these ones to some extent, but I worked more with Dr. Kargbo Labor until I was sent to Kambia and I worked with Dr. Smart for some years.

Interviewer: I was here with Dr. Smart myself and Dr. Masuba is the current guy, but he's been here two weeks only.

SI-1: Yes.

Interviewer: Okay. I'm a little bit confused about the number of CHWs. I know in Imperi--

SI-1: Imperi you have 164.

Interviewer: This is Imperi here. This is the Imperi region.

SI-1: I mean you have 130 in Imperi.

Interviewer: There's 130 including peer supervisors?

SI-1: Yes, I will give you the list. I have the soft copy of it which has the peer supervisor and that number is also being segregated by gender, male or female. I will also send that.

Interviewer: You can send all that to me. You don't mind e-mailing to me when you have a chance?

SI-1: Yes, I will send that.

Interviewer: How many in Sherbro island?

SI-1: They have 164.

Interviewer: In all Bonthe, how many CHWs?

SI-1: We have a total of 951. It used to be 981, but there were some attrition rates. Some people have died.

Interviewer: What is it currently?

SI-1: It's currently nine, five, one.

Interviewer: 951. Those CHWs, that 951 includes Imperi and Sherbro?

SI-1: Yes.

Interviewer: The outside Imperi and Sherbro those other CHWs are not included in the new forms project.

SI-1: No, they're not.

Interviewer: They're not in the forms? Okay, so only Imperi and Sherbro?

SI-1: Yes.

Interviewer: I'd say they wish they were Imperi and Sherbro.

SI-1: Many times that is where they wish. Even when in meetings, we tell them that, "We have hospital delivery **[unintelligible 00:51:23]** You're just focusing Imperi and Sherbro."

Interviewer: Why is it just Imperi and Sherbro?

SI-1: It's because of …

Interviewer: Because they're [crosstalk].

SI-1: Yes, limited resources and that is the mHealth project has been designed to operate.

Interviewer: That's shifting to UK?

SI-1: Yes.

Interviewer: I think Ireland is not very happy about that. We're almost finished. I just have one or just a few more things to ask so we should we should finish up within the next five or five to seven or eight minutes.

SI-1: Okay.

Interviewer: You know the CHWs very well. What do you think causes them to change their actions? If you want to change the CHWs, what do you think you have to do to change them? What causes change within the CHWs?

SI-1: One of the things I think we need to change is simple motivation. Not literally monetary motivation. There are many things that you can do to motivate them so

that they can change. For example, the annual appraisal where you can look among them and then do some evaluation. You can do your own evaluation and then PHU can do their evaluation. Then you get the best out of that. Then you just give some remuneration, maybe some praises, some gifts. That will help them change. Then the other is how we can also work with the community stakeholders to value them to know that they are important. That will also help them change.

Interviewer: How does that help them change?

SI-1: Well, if for example, what I was saying, if they're excluded in some of those manual works that are being done by the community people. Then the other one is if they are involved in some kind of education, in trainings. If you can improve on their trainings. For example, what we are doing is we are trying to see how we can work on the level of literacy. We have adult literacy classes that's being conducted for them. You saw that this lady today, the lady that was signing in the last … That was an illiterate. She has been attending the adult literacy class and now she can write her name.

Interviewer: Really?

SI-1: She can sign. Those are some of the gains that we have made. All of those ones can also contribute to change them.

Interviewer: Wow, that's really great. She was previously illiterate, wow. That's really interesting. That changes the actions of the CHWs. What do you think is the biggest motivator for CHWs? What motivates them? I know it's a similar question, but maybe a little bit different.

SI-1: Of late, what we have noticed is what motivate them is just by providing some kind of incentive, monetary incentive. It really motivates them because if somebody knows that at the end of the day, no matter how little it may be, if they are receiving some kind of monetary value, that's what motivated them Also, even the phones that we're providing for them, motivate them. Imagine somebody at that community who will receive Samsung J2 that costs …

Interviewer: $200.

SI-1: Yes and he is the only person in that community that has that type of phone. That one also will motivate them. Then giving them all of those raingears. Maybe he is the only person in that community that is being supplied with raingears. He has his boots, his raincoat, his T-shirts, his ID card to identify him. Even that ID card can motivate them because if they are going … Maybe they are going to cross the border and they have their picture and that is the only ID card maybe they may lay hand on.

Interviewer: It's the only one.

SI-1: Somebody can say, "This one is a community health worker." That one can motivate them. All of those things and you see them now giving treatment. The

ICCM that is being done. They have been trained in administering this simple treatment at community level. All of those ones motivate them to some extent.

Interviewer: That motivates them?

SI-1: Yes.

Interviewer: What about respect at their communities? Is that a big thing?

SI-1: It's also a big thing. It is because they are the first area of contact now. Now when somebody gets sick instead of going to the health facility first, they come to them now. Even if they don't have the drugs to test them, but they prepare a referral slip. They say," Okay, now, you go to that health facility." You see? That also is one of the motivating factors that is leading them to the level where they are now.

Interviewer: That's interesting. The CHWs are so proud of what they have. They're so pride of their bags, the t-shirts, the gear. They want to show-- They all wear their ID badges and it's great that they that. I can see that has a huge motivation factor, huge. They are all very proud to have it and to take pictures and to show me. It's really interesting. We're almost finished here. I just wanted to finish up with a few small things. The CHW hubs, do you think the CHWs are aware of the CHW hub and such?

SI-1: Yes, they are aware because many times when this guy is going to the field, they also do field visits and they do field monitoring also.

Interviewer: That's Albert Fandi.

SI-1: Yes, and UNICEF is also providing some support. They provide all of the important trainings and then the incentive. We have the UNICEF guy who usually also come to the field. At one point, we had a joint supervision. World Vision, UNICEF, and Kwame. They came to Imperi and we-- They came together also that they can look at what are we doing as World Vision and what is Kwame doing because they like say, "Are we not duplicating things?" We say, "No, we are not duplicating."

