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Strategies for scalability and sustainability of mobile health projects for Non-Communicable Diseases in developing countries: A qualitative review analysis

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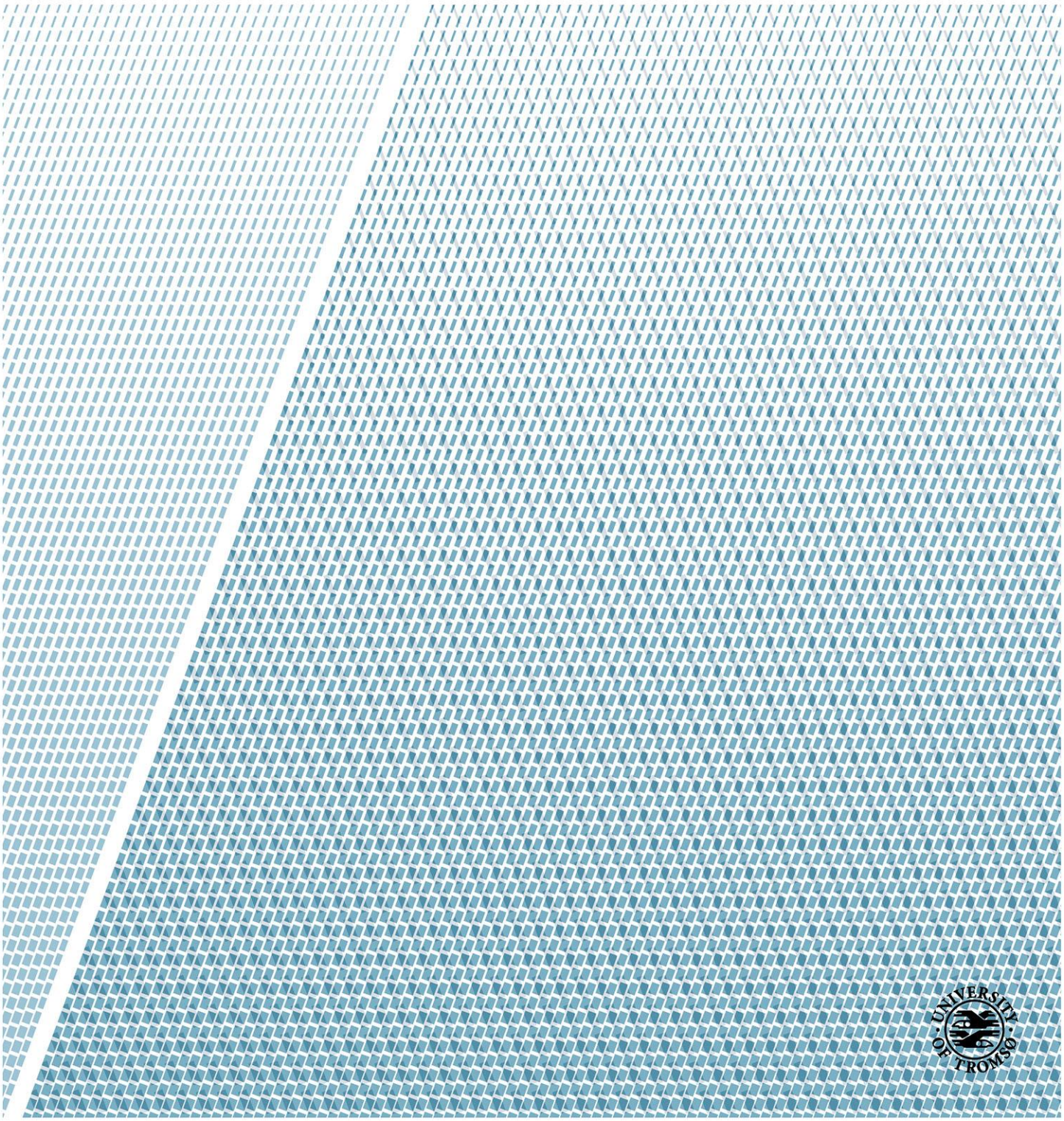

Dedication

This paper is dedicated to all the people who have fought and lost the battle against Non-Communicable Diseases (NCDs). We need to find better and effective ways to manage NCDs. We have won the battle in some areas, but the battle continues. I have learnt a lot through your struggles and fight and I continue to learn and hope the journey becomes easier for those who are yet to go through the same journey. Remembering all the beautiful souls.

Preface

This thesis is submitted in partial fulfilment of requirements for the degree in Master of Science (MSc) in Telemedicine and E-health at the Faculty of Health Sciences department of Clinical Medicine, University of Tromsø, Norway.

The thesis is intended to give guidance and suggestions to implementers of mobile health (mhealth) projects for Non-Communicable Diseases (NCDs) in developing countries where challenges have been observed pertaining to scalability and sustainability of the projects.

The main motivation for the research is that despite the increased availability of mobile phone technology in developing countries 'pilotisis' referring to mhealth projects never progressing beyond the pilot stages is still a major problem. It is hoped that the thesis provides guidance to mhealth implementers on how to overcome these challenges particularly with regards to projects concerning NCDs which have also increased and become a major problem to manage.

I would like to thank my supervisor, Professor Gunnar Ellingsen for his continued professional support and guidance throughout my studies. I am grateful to the department of Clinical Medicine at the University of Tromsø for giving me the opportunity to undertake my studies. I would also like to thank the staff at the National Centre for E-health Research (NSE) in Tromsø, Norway for expanding my knowledge by introducing me to a whole new world of Telemedicine and E-health technology.

Finally, I would like to thank my family for the continued support and encouragement during my stay away from home. Most importantly to the higher being, you give the grace, strength and open so many opportunities I could never have dreamt of. Thank you, for my next chapter begins now.

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Abstract

Background: This research reviews the strategies that are used for scalability and sustainability of mobile health (mhealth) projects for Non- Communicable Diseases (NCDs) in developing countries. Due to increased availability of mobile phones, use of mhealth to delivery healthcare services has become widely used in developing countries. An increase in rates of deaths from NCDs has also been observed in most developing countries thus creating a public health threat. Mhealth promises to provide improved and easily accessible healthcare services for NCDs however most mhealth projects fail to scale up and become sustainable. Consequently, identifying the strategies that are effective for scalability and sustainability of mhealth projects for NCDs in developing countries is vital.

Aims and objectives: The research aims to identify the strategies for scalability and sustainability of mhealth projects for NCDs that are used in developing countries. Informatics approaches of implementing Information Infrastructures (II) in healthcare are used to discuss the strategies.

Methods: The data was collected through a literature search of published scientific articles (journals and documents). A qualitative narrative review was used to interpret the study. Content analysis methods were used to analyse the data and provide new knowledge and insight on the subject.

Results: The research showed use of Design, Collaboration, Economic, Monitoring and Building Local Capacity strategies when considering scalability and sustainability of mhealth projects for NCDs in developing countries.

Conclusion: The research can be used as a guide on what strategies would be beneficial during planning for scalability and sustainability of mhealth projects for NCDs in developing countries.

Key words: Scalability, Sustainability, Mhealth, Information Infrastructure (II), Non-Communicable Diseases (NCDs), Developing countries.