Because usually I sit with Kwame and we look at our activities and wherever we see that there are duplication, we don't do at all. We leave it to them. For example, they are found in the monthly meetings with providing foods or transport. We are actually not funding that now because they are doing it. We have money in our budget to buy raingears, boots, but since they've provided that, we use the money otherwise. We bought bicycles for the peer supervisors.

Interviewer: I saw the bicycles in Mattru.

SI-1: That's how we're working. We see if there's any area looks like duplication, we also now do otherwise. We use the money in doing something else that they are not doing.

Interviewer: Does the CHW help coordinate that? He looks at all the ways everyone is operating, and he avoids duplication. Is that correct and you have the CHW hub?

SI-1: That was coordinated by UNICEF because they heard that we are also implementing some activities related to CHWs. Then they say, "Wait a minute. Let us go and see what these guys are doing." For us, what we are doing is a bit different for once, Kwame is doing. For example, Kwame was only giving money to all of those trainings in module one, module two, module three, but they were not giving money for refresher training.

Interviewer: Okay.

SI-1: What we're doing is after their training, we notice that there was a lot of gap in even doing the registration, referring. Because after the training December, we actually did our own self field visit and we noticed that there were gaps. We said, "Okay now, we have money to do refresher." Now we did a refresher training for Imperi, especially dealing with those registers. Because at the end of the year, we will be getting those reports, our outputs, outcomes. It's going to come from those reports from the registers. We train them on how they will effectively use those registers that they are given to them.

Interviewer: The e-health communications hub-- We talked to the guys Eddie Folding and I think Abdul. They said that they coordinate all mHealth pilots and mHealth projects in Sierra Leone, did mHealth plus have to go through the e-health communications hub?

SI-1: Yes, because Ali was in that. Ali can give you better information on that but at the national level, and even dealing with- I know Magnus has done quite a lot on this one with NATCOM and also the e-health home. Magnus has been-- I know when we're in EboDac, he used to come quite a lot. EboDac is also doing some- another research on modes, mobile technology for community health workers. He has done quite a lot of interface meeting with NATCOM and the e-Health hub. I know any Health Plus was paying something of percentage to somebody in the ministry every month.

Interviewer: Okay, but when we were speaking to those guys they said that any new mHealth project, any new pile of anything had to go through those, also get to go through the clearance and they have to sign it off. Ali, you, and Magnus were working to get mHealth Plus approved by the e-health communications guys in the.

SI-1: Yes.

Interviewer: Okay, that's really important. Just a few things to finish, **SI-1**. A few very important things then. A few people have used a very similar phrase. They've used the phrase strong relationship and a few people have said this. They've said that the forms create a strong relationship between the CHWs and the health staff. Would you agree with that and what you think it means?

SI-1: Sure, because what it means is that there's always a link. Whatever information that is in the CommCare app that is in the mobile phone is also the same with the PHU. For example, if the CHW see a woman with a danger sign and they need referral, that CHW is going to do the referral straight to the PHU. That create a very strong link and then the CHW also do call. If there's any emergency that he has noticed within that community, so he call to the PHU. That also create that strong link between the CHW and the PHU.

Interviewer: Okay, and referrals.

SI-1: Yes.

Interviewer: Okay, I think I have one last question and then we're finished. This is probably the most important question, maybe also the most difficult question. We've covered some of it, but I want to ask it again to finish just to hear your final thoughts.

SI-1: Okay.

Interviewer: What do you think causes change? All of my research is about the reasons that things work. With this project the reason it worked, the reason it didn't work, what are those reasons? What do you think are the reasons that the project, the mHealth-- Let's not talk about mHealth2. What are the reasons you think the mHealth one project through 2013 and '14 and the use of the forms through Ebola with the ushers? I know the form has degraded a bit after that and not many people are using them now. What do you think made those projects work well?

SI-1: One of the things that we can attribute to those gains that we made during that period is- what I can say is a strong relationship that we have built over the period with the communities. World Vision has a very strong base in community mobilization. Over the past years, the relationship that we have built with the community themselves has led to that level of innovations or the change that we have seen. You can see.

For example, we're even planning how to come and sit within the community where we operate, so that we will create that bond. People will see us as if we are together. For example, very soon we're going to stay here. The more the people see us with them, the more they feel that we are together, but if they see us far apart - we only come and visit and then we go back - they will not value us at all. Because of our existence within the community where we operate, also, is another attribution to that.

Interviewer: That's why you moved from Mattru Jong to here?

SI-1: Yes, even when we're operating in Mattru, our presences within those communities where we were operating was felt.

Interviewer: Yes, of course. What's the name of the place you moved to?

SI-1: Luawa

Interviewer: Can you spell that?

SI-1: L-U-A-W-A.

Interviewer: L-U-A-W-A?

SI-1: Yes.

Interviewer: Okay, do you think that the Comms model and the CVA model ties in with what you've said there, does that create the strong relationship between the community in Luawa?

SI-1: Sure, because all of these structures that you're referring to are structures that are embedded within the community. For example, the CV. The CV looks at influencing policies, how those policies can be implemented and they work together. They are intertwined with the Comms. The Comms also can do a health facility assessment, and then they can report to the CV, and the CV can see how those policies can be implemented by the government.

Interviewer: Okay, you didn't really mention the technology at all during this. It's all about the social stuff. Do you think that technology really matters here?

SI-1: The technology also matters because you remember what we have been saying? For the fact that CHW has the phone, and he's able to communicate as easy as it is when there are cases of emergencies, that also has contributed to this greatly.

Interviewer: Okay, Dr.

SI-1, that's all I wanted to know. Is there anything that I haven't asked you that you think might be interesting or important for me to know? Or anything you think I've left out that maybe is worth saying to me before we finish?