List of Abbreviations

ANT	Actor Network Theory
BHBM	Be He@lthy Be Mobile
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cardiovascular Disease
Ehealth	Electronic health
IBRD	International Bank for Reconstruction and Development
ICT	Information Communication Technology
II	Information Infrastructure
IT	Information Technology
ITU	International Telecommunication Union
M&E	Monitoring and Evaluation
Mhealth	Mobile health
MoH	Ministry of health
NCD	Non-Communicable Disease
NGO	Non-Governmental Organisation
PDA	Personal Digital Assistant
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
SMS	Short Message Service
UIT	Arctic University of Norway
UN	United Nations
WHO	World Health Organisation
ZICTA	Zambia Information and Communications Technological Authority

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1. Chapter 1 Introduction

1.1 Background to study

This research reviews the strategies that are used for scalability and sustainability of mobile health (mhealth) projects for Non- Communicable Diseases (NCDs) in developing countries. The research uses informatics approaches of implementing Information Infrastructures (IIs) in healthcare services to discuss the strategies of scalability and sustainability of the mhealth projects.

The use of mobile phones and devices to improve and delivery healthcare services is widely used in developing countries (Beratarrechea, et al., 2017). Lemaire, (2011) explains that mhealth is a section of electronic health (ehealth), which is the use of Information and Communication Technology (ICT) for provision of health services. Mhealth services will generally involves the use of mobile and wireless telecommunication and multimedia for healthcare delivery (Tamrat & Kachnowski, 2012). The functions of mhealth include collecting health data and delivery of healthcare information, real-time monitoring of patient's vital signs, and management of diseases (Wikipedia, 2017a). The concepts of using technology and its applications to remotely diagnose, monitor, and treat patients (Telemedicine), and to educate and support patients to manage their illnesses through self-care (Telehealth) are not new (Kao, et al., 2017). However, integration of Telemedicine and Telehealth with mobile phones and devices has transformed delivery of healthcare services (ibid). The World Bank, (2012) suggests that mhealth in a broader term involves use of mobile phone technology to address challenges of health access, quality, affordability, coordination of resources and assessment of human behaviour patterns through exchange of information. The World Health Organisation WHO, (2011a) defines mhealth as a medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. Mhealth has shown to be successful in delivery of healthcare services and its use particularly in developing countries has increased because of increased accessibility to mobile phones (Bloomfield, et al., 2014).

Applications of medical informatics or health informatics such as how IIs are built have long been used in healthcare to understand how information technology (IT) is integrated in

healthcare systems as in the case with the delivering of mhealth services (Shortliffe & Marsden, 2014; Hanseth & Lyytinen, 2010). Procter, (2009 p. np) defines medical informatics as;

"the interdisciplinary study of the design, development, adoption and application of IT-based innovations in healthcare services delivery, management and planning"

Medical informatics approaches of how IIs are implemented could be useful to understand how information systems in healthcare are integrated within the work environment, and how people adopt and deal with the system and its components (Monteiro, 2000; Gasser, 1986).

A shift in increased rates of deaths from communicable (infectious) diseases to NCDs has been observed in most developing countries and creates a public health threat (Stepani, et al., 2016). The WHO has recognised that NCDs, particularly cancer, heart diseases, respiratory disease and diabetes are the leading causes of deaths in developing countries and greatly affect the healthcare expenditure (ITU, 2017; Bloomfield, et al., 2014). NCDs account for 63 percent of global deaths annually with developing countries bearing 86 percent of the burden of the deaths (WHO, 2013). In developing countries, NCDs mostly affects the younger population between the ages of 30 and 70 years (Binagwaho, et al., 2014; WHO, 2013). Due to low quality healthcare infrastructures, poor health awareness, illiteracy, and poverty, management of NCDs is a huge challenge for developing countries, and if left unaddressed could also affect economic development (Asiimwe-Kateera, et al., 2015). WHO, (2011b) reports that NCDs are often accompanied by prolonged disabilities that require continuous use of healthcare services and therefore increases individual family health expenditures that consequently affects household's and communities' levels of income including labour productivity. Premature deaths from NCDs are preventable through implementing healthcare services targeted at people with the diseases and promoting healthier lifestyles that reduce the risk factors (WHO, 2013). Kontis, et al., (2014) reports that control of tobacco, alcohol, salt, blood pressure, obesity, and glucose which are the six major risk factors for NCDs could prevent premature deaths from NCDs.

In 2011 the United Nations (UN) officially declared NCDs as a public emergency (WHO, 2013). Through a historic commitment to control the diseases, a global action plan was set in 2012 to reduce 25 percent relative reduction in premature mortality from heart diseases,

cancer, diabetes, and chronic respiratory disease by 2025 (ibid). The action plan emphases six global objectives for management of NCDs; (1) prevention and control should be a priority (2) strengthen national capacity and leadership (3) reduce modifiable risk factors (4) strengthen healthcare systems (5) promote high-quality research and development (6) monitor the trends of disease (WHO, 2017a). In 2014, the UN further added four-time bound national commitments targeted for implementation in 2015 and 2016 with the objective to reduce risk factors, provide better care and track trends and progress of NCDs (WHO, 2018). WHO, (2017a) promotes and advises that the countries that committed to these action plans need to find practical methods to transform them to action.

Biological technology, ICT, and medical device innovations, all which mhealth contributes to, combined with greater involvement of patients, society, and organisations are necessary to achieve the WHO global action plan targets (Smith, et al., 2012). Studies show mhealth successfully being used in areas of communicable diseases and maternal and child health, to improve access to healthcare, educate healthcare professionals, treatment adherence, and monitoring and surveillance of disease (Mushamiri, et al., 2016; Källander, et al., 2013). In management of NCDs, mhealth promises to provide access to healthcare services to a larger population with minimum healthcare personnel and at reduced costs (Beratarrechea, et al., 2017). However, few studies have been conducted to demonstrate the effectiveness of mhealth in delivery of healthcare services for NCDs in developing countries (Bloomfield, et al., 2014). Consequently, it could be a challenge to identify the strategies that could be effective for scalability and sustainability of mhealth projects for NCDs.

1.2 Definition of scalability and sustainability in healthcare services

Scalability of an information system implies expanding the system in scope and size making it accessible to more users or increasing its functionalities (Sahay & Walsham, 2006). ExpandNet-WHO, (2010 p. 2) defines scalability in healthcare services as;

“efforts to increase the impact of healthcare innovations successfully tested in pilot or experimental projects to benefit more people and to foster policy and programme development on a lasting basis”.

Sahay & Walsham, (2006) adds that scalability concerns aspects of geographical location, software architecture, people, processes, infrastructure, technical and political support. Lemaire, (2013 p. 6) defines scalability in relation to mhealth as:

"Technology replication in multiple contexts, or an expansion or national scale up of a project, platform, or organisation"

Sustainability is described in healthcare as the continued use of a program's components and activities to achieve a desirable program and appropriate population outcomes (Scheirer & Dearing, 2011). Sarriot, et al., (2008) suggests that sustainability of an mhealth intervention refers to a process of enabling individuals, communities, and organisations utilise the benefits of an intervention that has developed and progressed beyond the pilot stage. Luna, et al., (2014) proposes the following factors to use when analysing sustainability of healthcare information technologies; the effectiveness of the system, the financial viability, reproducibility such as how easily it integrates and is applicable in different settings, and portability which is measured by the ease of implementing and adapting concepts and approaches to other environments. Whittaker, et al., (2004) indicates that a sustainable telemedicine system should not merely be able to be stable, but also renewable.

1.3 Definition of NCDs

NCDs are non-contagious diseases or medical conditions with the larger proportion in developing countries being cardiovascular diseases (CVDs), cancer, diabetes, and chronic lung diseases (chronic obstructive pulmonary disease -COPD and asthma) (WHO, 2017b; Alwan, 2010). Other NCDs include renal, endocrine, neurological, haematological, gastroenterological, hepatic, musculoskeletal, skin, and oral diseases and genetic disorders, mental disorders, disabilities including blindness and deafness, violence, and injuries (WHO, 2013).

1.4 Research problem and questions

The rise in incidences of NCDs has created a huge burden to the already weak and fragmented healthcare systems in developing countries (Asiimwe-Kateera, et al., 2015). This has also

been exacerbated by the low number of healthcare professionals in the regions (Beratarrechea, et al., 2017). Due to increased accessibility of mobile phones in developing countries, using mhealth services to manage NCDs seems particularly applicable to these countries (ibid). Bloomfield, et al., (2014) suggests that the available mhealth technology has the potential to improve the population's access to healthcare services and strengthen healthcare systems in developing countries. Healthcare systems in developing countries are however mainly geared towards dealing with acute and infectious diseases than providing services for long-term NCDs (NCDs Alliance, 2011). Consequently, current healthcare systems and strategies are not designed to effectively prevent and manage NCDs (Smith, et al., 2012; NCDs Alliance, 2011). In view of the healthcare services constraints, understanding effective strategies for scalability and sustainability of mhealth projects for NCDs that could further improve disease prevention and management is important.

Scalability and sustainability strategies are particularly important to consider when implementing mhealth projects for NCDs. Braa, et al., (2004) suggests that scalability of information systems is concerned with making one technologically working solution to be expanded and adapted to other sites, reproducing, and translating the necessary learning processes alongside the spreading of artefacts, funding, and people. Sustainability concerns ensuring the continuous functionality of an information system, whose use is intended to persist over time even when external funding is terminated (ibid). However, this has been reported to be challenging for most developing countries to achieve, resulting in several mhealth projects rarely scaling up and becoming sustainable beyond the pilot stages (Tomlinson, et al., 2013).

The WHO, (2015) states that most mhealth projects in developing countries consist largely of small-scale implementations which focus on establishing evidence of feasibility and effect, without extensive exploration of the infrastructure needed for future scaling up and sustainability. Consequently, limited information is known on what may be required to transform the mhealth projects into large scale and sustainable projects (ibid). This research therefore seeks to address the question of, what strategies are used for scalability and sustainability of mhealth projects for NCDs in developing countries. Approaches from implementation of II in healthcare are used to discuss the strategies.

1.5 Aims and Objectives

The aim of this research is to determine the scalability and sustainability strategies of mhealth projects for NCDs that are used in developing countries. The objectives are:

- To identify the strategies for scalability and sustainability of mhealth projects for NCDs in developing countries.
- To group and analyse the strategies for scalability and sustainability of mhealth projects for the NCDs.
- To discuss the strategies in relation to developing countries using approaches of implementing II in healthcare systems.

The research contributes to knowledge on effective strategies to use for scaling up and sustaining mhealth projects that promote management of NCDs in developing countries.

1.6 Scope of the research

The research scope includes a review and discussion of literature on the strategies used for scalability and sustainability of mhealth projects for NCDs in developing countries. The study uses a broader term of the definition of mhealth to include telemedicine and telehealth projects, but only those that used mobile phones and devices for management of NCDs. The conditions of NCDs that were researched are as defined by the WHO (WHO, 2017b; WHO, 2013).

1.7 Summary

This chapter discussed the background to the study, the research problem, the aims, and objectives. The scope of the research is also defined. The definitions of scalability and sustainability in relation to mhealth and the definition to be used for NCDs is given. The remaining chapters in this document will be organised and discussed as follows; Firstly, the theory in relation to the research, then the methodology and the results. The document will end with a detailed discussion, recommendations, and conclusion. The next chapter discusses the theory.

2. Chapter 2 Theory

2.1 Introduction

This chapter reviews the relevant literature on the topic. The chapter is planned to first highlight how large scale IIs such as mhealth projects are built, the barriers for scalability and sustainability of mhealth projects in developing countries are then discussed. The chapter proceeds to bring to light the various recommended scalability and sustainability strategies for mhealth projects and how approaches of implementing IIs in healthcare clarifies the strategies.

2.2 Building IIs for scalability and sustainability

Scalability and sustainability of mhealth projects entails building large scale IIs (Sanner, et al., 2012). Aanestad & Jensen, (2011) defines large scale IIs as complex and integrated information systems and communication technology consisting of technical and non - technical elements, integrating humans and technology as actors in a network. Hanseth & Lundberg, (2001) identifies four qualities of IIs that; (1) they are shared resources for a community; (2) their components are integrated through standardised interfaces; (3) they are open, with no strict limit as to what is included, who can use it and for which purpose; and (4) they are heterogeneous, consisting of both human and technological components. Due to the huge involvement of both technical and non technical components, large scale IIs could be a challenge to build, scale up and sustain (Sanner, et al., 2012; Aanestad & Jensen, 2011). Aanestad & Jensen, (2011) point outs that building or cultivating from the already existing infrastructure using iterative and adaptive development approaches along with ongoing alertness, monitoring, and interventions is useful to understand how IIs are built, become sustainable, and could also reduce costs. Sanner, et al., (2012) defines this process as ‘installed base cultivation’ and explains the concept as that large and complex information systems, are never built from scratch, but always evolve through the extensions and improvement (cultivation) of what is already in place (the installed base).

Aanestad & Jensen, (2011) describes the concept of the installed base of IIs as socio-technical and practice-oriented, comprising of the physical and social context of work, existing

technologies and routines including the worker's skills and beliefs. In relation to existing IIs of mhealth projects, Braa & Sanner, (2011) gives examples of the installed base to include, a socio-technical collective of health workers and their paper registers at the community health facilities, computers and data analysts at the district levels, the servers and monitoring and evaluation officers at the state level, basic infrastructures required to support mobile phone use, charging facilities, maintenance support and network coverage. Using the installed base as the starting point and tactfully build on it enables dealing with multiple stakeholders and could mobilise and coordinate them (Aanestad & Jensen, 2011). This eventually leads to aligned actors in a network that are irreversible or sustainable (Monteiro, 2000).

In understanding scalability and sustainbility, Sanner, et al., (2014) uses grafting for the same concept as cultivating from the installed base, and explains that grafting entails working with available resources and interested parties to merge an information system's innovation with the existing IIs by identifying suitable moments and parts of the installed base to control. Therefore, grafting involves managing relationships with the key stakeholders responsible for the implementation process, who also hold some control over parts of the previously existing II (ibid). By drawing on the notion of grafting, the question of how some actors can control parts of the installed base and summon stakeholders to support an initially fragile information system's innovation could be addressed (ibid). This could assist to understand what strategies were used to build an II and how it came into being, scalable and sustainable or conversely unstable or failed (Monteiro, 2000). Coiera, (2009) however cautions that in healthcare settings, building IIs from the installed base (which is the bottom up approach) could in certain instances be perceived as an organisation's voluntary affair, and a national's government may largely be disinterested in it and not include it in its national policy goals. In this regard when implementing mhealth projects or services early involvement and support of all relevant government ministries, organisations, internal and external stakeholders, including telecommunications and mobile network companies, end-users, and financial donors is vital (Lemaire, 2011).

Aanestad, et al., (2017) mentions that the challenges of building from the installed based is that as the II is growing, its fitted parts are also changing therefore transformation is taking place at the same time. In such a situation a paradox is created because new developments to the system need to fit while making use of the existing system and at the same time transforming it (ibid). The II must also constantly be aligned or move towards irreversibility

or stability with the continuously fitted developments to allow new connections to be created (Aanestad, et al., 2017; Monteiro, 2000). Due to the continuously evolving process the implemented strategies need to consider future evolution of the II for it to be effective (Aanestad, et al., 2017).