SI-1: Well, maybe the other thing we can say that we are praying is that this new government gets a buy-in. For what we have seen, all of this corruption issues settled because our concern has always been this, how are we going to maintain the community health workers that are receiving the incentive now? How can this be maintained? Is it sustainable? If we have the government buy-in into this, taking it as their program just like the front-line workers, like the health facilities staff, the one they are paying. If they can also get the buy-in and then continue this process in providing the incentive for the community health workers, then we'll see much improvement in the infant and maternal mortality being reduced to an expected level.

Interviewer: Government at national level does have a lot to do here?

SI-1: Yes.

Interviewer: What they do makes a big difference?

SI-1: Sure.

Interviewer: It does come down the systems. The systems seem very effective for getting information from the national level right down to community CHW level.

SI-1: Yes.

Interviewer: It seems very effective to do that, so hopefully, the new government will be effective, new policies will be implemented especially with the e-health communications hub that they're revisiting now. I hope it works. I hope it does work.

SI-1: Sure, we're hopeful. We're hopeful because the government is so strategic in working towards increasing the level of education for Sierra Leonians, and in doing that, that's also very sustainable because it's a ripple effect to other-- It can also even improve the health outcomes referring to a reduction in maternal mortality and mobility among children.

Interviewer: SI-1, thank you so much. I really appreciate all of that time you've given me. It's been an hour and 10 minutes.

SI-1: Thank you.

Interviewer: I'll stop recording.

SI-1: Okay.

[01:10:52]

Appendix 12: Transcript of Focus Group Discussion (Yargoi CHC)

Please note that participants in this focus group discussion transcript have been anonymized in line with the ethical approval received from both Trinity College Dublin and the MoHS in Sierra Leone. A total of 7 focus group discussions took place as outlined in Appendix 2. All focus group discussions were transcribed in full.

FOCUS GROUP DISCUSSION YARGOI CHP

DATA TRANSCRIPTION TEMPLATE

DATE: 26/07/2018 **# OF PARTICIPANTS: 05** **FACILITY TYPE: CHP**

Q#	QUESTIONS	RESPONSES
1	How long have you been a CHW?	Y4- when we started this work if am not mistaking, it is now five years because we started with WV but when Ebola came we sat but we were working. Y5- we started this work in 2012 and this is now 7 years. Y2- like peer supervisor said this is the 7th year. Y3- like peer supervisor said this is now 7 years. Y1- this is my one year in this work since CUAMM trained us.
2	Why did you become a CHW?	Y5- because we want our children, our sisters and our grandmothers to know certain things that they don't know so that our community will be better at health. Things like medicine, food, caring for children. For instance, people use to give children hot water, herbs but we now tell them that breastmilk is the best for children to grow and survive and have a healthy life. Y4- why they really selected us and we volunteered is because of our sisters and our children, when they are pregnant they don't go to the hospital. Nurses are in the health centres. For this reason, they said we should join hands with the nurses so that we can search for our people, encourage them to come to the health centre so that they can get the benefits. What are these benefits? Marklate and worm medicine, until they give birth and get mosquito net, the baby to get the benefit of the health centre. When she gives birth, we will keep monitoring her until the child reaches age two. Y1- why I am willingly doing this work is that when we were given birth to, our mothers used herbs to treat us. But it came to time when child death became rampant. So, we have decided to help the nurses in

		the health centres because we have volunteered to do it. We can go after our people and talk to them if one is pregnant, we are the people who will walk in the rains and visit you to talk to you to seek medical attention. We encourage you and tell you problem stories and that will make you go to join clinic. When you join the health centre, we are the ones who will be closer to you to observe you gradually and make sure that any benefit that comes to this centre, you get yours. Also, there are medicines CUAMM has told us to give to our people. And for them to use the medicine properly, we are the ones that will visit and monitor you and make sure you use the medicine properly. To make sure you have the correct dosage and take the drugs properly, we will call for it and inspect. Then we will realise the nurses are supporting us in this work. **Y2- the reason I joined this voluntary work as CHW is that our people were dying a lot. They used to waste time with pregnant women in labour until at that time when thy would want to take the person to hospital, the condition would be worse. That person will die. This is why we tracked the pregnant women and made by-laws that no pregnant women should deliver at the home. That when a pregnant woman is approaching her 9th months, she should be near the health centre now. When this was done, we now see that god is worthy to be praised. Maternal death is reduced, polio that used to affect children is no more common and convulsion that makes children to fight irresistibly is not common again. Because if they come and take marklate, it will drive the sickness away from them. So, that is why we joined this volunteer work to help our people in the community.** **Y3- the reason that made be very happy to do this is to help my people. This is a work that is worth doing as I have seen. Because there were conditions that used to occur. Some of our mates, when they are pregnant, they don't want anything concerning the white man. They will be in the village for as long as they are pregnant but now that we have taken up this job, we go and talk to them. They come for check ups and they are told the position of their baby; if the baby is well positioned or not. If they are to deliver and the health centre, they are told and if not, they are told also, they take you to the bigger side. This why I am so happy to do this work for my people.**
3	**Why do you do this job?**	**Y4- the reason I am still in this work is that, we started it when there was nothing given as payment, we volunteered. But, in this work, they come with incentives like the phones they came with who got it. It was meant for their work but we also call our people using the phones. So, we get other benefits even though we are not getting monthly salary, that small**