Walsham, (1997) describes information systems as networks of human and non-human elements or actors which include people, organisation, software, computer and communications hardware and infrastructure standards. Each of the actors is affected by the behaviour of the other and affects the development of the system termed 'Actor Network Theory' (ANT) (ibid). Monteiro, (2000) suggests that ANT can be used to understand the socio-technical nature of how information systems develop. ANT explains the hetergenous socio-technical network of actors with aligned interests that are enrolled in the network and create a body of allies through negotiation (translation and inscription) of their interests to be aligned with the network (Walsham, 1997). Through translation and inscriptions the network becomes aligned to a degree of irreversibility termed 'black box' (ibid). Monteiro, (2000 p. 75) explains translation as the design process of an II;

"where the users and others' interests may, according to typical ideal models, be translated into specific needs, the specific needs are further translated into more general and unified needs so that these needs might be translated into one and the same solution".

When the system becomes operational, it will be adopted by the users by translating the system into the context of their specific work tasks and situations which will include inscribing programs of action for the users, including their defines roles (ibid). Actors enrolled in the network with strong properties of irreversibility that trancend in time and place are termed immutable mobile (Walsham, 1997). ANT provides a useful way of describing the processes of network formation of how technology and humans merge together in a socio-technological network and how the network stabilises or becomes sustainable (Ellingsen & Obstfelder, 2007). ANT stresses that the achieved goals of a network are a result of negotiation of the actors' interests, and in such a process, an agreement between two actors may result in a displacement of their original goals (translation) to agree on a unified goal (Larsen & Ellingsen, 2010). Walsham, (1997) points out that depending on the process of translation and network building that occurred in a network, similar information systems could attain different outcomes in different locations. ANT could therefore be useful to

understand technology and its role during implementation in healthcare settings, and how social effects are generated due to associations between different actors in the network (Cresswell, et al., 2010).

2.3 Barriers to scalability and sustainability of mhealth projects in developing countries

Due to the high influx of mobile phones, mhealth promises to provide improved healthcare services in developing countries (Beratarrechea, et al., 2017). This has therefore prompted the implementation of several mhealth projects. However most of the mhealth projects implemented in developing countries fail to scale up from pilot stages and become sustainable, leading to the term 'pilotitis' (Tomlinson, et al., 2013). Sundin, et al., (2016) reports that despite strong financial, logistical, and clinical support from Non-Governmental Organisations (NGOs), government ministries and private sectors, 'pilotitis' continues to be a major problem for developing countries. Sundin, et al., (2016) also points out that most of the barriers to scalability and sustainability of mhealth projects are social and economic, rather than technological. Below the technological, financial, social and culture barriers of scalability and sustainability of mhealth projects in developing countries are outlined and discussed.

2.3.1 Technological barriers

Luna, et al., (2014) reports that developing countries have considerable infrastructure deficits in their information networks, due to high costs, geographic dispersion, and high percentages of people living in rural areas. Furthermore, despite the wide spread availability of mobile phones in developing countries, most mobile phones used are simple handsets with limited computing power, memory, text message length and language capabilities which usually rely mainly on Short Messaging Services (SMSs) (Sundin, et al., 2016). Low computing power or memory capacity prevents the storage of large amounts of data obtained from mhealth services, in turn leading to loss of data (ibid). Using smartphones that connect to the internet and allows quick transfer and storage of data to central servers could be a solution. However, a smaller percentage of the population in developing countries own smartphones (Hampshire, et al., 2015) and thus could limit the mhealth project target population. Furthermore, internet bandwidth is still quite expensive, scarce, and of low quality predominantly in rural areas of

developing countries (Luna, et al., 2014). Sundin, et al., (2016) also points out that most developing countries have not yet developed integrated, reliable, and secure modems and data servers that have the capacity to transmit, store and analyse the large data obtained from mhealth services. Although it could be globally common for health information systems to be fragmented, this problem is dominant in developing countries (Luna, et al., 2014). To enable exchange of information, well integrated mhealth systems need to be in place (ibid). In addition, reliable data storage systems need to be established to ensure security and privacy for the collected mhealth data, especially as the volume of data increases significantly (Sundin, et al., 2016).

Access to electricity in developing countries is also a huge challenge (Sundin, et al., 2016). The International Bank for Reconstruction and Development IBRD, (2017) reports that in Sub- Sahara Africa alone an estimated 530 million people will still not have access to electricity by the year 2040 due to high population growth in the area. Mhealth technology including basic cell phones requires electricity for continuous use. Therefore, lack or scarce supply of electricity in certain regions affects recruitment of potential users and could be a hinderance to scalability and sustainability of the mhealth project (Sundin, et al., 2016).

2.3.2 Financial barriers

Sundin, et al., (2016), highlights that mhealth services are usually free for public use at the pilot stages and funded by wealthy donors, however beyond the pilot stages donor funding is normally discontinued. Therefore, introducing payment to scale up and sustain the mhealth project could be a challenge (Mangone, et al., 2016). Telecommunication operation costs have also been suggested to exponentially increase as the mhealth project expands to include more users (Sundin, et al., 2016). Tomlinson, et al., (2013) however highlights that despite donor's willingness to financially support most mhealth projects beyond the pilot stages most of the projects still rarely meet the standards for scalability. Lewis, et al., (2012) suggests that developing countries could reduce reliance on donor funding of mhealth projects by examining alternative and diverse revenue sources, such as government contracts, insurance, or direct payments from the consumers. Mangone, et al., (2016) however suggests that direct payment from consumers could be a hinderance to scalability, because the mhealth project may not cater to those who are too poor to pay, thus limiting the project's reach and impact. O'Connor & O'Donoghue, (2015) suggests that financial barriers could also arise due to

political situations. The planning and budgeting process is limited by the government's expenditures in previous years, therefore developing countries often face difficulty to mobilise funds for full-scale mhealth implementation as there may be no guaranteed governmental financial support for sustaining the project (ibid). Sundin, et al., (2016) however states that most of the financial problems could be alleviated by creating local and international partnerships with relevant organisations.

2.3.3 Social and cultural barriers

Social and culture norms can influence acceptance and adoption of mhealth technologies and services (Lemaire, 2013). O'Connor & O'Donoghue, (2015) highlights that where the mhealth project implementation team is unaware of the cultural perceptions or stigma of a disease in a community, it would be difficult to understand the population's resistance to participating in the project. Identifying and addressing the social and culture norms that affect and hinder the target population from participating in the mhealth project are therefore important (ibid). However, in such instances, resources need to be deployed not only for direct management of the disease but also to change culture views about the disease (Sundin, et al., 2016). Gender dynamics can also significantly affect the user recruitment to the mhealth project (O'Connor & O'Donoghue, 2015). In developing countries particularly in Africa, studies indicate that men receive preferential treatment over women (ibid). Furthermore, reports show that fewer women own cell phones or mobile devices compared to men (Sundin, et al., 2016; Zambia Information and Communications Technological Authority ZICTA, 2015). This could result to exclusion of women participation. In a case where the mhealth project is targeted towards women, several potential users would be missed thus reducing effectiveness of the project (O'Connor & O'Donoghue, 2015).