		token that we get whenever they call us for programmes takes care of our needs. Therefore, we are still in this work. Really because our people are not dying against in labour. Infants death is no more. U5 death is no more. Therefore, we are still doing this job. Y5- the reason I am still in this job is that there is benefit because the government said we will be given incentives for soap money. Apart from that, WV also encourages us to do the job for instance the phone. If they give us the phone now, we won't use paper. All what we've learnt will be in the phone and we will report through the phone. This will reduce our work burden. So, these are the reasons we are working as CHW. Like bicycle. The distance we cover to work are far but if we have bicycle, it will make it shorter. **Y2- we are still in this work because we have realized that when we joined the work, child death is not plenty, maternal death is not frequent, and we have seen that there is now help in our community in that area. Apart from that, CUAMM also has got interest in our work. Although we are not getting anything but, we now go around and people say these are CHWs. They now value us, WV also has valued us. Anywhere, we go now, we are respected. They value us through the supply of rain gears for us to do our work. They supply us bags, light and a lot. They also talk to communities to know that we are there to defend them. For them to respect us because we are working for. Our people now respect us and we enter special places with recognition because we work for our community.** **Y1- as for me the reason i am committed to this work even though I have just joined is, now there is now witch python, our people would have a sleepless night shouting witch python and their children suffering from polio were attached to witchcraft but now there is no witchcraft because of our work. Apart from that, we have morale now even in public gatherings we are given chair to sit for what we do in the town. Our chief respects us. A suckling mother in this town attempt going to the health centre without referral from us, the health centre will return you back to us. This has boosted our morale. This is because as we have rendered ourselves to work for them, they are happy. We are happy to work with the community. CUAMM or WV asks us, we will always be happy in this work.** **Y3- I am happy in this job because I agreed to do it for my people and till now am doing it. Because, some of the things were hidden but now have been brought to light. Why were they hidden? In those days people didn't like to go to the health centre during pregnancy until they are delivered. They drank herbs but all that we have condemned. You that is pregnant, we will monitor you always and when the time is closer for**

		your delivery, we ask you to go to the health centre for you and the child to get the benefits of the health centre. So, this is really the reason I am liking this job always. And, those preventable deaths and sicknesses that make people appear like animals, have reduced. Even women dying in pregnancy have reduced. They are still there but not as it used to be rampant.
4	**Have you ever received incentives?**	**Y5- Yes, we received incentive from CUAMM** **Y3- I have not received it.** **Five participants (out of 6) agreed to have received incentives from CUAMM.**
5	**What did you receive?**	**Y2/Y4/Y6- received Le 450,000 as incentives for CHW.** **Y1&Y5- received Le 750,000 as incentive for peer supervisor.** **Y3- has received nothing.**
6	**Where you part of the original mHealth Project in 2013-14 (ttC project for maternal and child health)?**	**Y5-nyes** **Y4-yes** **Y3-yes** **Y2-yes** **Y1- I was not part because I have just joined.**
	Did you receive a phone as part of your job as CHW?	**Y5- I received a phone and worked with it.** **Y2- I received a phone and I worked with it.** **Y3- I received a phone and I worked with it.** **Y4- I got the phone and used it.**
	When was the phone given?	**All said WV gave us the phone in 2015.**
	What type of phone?	**Y5- Nokia Asha.** **All agreed it was Nokia Asha.**
	Do you still have the phone?	**All are without except Y2 has his phone.**
	If not, what happened to the phone?	**Y4-I don't have the phone now because it was stolen.** **Y5-the screen of my phone got spoilt and later it dropped into a stream.** **Y3- my phone was stolen long ago.** **Y2- I have my own phone but there no application in it.**
	For how long did you use the phone before losing it?	**Y5- I used mine for two years** **Y4- it was in 2017 that they stole it** **Y3- I used mine for one year.**
	Did the phone help you in you work?	**All said it helped in the work.**
	How?	**Y2- when I used to visit, sit and asked those questions on paper, it came to a time that it was not the one asking, the phone did. I will only answer the question**

		in the phone. That is the way it helped me as my work was not too much again. **Y4- that worked for me because as I reached a pregnant woman, I press my phone because all the questions I go to ask are in the phone and really helped me in my work that I was doing.** **Y5- that phone worked a lot for me because all the training we went through was in the phone so I you are going to home care, the visit that you are going to, it is only that visit you will press and you are only to listen now and the phone will do the questioning for you. When you want to send your report, your only role is to press to send and it is gone. You don't call, you don't write to send your report. So, it helped me a lot.** **Y3-that phone did for us many things. All the works we were to do. You just needed to press and the phone does the rest.** **Y2- apart from the medical work, I called to talk to my families so, it did well for me.** **Y1- that you that you give to them as we saw worked for them very well. Because, sometimes when you go to someone, the person will say the lady has brought her phone again and we saw the CHWs saying that the phone was there to do a job and not just a phone politely. We come to you for something important but this phone is what we use and so we don't depart from it. We used to see them used the phone. They will only press a button and all what they needed would appear.**
	What were the problems encountered with/using the phone?	**Y4- at that time, we were not given credit by them. Like the one from CUAMM they told us they will send topup on it.** **Y5- the phone they gave us, the solar charger was not able to charge the phone, it was not good.** **Y3- the solar charger was not good.** **Y2- one of the problems with the phone was to activate it. Initially when the phones were given, we found it difficult to send reports. Sometimes, when we record evidences, struggling to send will have the deleted unknowingly. The solar chargers spoilt and when we took it for charging, they used to steal it.** **Y1- I saw them using it. But what I saw as a problem using the phone was, when they would want to send report, network coverage was hard to detect. They walked longer distance to find coverage. The day you**

		are supposed to send report, you will be faced with this challenge to get network.
	Have you received payment for this work?	**All received incentive except Y3**
	When and how much?	**Y5- june 1st and I got Le 750,000 as peer supervisor** **As CHWs, all got Le 450,000 except Y3**
	Where there any problems with the payment?	**Y3- I didn't get mine because my sim is locked with a password that I have forgotten.** **Y5- that payment had challenge because they assembled us at Moriba town and were there for the rest of the day without giving us even water.it was during the night we got our money.** **Y4- they took us to Moriba Town, we didn't get a place to sit. We stood for the rest of the day, no food until during the night that we final got our money. But they have never done that to us even though it was so this time.** **Y3- when they called us to Moriba Town, we suffered because the was no food. I almost fainted as I was very hungry throughout the day.** **Y1- there is difficulty. They said we are working so the wan to appreciate us. They asked us to go to Moriba town but we paid our way to and from there. They said they won't provide anything because we went to collect money for ourselves. No water, no place to sit and no food was given. We sat on the bare ground for the whole day until 9PM when we received our money and left.** **Y2- the problem was heavy. We paid our way to and from. We didn't get food and when the money finally arrived it was almost gone.** **Y5- some CHWs have not received their money up to now but they were all there. They checked their phones but could not pay. The reason I see it as a problem on their part, they always promised sending the money but nothing is sent.**
	What do you do if you have any problems as a CHW?	**Y4- if am working and I face a difficult situation, I will tell my supervisor for our project because we started with WV so we tell them. Like the last time we were promised that we will received our two quarters money on June 10 but we have not received it. The one we got we have eaten. Since we returned, I have been on sick bed and we don't have medicine here. If I am without money, the only person I will call for support is my CHW.**

		Y2- the problem that will make me call my PS is when there is a pregnant woman who needs referral. Also, if somebody from the community does me, I report to my Peer Supervisor. **Y3- if someone does something to me that does not fit me, I will report to my PS.** **Y1- if I go to a house then someone want to fight me for visiting, I will call my PS and both of us will go there to find out the problem and resolve it.** **Y5- like for us the CHW under this centre if we realised that a pregnant woman has no money to pay transportation, so the CHWs will then got into the coffer of our monthly contribution of Le 2,000 per person and try to help to save life.**
	Has this been successful?	**Y5- Yes. When we send those reports, if we don't get people from WV we will get from DHMT.** **Y2- if it is for that, our peer supervisor is really working. Any sickness that attacks a pregnant woman or a child that can't be handled here, he straight away call from the big hospital and the person is lifted to Mattru.** **Y1- just like how the man said, he is really doing great. In fact, he is a leader and that is why he was given that position. Any problem that arises, even when he is eating, he will come and solve the problem first. He always responds to calls in critical times.** **Y3- we thank our supervisor because he is really working for us. Any problem that we encounter, even when he is sleeping he will attend to us.**
	Have you ever received training as a CHW?	**Y2- we were trained how to work by.** **Y1- WV and CUAMM have trained us.** **Y3- WV and CUAMM trained us.** **Y2- WV did the initial training and recently CUAMM trained us.** **Y5- WV, CUAMM, GOAL and Marie stopes have trained us for this work.**
	How many times have you been trained?	**Y4- they have trained us many times that I can't remember the amount.** **All accepted what Y4 said.**
	Did the training help with your job?	**All said the training helped them do the work better.**
	How did the training help with your work?	**Y- the training has help us a lot. We now know how to detect a woman is newly pregnant, how to know if a new born baby has a problem and encourages the mother to come to the centre to be treated.**

		Y1- what we have learnt is part of us now. First, whether they call you to see a sick person, they gave us a book that I will always take along with me and will use it through to know that I have not forgot what I was taught. **Y3- what is helpful about what I have learnt is that maternal mortality has reduced, child death has reduced and certain illnesses as polio, measles has also reduced. So, I can say that this training has helped us in many ways. Because I am now able to tell people that when this happens this is what you should do, go to the health centre.** **Y4- the training I have received has helped me because I never knew how to write my name but through the ttC project, I can now write my name and don't need ink pad to sign again.** **Y5- what the training has done for me is hygiene practice. In those days we would touch refuse and touch food. We never kept our toilet clean but now that I have the knowledge of the effects of this, my toilet is always cleaned and closed.**
	Do you currently use mobile phone for your work?	**Y2- I am using mobile to work because I call WV and CUAMM.** **Y4- I used mobile phone to do my work** **Y3- I have a mobile phone but I use it through a helper because I don't know how to use it.** **Y5- I have a phone and I am really using it in my work.**
	Is this a personal phone or a phone given to you for the job? Who gave it to you?	**Y5- it is mine and I bought it.** **Y2- it is my personal phone.** **Y3- mine** **Y4- my phone**
	How do you work with the phone?	**Y4- if I go to certain places and see a pregnant woman or child that is not well and I ask them to go to the hospital and they refused, I will call the PS and report. Or if they need us, we will call our colleagues who are in the villages to tell them.** **Y5- I use my phone to call CHWs if they are needed or whatever confuses them, they call me or if they are not able they will call me to go. When I need them also, I will call.** **Y5- if I go to a pregnant and advise her to go to health centre and she refused, I will call my supervisor to come immediately and intervene.** **Y2- the way I work with my mobile is I call the supervisor when I meet a pregnant woman for example that is sick and cannot walk and he will in**

		turn call an ambulance or other vehicle to come and take her to the health centre. **Y1- I call my supervisor and other CHWs far away. If we have any message for them, I call the immediately.**
	Do you use a personal sim in the phone and why?	**All except Y4 are using their personal sim.**
	Did you work during Ebola?	**All said they worked during Ebola.**
	What did you do during Ebola?	**Y2- I did work for health and it was my community that asked me to work for them during Ebola. I did wash people's hands before they entered the hospital and used thermometer to take their temperature.** **Y1- during Ebola, I was responsible of hand washing here. If someone did not wash their hand, they weren't allowed to enter the health centre.** **Y3- I monitor hand washing upon entering the health centre. Anybody entering the centre did so after washing their hands.** **Y5- I was a screener in this centre.**
	Were you trained, and by whom?	**Y5- I was trained by Marie Stopes and IPC** **Y3-I was not trained. I only needed telling people to wash their hands and I also washed my hands always.** **Y2- I was trained by health/DHMT.** **Y1- I was trained by DHMT.**
	Did you use a mobile phone as part of your work during Ebola? How?	**Y5 - no** **Y2- I used mobile. When I had difficulty in my work like shortage of chlorine or soap or gloves, I called health for another supply.** **Y1- I didn't use a mobile at that time. I was in the health centre so when I lacked even chlorine I go to the nurse in person.**
	Are you using mobile phones now? For why?	**Y5 - I am using mobile phone for my work because it makes my worker quicker. This is because my CHWs are far away so I can't say I will always meet with them. Most of the time I call them.** **Y4- I use my phone to get clarification from my PS when I am in doubt of anything.** **Y3- I am using phone to call my supervisor when I meet challenges on the field. Even though I don't know how to interact the phone I will ask someone to assist me through it.** **Y2- I use the phone for my personal issues and also for the work.**