Technology knowledge levels could also be a barrier to scalability and sustainability of mhealth projects in developing countries (Lemaire, 2013). The healthcare professionals in most developing countries usually do not have the adequate knowledge and training or sufficient language skills to understand and operate the introduced mhealth technological to full capacity (Sundin, et al., 2016). O'Connor & O'Donoghue, (2015) attributes this to be due to that most mhealth solutions are developed in western societies that use the English language. Sundin, et al., (2016) however suggests that lack of knowledge has been exacerbated by many healthcare professionals from developing countries migrating to more

industrialised nations to find better salaries, benefits, and a higher quality of life. Therefore, finding specialist healthcare professionals as well as mhealth technology experts in developing countries has become a challenge (ibid). To deal with the shortages of healthcare specialists, most developing countries have implemented where applicable 'task shifting', a shift in primary care functions from professional or specialist healthcare staff to health workers with short training or lower qualifications (Clifford, et al., 2014). Noubiap, et al., (2014) suggests that task shifting when incorporated with mhealth services could increase access to prevention and curative services for NCDs. Noubiap, et al., (2014) however cautions that task shifting must be implemented as proposed by WHO, (2007), within systems that contain adequate checks and balances to protect both the healthcare workers and the people receiving the mhealth services.

Despite the existing barriers, some mhealth projects in developing countries have managed to scale up and become sustainable (Lemaire, 2011). To achieve scalability and sustainability of mhealth projects for NCDs in developing countries the WHO advocates for creating global, regional, and country level policies (Be He@lthy Be Mobile BHBM, 2013). Holeman, et al., (2014) suggests that how we coordinate in delivering healthcare services, and how we utilise the established solutions to tackle new problems, using knowledge from local healthcare professionals, patients, and the community influences the scalability and sustainability of mhealth projects. The next section of this chapter discusses the strategies for scalability and sustainability of mhealth projects.

2.4 Scalability and sustainability strategies for mhealth projects

Different researchers have analysed and reported of strategies that could be effective to scale up and sustain mhealth projects (Lundin & Dumont, 2017; Sundin, et al., 2016; Lemaire, 2011). Although these cases and reports are not specifically studied for NCDs, the recommended practices could be used for scalability and sustainability of mhealth projects for NCDs in developing countries. ExpandNet-WHO, (2010) provides a conceptual framework on scalability of health interventions, consisting of five elements with the scaling up strategy as the centrepiece and five strategic choice areas as indicated in Figure1. In describing the five elements, the innovation refers to health interventions or other practices that are being scaled up, the user organisation(s) refers to the institution that seeks to or is expected to adopt and implement the innovation on a large scale, the environment refers to the conditions and

institutions which are external to the user organisation but fundamentally affect the prospects for scaling up, the resource team refers to the individuals and organisations that seek to promote and facilitate wider use of the innovation, and the scaling-up strategy refers to the plans and actions necessary to fully establish the innovation in policies, programmes and service delivery (ibid). Depending of the type of scale up (vertical, horizontal, diversification or spontaneous) strategic choices will have to be made on dissemination and advocacy, organisational process, costs, and resource mobilisation and monitoring and evaluation (ibid) as depicted in Figure 2.

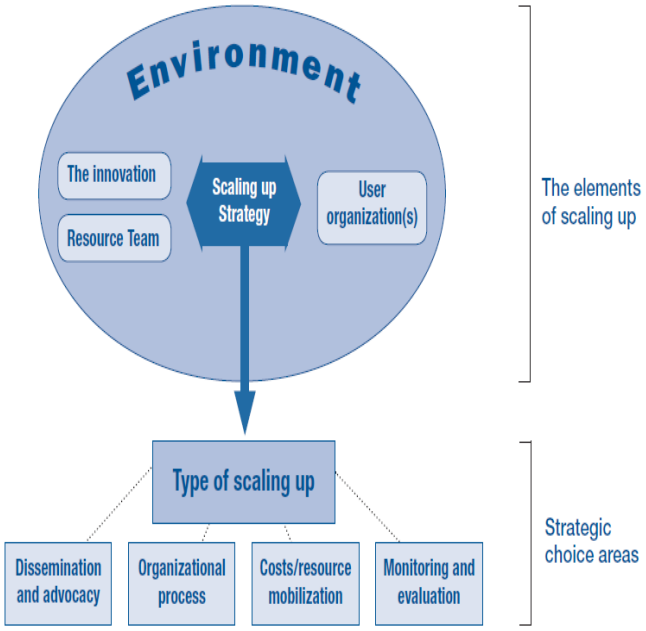

Figure 1 Conceptual framework on scale up of health interventions (ExpandNet-WHO, 2010)

Strategic choice areas	Examples
Type of scaling up	▪ vertical scaling up—institutionalization through policy, political, legal, budgetary or other health systems change ▪ horizontal scaling up—expansion/replication ▪ diversification ▪ spontaneous scaling up.
For each of the above types of scaling up, choices will have to be made about the following:	
Dissemination and advocacy	▪ ***personal:*** training, technical assistance, policy dialogues, cultivating champions and gatekeepers ▪ ***impersonal:*** web sites, publications, policy briefs, toolkits.
Organizational process	▪ scope of scaling up (extent of geographic expansion and levels within the health system) ▪ pace of scaling up (gradual or rapid) ▪ number of agencies involved ▪ centralized or decentralized ▪ adaptive or fixed process ▪ participatory or donor/expert-driven.
Costs/resource mobilization	▪ assessing costs ▪ linking scaling up to macro-level funding mechanisms ▪ ensuring adequate budgetary allocation.
Monitoring and evaluation	▪ special indicators to assess the process, outcome and impact of scaling up ▪ service statistics ▪ special studies ▪ local assessments ▪ environmental analysis.

Figure 2 Scale-up framework strategic choices (ExpandNet-WHO, 2010)

Using this framework ExpandNet-WHO, (2010) suggests nine steps as indicated in Figure 3 for developing a scale up strategy and points out that the nine steps should be based on the below four principles;

1. Systems thinking, which implies being aware that the expansion and institutionalisation of innovations occur in a complex network of interactions and influences, which should be considered to ensure scaling-up success.

2. A focus on sustainability: meaning scaling up must be concerned with sustainable policy and programme development including attention to institutionalising the innovation in policies, programme guidelines, budgets, and other dimensions of the health system and to the roll out of innovations to new areas.

3. Enhancing scalability: meaning assessing and enhancing scalability is part of the process of strategic planning.

4. Respect for human rights, equity, and gender perspectives: meaning scaling up should be grounded in the values of human rights and guided by participatory and client-centred approaches, thus ensuring attention to human dignity, the needs, and rights of the vulnerable.

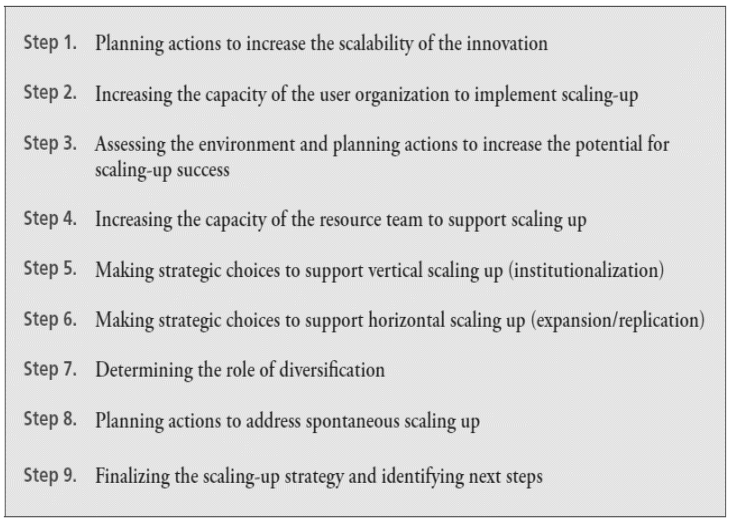

Figure 3 Nine steps for developing scale up strategies (ExpandNet-WHO, 2010)

The conceptual frame work could be a useful tool and baseline to use for scalability and sustainability of mhealth projects for NCDs in developing countries. ExpandNet-WHO, (2010) however emphases that scalability and sustainability of health interventions requires consideration of a broader range of factors and balances on what is required and is feasible. Bagot, et al., (2017) states that when dealing with complex healthcare systems as in mhealth projects, a single blueprint strategy is unlikely to be successful across all areas, therefore a combination of various factors combined with the right timing increases chances of success. Below the various strategies that could enable successful scalability and sustainability of mhealth projects for NCDs in developing countries are highlighted.