		Y1- I use my phone to ask my supervisor when I need help.
	What is your main work now?	**Y2- the works that I am known for are fishing, farming and CHW.** **Y1- for now the only work that am known for is CHW.** **Y3- the work they know me for is CHW but I farm rice for me to eat.** **Y4-they know me more for CHW work but I do gardening.** **Y5- as for me, I do gardening, petty trading and CHW and TBA.**
	If not CHW, how do you compromise the CHW work?	**Y5- petty trading is only on Mondays for the trade fare. The rest of the other days belong to my CHW work.** **Y4- I do my CHW work in the morning and go to my farm later.** **Y2- I do the CHW work in the morning and the rest fall after.**
	Do you use a phone as part of this work?	**All use phones as part of the work.**
	Do you use a mobile app to do the work?	**All said no.**
	If yes, which phone and mobile app?	**None.**
	Do you use a paper-based system?	**Y4- I use book.** **All others said book and mouth.**
	Which do you prefer between phone and paper and why?	**Y5- phone is good for this work because if the app is in the phone all the modules are in the phone.** **Y4- phone is quicker to work because everything is in the phone. When you use the phone, you don't have to talk a lot because the phone will do all the talking except you explain something to the person.** **Y3- the phone is simple to carry and have everything inside.** **Y2- the book is good because I didn't go to school. The visual drawings also help to teach clearly with the paper. If your foot is swollen, you watch in the book you know exactly.**
	What most supports you in your work?	**Y5- what now motivates us in this work is the incentives that they have promised to give to us for buying soap. But, the encouragement, WV, Health Marie stopes UNICEF and all others recognize us. This shows that we are important. We are also doing this work for our sisters and our children.**

		Y4-we started as volunteers and now they have started receiving something. This is why I am doing this job. **Y2- when they have decided to give us incentives is what has encouraged me more because we started it without money.** **Y3- the reduction in maternal death is what has encouraged me to work more. I don't wat it to be reversed.** **Y1- we have got labels for this work. Anywhere we pass right now people will say the CHWs are rich guys. We want to stay and be rich one day because if you are given bad name for something, continue it as there will be good at the end.**
	What do you need for this work?	**Y1- we need means of transportation as our distance are longer.** **Y4- we need mobile phone to ease our work.** **Y2- we need our money and on time.** **All other admitted these are what they need to do the work better.**
	Why do you keep doing this work?	**Y2- to save lives in our community so that we will always have to be with love ones.** **All accepted that this is the principal reason the became CHWs.**
	What are your biggest challenges as a CHW?	**Y5- the biggest challenge is transportation because of the distance I cover for supervision.** **Y4- what is more challenging in this job is that the work is too much. What they have showed to be given us is not enough for this work.** **Y3-the incentives is so small for the work. The work is too much.** **Y1- they have given us too many to do for an incentive that we don't see. And we have no rest for this work now.**
	Have you heard about the CHW Hub?	**All do not know.**
	What do you know about it?	**All do not know.**
	Does the CHW hub has any influence on your work?	**Nobody knows.**
	Have you heard about the eHealth Hub?	**No one has heard about it.**
	Do you know about the National CHW Policy?	**No one has heard about it.**

	What do you know about the policy?	**None.**
	Does it influence your work? And how? (CHW Training)	**Don't know.**
	Do you know the CHW Focal?	**The do not know the focal person.**
	How do they influence your work as CHW?	**None.**
	What else do you need to do your work?	**Y5- we need life jackets for CHWs living behind the sea.** **Y4- let them add our incentives.** **Y3- we have told pregnant women to come to the hospital, but when they come there is no bed. Even when they deliver, the bed is one and so hard for a new mother.** **Y2-there is no waiting room for our pregnant women. We need that. We need life jacket. We also need medicine at this health centre so when we refer people they get treated. We refer pregnant women and sometimes more than one of them give birth and there is no bed to keep them. That bed you are seeing is where they admit pregnant were after delivering, that is if they are more than one.**
	Tell me how this will change what you do.	**Y5- I talked about life jacket and I know if the CHWs from the riverine towns have it, they will hardly give excuses for not doing their assignment For not coming for meetins.** **Y4- if our money is added, we will sit for the work and the work only and anything additional work that comes, we will doit happily.** **Y3-if the beds are provided, we will be happy because our pregnant women will not suffer after delivering on strong and narrow beds.** **Y2- I know live jacket will make the work fine because there are pregnant women who refused to sit in outboard boats to come to the health. The jacket will reduce their fear. The essential drugs that should be provided for CHWs will make people not to work for longer distance for minor ailments as malaria. With a good labour room, people come for labour and there is no good bed. Of we have a very good place, even if four women deliver together, there will still be place to admit them.** **Y1-we will amount morale if our centre that we refer people to is well equipped with labour room and waiting room. This will make us proud.**

Appendix 13: Practical Examples of Data Analysis Methodology

The data analysis processes and methodologies has been described in detail in Section 6.5, specifically sub-sections 6.5.1 and 6.5.2. All data analysis processes and methodologies are based on the PhD research framework which is presented graphically in Section 5.5, Figure 5.5. The data analysis process is now summarised briefly to provide context for the practical examples of data analysis and retroduction which follow below.

As previously mentioned, two separate levels of data analysis were carried out based on the primary research data. The first level was a descriptive level of data analysis which produced the factual case study descriptions and the chronological account of events. These two documents have been adapted to present the story of mHealth in Bonthe District as presented in Chapter 2. This data analysis stage involved the use of NVivo software for thematic analysis of the documents collected, the transcripts of the semi-structured interviews, the transcripts of the focus group discussions, and the other observation data gathered. An example of both an interview transcript and a focus group discussion transcript (Yargoi CHC) are included in Appendix 11 and Appendix 12 respectively.

The first level of thematic data analysis started with open coding using NVivo which initially resulted in 80 free nodes. These were grouped into emergent categories in an effort to search for themes. All themes were subject to change and were added to when appropriate, with hierarchical relationships also being identified at this point. Furthermore, a variety of node sets, deeper thematic nodes, and relationship nodes were identified which were primarily derived from the free nodes as initially identified. As more documents and focus group and interview transcripts were analyzed the accounts became increasingly richer. Eventually it was decided that no new themes were emerging and theoretical saturation was considered to have been reached. At this

point it was decided that both the detailed factual case study description of the mHealth case and the chronological account of events were substantively completed.

As there is little methodological guidance for critical realist-based research of this type, it was decided that an additional layer of data analysis should be carried out. The factual case study and chronological account of events were provided separately to multiple key stakeholders in World Vision Ireland and World Vision Sierra Leone for validation and corroboration, and they were asked not to discuss this with each other. Each of the World Vision stakeholders provided feedback that both the factual case study and chronological account of events were an accurate representation of what happened, and they did not identify any omissions or suggest anything that needed to be added to either document. These documents were considered to be completed at this point and have been used to present an adapted version of the story of the mHealth project in Bonthe District as presented in Chapter 2.

The detailed factual case study description and the chronological account of events then gave rise to identification of 3 distinct M/M cycles. Each of the M/M cycles seeks to explain how change (morphogenesis) or reproduction (morphostasis) take place. Analysis of the 3 M/M cycles was completed over discrete time periods using the 3 domains of social reality for SEPs, CEPs and PEPs (see Chapter 6 for additional detail on this). The 3 M/M cycles identified empirically are:

- M/M I - The “mHealth Planning and Pilot Cycle”
- M/M II - the “Ebola Virus Cycle”
- M/M III - The “mHealth2 Cycle”

The empirical identification of these M/M cycles was initially identified by the Principal Investigator who completed this process based on his knowledge, observations, and experience of the mHealth project. The identification of the M/M cycles was completed in this way as there is no established or widely accepted methodology for doing this, with little available literature or other instruction to guide this process. Taking this into account, the process was guided by the work of Njihia & Merali (2013) who completed a similar process to identify M/M cycles in their own work.

Because of the lack of literature or other instrument to guide the process of identification of the M/M cycles in this case, it was decided that a further level of analysis may be needed. This was carried out by asking 3 key persons to each separately identify what they could see as separate cycles or "phases" in the mHealth project. They were asked not to collaborate on the task they had been given. Each of these people have worked in World Vision with this particular mHealth project for many years and all have intimate knowledge of the mHealth project. The 3 persons were not asked to identify "M/M cycles" as such as they did not have a detailed knowledge of critical realism and the morphogenetic approach required to do so. Instead, they were asked to break the mHealth project into what they considered to be logical parts or phases. Each person provided an almost identical breakdown of the mHealth project into 3 phases or cycles which corresponded very closely to the original M/M cycles identified.

As outlined in the preceding chapters, in order for theorization of the mechanisms to occur, each of the M/M cycles needs to be analysed using the 4-step methodology as proposed by Raduescu & Vessey (2008). The 4 steps in the methodology are as follows:

1. Identify the internal and necessary relations within and between social structure; that is identify the structural emergent properties via the transcendental argument. This is done by asking questions about what needs to be the case, what needs to be present for X to be such it is, and not what people think, tell, or believe it is.
2. Look for causal influences exerted by social structures on social interaction.
3. Look for causal relationships between various types of agents at the level of social interactions.
4. Identify how social interaction elaborates upon the composition of social structures by modifying the current internal and necessary structural relations and introducing new ones as in the case of morphogenesis. The congruence between both sets of powers (structural and people's causal powers) results in transformation. Alternatively, if the social interaction reproduces the existing internal and necessary structural relations then morphostasis applies. This effectively means that the two sets of powers are incongruent and change does not occur.

Raduescu & Vessey's 4-step methodology has already been discussed in detail in both Chapter 6 and Chapter 7. In addition, please refer to Section 6.5.1 for additional detail on the factual case study description and chronological account of events, and Section 6.5.2 for more detail on the M/M cycles. Chapter 5 presents the research framework in its entirety and also contains additional detail on the specific components of the research framework.

A number of examples of how the data analysis took place are now provided which will demonstrate how the mechanisms were hypothesized. The process starts with the application of Raduescu & Vessey's 4-step methodology. This methodology has been rephrased into the following 4 distinct methodological steps to make its application more practical in this case:

- Identify structural emergent properties via the transcendental argument. This requires asking questions about what needs to be the case for X to be such as it is, as opposed to what people think or believe it is.
- Are there any causal influences exerted by social structures on social interaction?
- Are there any causal influences which might lead to causal relationship between agents?
- Based on the answers to 2 and 3 either morphogenesis or morphostasis is then hypothesized. This is done as follows:
    - Where key players converge ideologically -> cultural or structural elaboration is hypothesized.
    - Where institutional reconfiguration in the face of pressures occurs -> structural elaboration is hypothesized.
    - Where key players do not converge ideologically -> it is hypothesized that there is no cultural or structural elaboration.