2.4.1 Design strategies

Aanestad & Jensen, (2011) defines design of IIs as a process where various interests are translated into technological solutions and organisational arrangements and procedures to make the technology work properly. Berg, (1999) suggests that information systems must be designed step by step, using iterative approaches so that the changes in the technology and

work practices can evolve together and one can foresee all consequences and creatively draw upon encountered problems or unanticipated use in the further development of the system. Aanestad & Jensen, (2011) suggests designing from already existing infrastructures or the installed based. Aanestad & Jensen, (2011) and Berg, (1999) bring to light the challenges of designing information systems and Hanseth & Lyytinen, (2010) describes these challenges as the bootstrap and adaptability problems. To deal with the bootstrap problem Hanseth & Lyytinen, (2010) recommends designing initially for the user, building upon already existing infrastructures, and expanding from the existing infrastructure to gain momentum. To resolve the adaptability problem Hanseth & Lyytinen, (2010) recommends designing the information systems capability as simple as possible and ensuring that the information systems capabilities and their combinations allow independent and incremental growth and changes of the system.

To facilitate coordinated actions from implementation through to scale up, BHBM, (2016) recommends that mhealth projects for NCDs be designed to integrate all related functions with national health information systems for effective management, precise data collection and monitoring. In this regard it is important to consider the choice of the mhealth technology's software and hardware which should be designed carefully, taking consideration of the available resources (Lemaire, 2011). Subsequently, it is important to identify the needs, understand the local settings, available healthcare facilities, mhealth technology infrastructure, language requirements, cultural practices, what motivates the end-user and what contributes to user satisfaction (Lundin & Dumont, 2017). Dealing with these factors at initial stages influences the acceptance of the technology and overall acceptance of the mhealth project (ibid). Sahay & Walsham, (2006) highlights that to deal with the complexities of an implemented information system the end users should have technical competence to use the system effectively. Aranda-Jan, et al., (2014) emphases that it is therefore crucial to involve the end users, and to design a user-friendly technology which leads to easier and successful uptake of the mhealth project. Hirschheim, (1989) terms this approach as 'participative systems design' and defines it as a systems approach where the users take the lead and control of the technology development process, and the substance of development is expanded to include social and organisational concerns. Hirschheim, (1989) recommends this design approach for large and complex systems and reports of end users responding positively to the approach. Christensen, et al., (2014) however cautions that although user participation is important in design of large scale information systems, when and how to organise and

implement the participation process could be challenging and should be carefully considered. Christensen, et al., (2014) suggests that one needs to gain knowledge of the varying nature of participation, and the development process of the information system also needs to be analysed over time to fully understand its functionalities.

Data security is another factor that needs to be considered when designing mhealth projects. Arora, et al., (2014) reports that not only is the sensitivity of the data an issue for privacy and security, but also the huge amounts (big data) that is collected using mobile phones and devices. Luna, et al., (2014) points out that some characteristics of big data such as lack of structure and the informal nature of the data can be a problem if they are sensitive with potential privacy, safety, or legal issues. In this regard ways to overcome the public's uncertainty with respect to privacy and security need to be addressed before mhealth projects are scaled up (ibid). Hanseth & Lyytinen, (2010) emphases that security capabilities should be included in the design of the II particularly as it begins to grow in complexity and scale.

2.4.2 Economic strategies

In considering the financial aspects, Lundin & Dumont, (2017) emphases that successful scalability and sustainability of mhealth projects requires financial planning based on sound sustainable business models, effective partnerships, local processes, and policy-making. Providing free mhealth services could initially quickly increase the population that have access to the services, however in the long term, a financially stable revenue model needs to be established (Sundin, et al., 2016). Mangone, et al., (2016) recommends establishing a financially sustainable business model that indicates all the operational and expenditure costs for the mhealth project. LeFevre, et al., (2017) goes a step further to suggest a process of economic and financial evaluation involving comparative analysis for determining value for money and the costs of implementing the mhealth project, estimation of costs for scalability and sustainability, and assessment of its affordability. Lemaire, (2011) recommends developing a long-term funding plan for the mhealth project and advises investing and utilising local human resources to reduce the costs of operations. The World Bank, (2012) recommends that a sustainable business model for mhealth needs to follow the actual healthcare needs of individuals and the public and should also be aligned with public policy plans. In healthcare information systems Larsen & Ellingsen, (2010) recommends that the users should be encouraged to work closely with the designers to design an II service that the

users will be willing to pay for. Aanestad & Jensen, (2011) suggests that the encouragement of users to use the services initially happens by offering immediate and direct usefulness of the services. The existing user base thus extends and creates user communities that are offered additional incentives to continue to participate and to further innovate the services (ibid). In the process, the information system obtains new adoption levels so that the proposed capability will have enough users willing to cover the extra costs (Hanseth & Lyytinen, 2010). In this regard the implementation of the II is organised in such a way that it does not require long term commitment from stakeholders or financial donors as it self-organises and becomes economically stable (Aanestad & Jensen, 2011).

2.4.3 Integrate mhealth projects with existing health systems

Aranda-Jan, et al., (2014) states that failure of a mhealth project may happen when there is a lack of integration within the healthcare system. Management of NCDs requires continuous patient follow up, therefore, a nationally integrated information system assists to provide effective coordinated care (BHBM, 2016). Aanestad, et al., (2017) suggests that IIs expand through integrating previously fragmented systems, which involves coordinating technical aspects of achieving interoperability, as well as political process and institutional interests. Consequently, several heterogeneous actors with diverse interests are involved in the process which requires ongoing negotiations for their various interests to be achieved (ibid). To be successful, integrating of health information systems needs to be coordination between various involved stakeholders and their associated information systems, and this could create interdependencies between different systems with similar work practices (Larsen & Ellingsen, 2010). Ellingsen, et al., (2013) cautions that as information systems are interlinked and integrated they create unforeseen needs and new types of complexities that affects all areas of the integrated system that could become difficult to solve. In this regard the involved stakeholders will have to negotiate for a best workable approach acceptable for all parties (Ellingsen, et al., 2013; Monteiro, 2000). Lemaire, (2011) suggests that there should be clearly defined objectives for what the mhealth project is trying to achieve with the technology as well as target outcomes that are aligned with local health priorities and serve the goals of the national health system. This could assist to align the various involved stakeholders work practices as the mhealth project is interlinked and integrated with its various areas of operation. According to (Lemaire, 2011) aligning the mhealth project with the government's health strategies ensures that the project has strong justifications to be

integrated in the national health systems and promotes long term sustainability of the project. Aranda-Jan, et al., (2014) further adds that in developing countries, especially in Africa participation of the government, particularly through the Ministry of Health (MoH) is a key aspect for success of mhealth projects.

2.4.4 Build partnerships and collaborations

Sundin, et al., (2016) highlights that most mhealth projects are rarely self- sustaining from the initial stages therefore to ensure scalability and sustainability, the project should be in partnership with other local and international companies, non-profit organisations, and the government. Lemaire, (2011) advocates for strategic mhealth partnership particularly with relevant industry partners such as mobile phone network operators and technology companies, that can provide technical expertise, core competencies, resources, and network to contribute to the scalability and sustainability of the project. Strategic partnering could also reduce costs (Mangone, et al., 2016).

Aranda-Jan, et al., (2014) suggests that building public- private partnerships increases the chances of successful scalability and sustainability of the mhealth project. Figure 4 highlights the considerations for an effective mhealth project as suggested by Aranda-Jan, et al., (2014) as; 1) Select a project design that adapts to the local context, 2) Technology and resources, - use local resources, capacity building, availability, and maintenance, 3) Involvement strong stakeholders by building public-private partnership, multidisciplinary teams, MoH, political leadership, and local champions, 4) Integrate to the health system through government e-health and m-health department to enable program monitoring and evaluation.

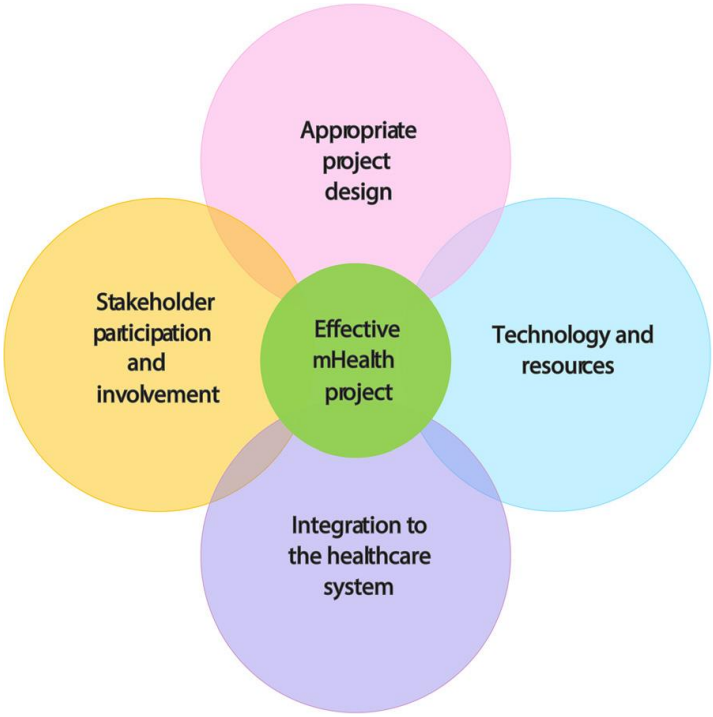

Figure 4 Considerations for an effective mhealth project (Aranda-Jan, et al., 2014)

Lee, et al., (2017) goes a step further to suggests that regional collaboration of mhealth projects could contribute to creating opportunities for exchanging hands-on knowledge and lessons learned among countries with different levels of experience. Lee, et al., (2017) gives an example of several cluster countries in Sub-Saharan Africa that share common languages or common mobile phone network providers, which could be beneficial in regional collaboration and information sharing for scalability and sustainability of the mhealth projects.

The mhealth project's collaborations and partnerships will require groups of people or stakeholders to collectively work together to achieve sustainability and scalability of the project (Sundin, et al., 2016). Ellingsen & Obstfelder, (2007) suggests that members in a group who act together with the intention of achieving similar goals must coordinate their actions such that their intended purpose is actualised known as the theory of collective action. Marshall, (1998) defines the theory of collective action as the action taken by a group (either directly or on its behalf through an organisation) in pursuit of members perceived shared interests. The theory is based on the argument that any group of individuals attempting to provide a public good has troubles to do so efficiently (Wikipedia, 2016). To achieve their

intended goal there must be coordination and cooperation among the groups, however conflicts between individuals and their collective interests may arise which need to be addressed before collective action could be achieved (Ellingsen & Obstfelder, 2007). Vanni, (2014) cautions of 'free riding' in collective action where some stakeholders intentionally or calculatingly do not actively contribute to the group's efforts because they benefit from the other member's activities. The free riding problems depends on the size of the group and becomes stronger with collaborations of large groups (Wikipedia, 2016). In this regard it becomes important to look for strategically aligned and committed partnerships and collaborations to ensure success of the mhealth project (Lemaire, 2013).

2.4.5 Perform Monitoring and Evaluation (M&E)

WHO, (2011a) has reported that although mhealth has the potential to transform the face of healthcare delivery across the globe, very few countries report of evaluating their implemented mhealth projects. BHBM, (2016) defines M&E of an mhealth project as the routine tracking of its performance using data collected on a regular and ongoing basis on specified indicators to assess the extent to which the project is achieving its intended targets on time and on budget. Evaluation of the environment the mhealth project will be operating in prior to implementation is important. Lemaire, (2011) highlights the importance of assessing all factors for scalability and sustainability before implementation of the mhealth project. Lemaire, (2013) suggests that one of the main drivers to scalability of mhealth is the evaluation and collection of data to prove the efficacy and efficiency of the project in achieving its target outcomes and meeting local or national healthcare priorities. It is therefore important to establish a framework and evaluation plan from the beginning of an mhealth project to understand the level of evidence and the outcomes that may be required by decision-makers for scalability and sustainability (WHO, 2016; ExpandNet-WHO, 2010). However, it is recommended that flexibility in the project implementation is maintained, to allow for adaptation to changing needs and priorities of the users to avoid failures (ExpandNet-WHO, 2010). Berg, (1999) suggests that because of the changes in the implementing processes of health information systems, an iterative approach to development of the system is required because it allows for creative, organisational, and technological co-development. Users should be involved throughout the process to give feedback which is in turn used to continuously analyse and design the information system such that design continues during implementation, and evaluation (ibid). In this regard, design,

implementation, and evaluation become co-occurring activities (ibid). Monteiro, (2000) posits that the development, introduction and use of an II is a socio-technical process of negotiations that occurs among actors within a network or an organisation. When various actors come together, they mutually negotiate through a process called translation to determine the agency and importance of individual actors in a developing network (ibid). If actors achieve alignment and function in unison, a stabilised network 'black box' is form (Walsham, 1997). Alignment is a relative measure of the extent to which the agendas and interests of the network pull in the same direction, and serve the same purpose creating a strong, sustainable network (Braa, et al., 2004).

2.4.6 Building local capacity and training

To achieve scalability and sustainability of an mhealth project the various stakeholders involved should have knowledge of how the technology functions therefore training and having the required technology competency is crucial (Luna, et al., 2014). Implementation of large scale IIs involves large numbers of independent actors including designers and users of the information system (Aanestad & Jensen, 2011). During the design process the designer develops a plan for how the information system will function which includes programs of action and defined roles and competencies for the users, which are enrolled or inscribed in the system (Monteiro, 2000). Monteiro, (2000) suggest that for the various actors to perform their roles in the network their inscribed roles and behaviour need to be developed to assist with effective function of the system. It is not possible to know in advance which inscriptions are needed to achieve a desired outcome (ibid). Hanseth & Monteiro, (1996) suggest that only through a sequence of testing the various inscriptions can the strength of the desired inscription be identified and inscribed in to the system to achieve the desired outcome. In the case of mhealth project particularly for developing countries this implies building local capacity and training. Various methods of training and building competencies of the healthcare staff and involved stakeholders to improve use of the mhealth systems could be implemented to test the methods that could lead to scalability and sustainability of the mhealth project. Educational programs and collaborating with trusted training institutions could assist to facilitate training and should be included in the planning phase of scaling up mhealth projects (Luna, et al., 2014). Working with previous local or international organisations that have achieved success with their mhealth projects could also be used to

enable selection of training programs that could be required for desired outcomes (Lemaire, 2011).