- Where institutional reconfiguration in the face of pressures does not occur -> it is hypothesized that there is no structural elaboration.

This analysis is applied to the data empirically on an iterative basis. A previous example of where this particular empirical methodology has been adopted is provided by Njihia & Merali (2013). Based on this approach the 4 steps of Raduescu & Vessey's methodology were applied to M/M I, M/M II, and M/M III in turn. This led to a variety of hypothesizations of either morphogenesis or morphostasis being made. These hypothesizations were made in line with whether or not cultural or structural elaboration was hypothesized as described in step 4 (specifically the 4 sub-steps) of Raduescu & Vessey's methodology above.

An example of the way this methodology was applied to M/M I is now demonstrated. The methodology is broken down into distinct parts, with the analysis process for M/M I beginning by examining the introduction of the mHealth project which included both the mobile phone hardware and mHealth mobile application as well as the people needed to make the project work. It is important to recognise that the steps needed to hypothesize either cultural or structural elaboration were followed carefully and very carefully, via the transcendental argument, as described above. This was a long and detailed process which took considerable time as it was required to be carried out for the three M/M cycles identified and the many questions (transcendental arguments) identified within each of these M/M cycles.

Example 1

Following is the first example of this process as applied to the M/M I cycle. The numbers indicate the part of Raduescu & Vessey's 4-step methodology that is being applied.

- Identify structural emergent properties via the transcendental argument. This led to the first question being asked "what needed to be present for the mHealth project to be implemented correctly?". This represents the question which asks what needs to be present for X to be such as it is, and not what people think or believe it is. This

question was addressed by looking at hardware and software infrastructure available to the mHealth project. The people available (e.g. the CHWs, the mHealth project management team, members of the DHMT in Bonthe District) were also considered as the mHealth project would not be able to work without actual people. The mHealth project management team in Bonthe District contained project champions, and the CHWs were considered to be highly motivated and willing to adopt the new mHealth technologies if these technologies enabled them to do their jobs more effectively.

- Were there any causal influences exerted by social structures on social interaction? None were hypothesized for this particular transcendental argument.
- Were there any causal influences which might lead to causal relationship between agents? Yes - the mobile phones and the potential of the CHWs to do their jobs more effectively with this technology was seen as a causal influence in this instance. This also created a new causal relationship between the 3 groups of agents: the World Vision mHealth management team, the DHMT and the CHWs.
- Is either morphogenesis or morphostasis hypothesized? Yes - this situation is hypothesized to have resulted in cultural transformation or morphogenesis of the CHWs social system as these 3 agental players clearly converged ideologically around the potential value of the mHealth systems.

The result of this first application of Raduescu & Vessey's 4-step methodology was to hypothesize cultural morphogenesis in line with Margaret Archer's morphogenetic approach. This hypothesization of cultural morphogenesis is particularly relevant because the CHWs social structures were reconfigured and elaborated in fundamental ways in line with the mHealth infrastructure. Included in this reconfiguration was the CHWs working structures, the CHWs family structures, and the overall status of the CHWs in the community. This all resulted from the CHWs being in possession of a mobile phone and a solar charger and their ability to use this mobile hardware in a

variety of ways for both work and in their personal lives, including their new-found ability to create communities of practice. Taking all of this into account, significant cultural transformation or morphogenesis was hypothesized in this instance.

Example 2

A second example of Raduescu & Vessey's (2008) 4-step methodology being applied to M/M III is now presented.

- Identify structural emergent properties via the transcendental argument. This led to the question being asked "how did the financial payment now given to the CHWs (750k SLL or approximately 90 Euro per quarter) reconfigure their practice?". It was recognised that Structural emergent properties via the transcendental argument in this instance are similar to those recognised in both M/M I and M/M II and involve the vocation and high levels of motivation, vocation and dedication amongst the CHWs.
- Were there any causal influences exerted by social structures on social interaction? None were hypothesized for this particular transcendental argument. However, it was recognised that there was potentially significant cross-over to hypothesization of causal influences which might lead to causal relationships between agents in step 3 below.
- Were there any causal influences which might lead to causal relationship between agents? Yes - there were a number of potential causal relationships for this transcendental argument.
- Can either morphogenesis or morphostasis was then hypothesized. Yes - the CHWs knew the mHealth project depended on them and were thus in a position of power. This meant they could ask for additional financial and non-financial benefits. This led to significant potential causal relationships between CHW agents. Thus, morphogenesis was hypothesized.

Again, the result of this application of Raduescu & Vessey's methodology was to hypothesize cultural morphogenesis in line with Margaret Archer's morphogenetic approach.

A similar process was carried out for 7 transcendental arguments for each of the M/M cycles, with a total of 21 transcendental arguments across the 3 M/M cycles being analysed in a manner similar to example 1 and 2 above. This resulted in a significant amount of morphogenesis and morphostasis being hypothesized, with a possible total of 8 mechanisms being hypothesized at this point. Analysis was then carried out on the 8 mechanisms hypothesized, and as a number of these were very similar an empirical approach which relied on the Principal Investigators knowledge of the mHealth project was used to refine the final number of hypothesized mechanisms to 5. Thise 5 mechanisms are outlined in Section 7.2, Chapter 7and are as follows:

1. The communications and technological infrastructure built around the mHealth project.
2. The motivation, vocation, and attitude of the CHWs.
3. The mHealth management team in Bonthe District and the manner in which key people became project champions for the mHealth project.
4. The mHealth infrastructure in its entirety.
5. The incentives given to the CHWs.

As we have seen in examples 1 and 2 the methodology for hypothesization of the mechanisms relies heavily on Raduescu & Vessey's 4-step methodology. As there is little practical methodological guidance on this in the literature, the methodological approach adopted by Njihia & Merali (2013) was, again, relied on.