This chapter delved in to the theory relating to scalability and sustainability strategies of II as in mhealth projects. The next section discusses the research methodology of the study.

3. Chapter 3 Methodology

3.1 Introduction

In this chapter the methods used for the research are discussed. The chapter is outlined to begin with the research strategy which was formed to align with the intended research questions and objectives to be achieved. The data collection methods, how data was categorised for analysis and data analyses methods are described. The limitations to the study are also highlighted.

3.2 Research design

The research design refers to the overall structure of the research being conducted (Jalil, 2013). The structure of the research design depends on the aims and objectives of the study, and thus enables the researcher to answer the outlined research questions of the study (Wikipedia, 2017b; Jalil, 2013). The research question in this study was, what strategies for scalability and sustainability of mhealth projects for NCDs are used in developing countries. Approaches from implementation of IIs in healthcare are used to discuss the strategies. The research was conducted through a literature review and qualitative analysis of published scientific journals and documents (articles) obtained from research databases.

3.2.1 Research reviews and qualitative research

In general research reviews are intended to summarise and explain the current state of knowledge on existing literature on a topic, and are in three forms; narrative, systematic and meta-analyses (Pearson, et al., 2015; Dochy, 2006). A narrative review was used for the study. Dochy, (2006) explains that a narrative review summarises different primary studies from which conclusions are drawn and holistically interpreted using the reviewers' own experience, existing theories, and models. Page, et al., (2014) describes a systematic review as a summary of evidence from multiple studies to answer a specific research question. The Cochrain Collaboration, (2017) posits that a systematic review uses precise systematic methods to minimise bias in the identification, selection, synthesis, and summary of studies. A systematic review approach was used to identify the relevant articles for collecting the required data. To ensure accuracy during selection of the articles for inclusion, the Preferred Reporting Items

for Systematic Reviews, and Meta-Analyses (PRISMA) diagram flow as shown in Figure 5 below is recommended (Moher, et al., 2009) and was used in this study. The review was conducted using qualitative research methods.

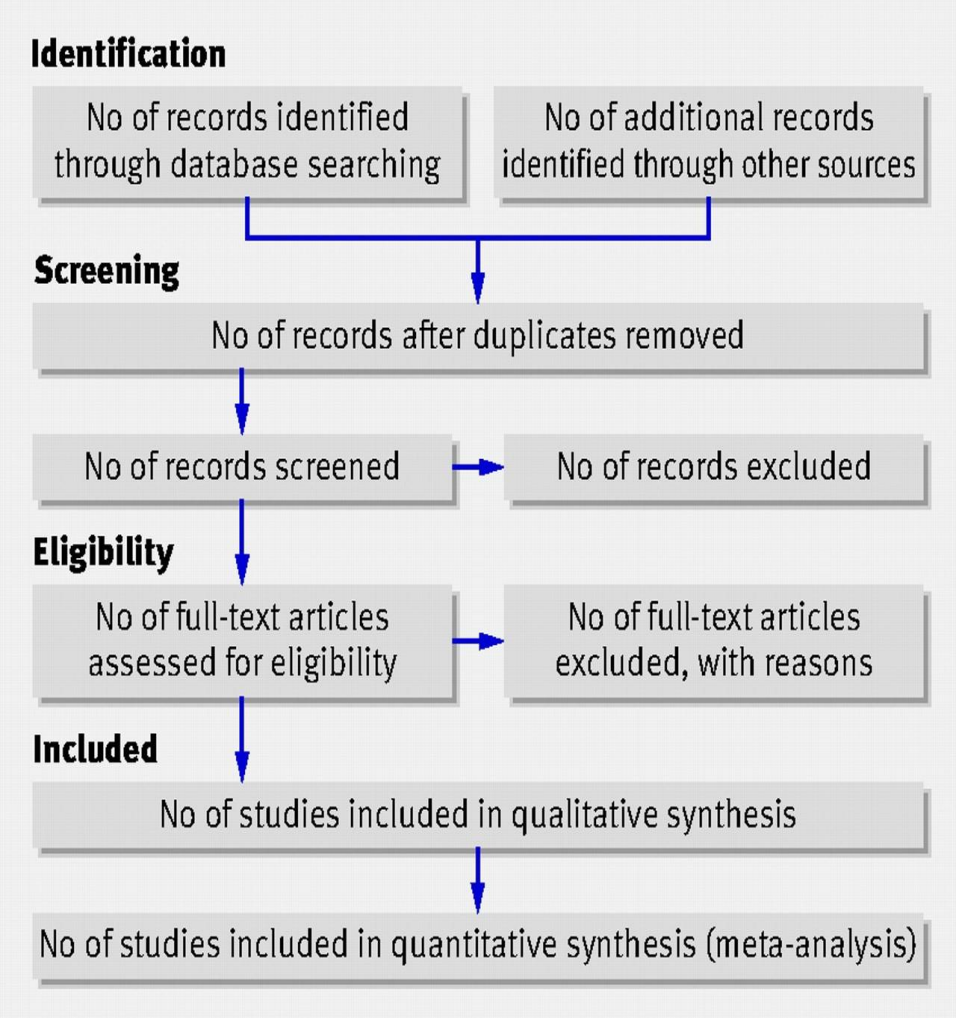

Figure 5 The PRISMA Flow Diagram (Moher, et al., 2009)

Robson, (2002) describes qualitative research methods as flexible designs which are conducted through continuous interactions with what one is investigating and has the data collection and analysis intertwined. Robson, (2002) states that flexible designs evolve, develop, and unfold during the research, therefore the detailed structure of the design emerges as the research progresses. An area of qualitative research that has gained interest is the analysis of documents (Bowen, 2009). Analysis of documents is described as a form of

qualitative research in which documents are interpreted by the researcher to give voice and meaning around a given topic (ibid). These documents could be books, newspapers, magazines, letters, notices or other non -written documents such a film and television and pictures (Robson, 2002). A common method used in document analysis is content analysis (ibid). Krippendorff, (2013) defines content analysis as a research technique for making replicable and valid references from text or other meaningful matter to the context of their use. Content analysis therefore increases the researcher's understanding and gives more insight on a subject and could provide a practical guide to action (ibid). Content analysis is conducted using deductive or inductive approaches (Robson, 2002). Elo & Kyngas, (2008) states that inductive content analysis is used in situations where no previous studies are available on a topic or when studies are fragmented, while the deductive approach is useful where the aim is to test a previous theory in a different situation or when comparing categories at different time periods. Inductive content analysis was used in the study. Thomas, (2006 p. 238) highlights three purposes of using the inductive approach as;

1. To condense the raw textual data into a brief, summary format.
2. To establish clear links between the research objectives and the summarised findings obtained from the raw data.
3. To develop a model or theory from the information that becomes evident in the raw data.

Qualitative methods using inductive content analysis were used and considered appropriate for this study to gain insight on the strategies for scalability and sustainability of mhealth projects for NCDs implemented in developing countries.

3.2.2 Data collection

The data was collected using the format of the PRISMA flow diagram as indicated in Figure 5. A literature search was conducted between October and December 2017 in pubmed (Medline) and google databases. Peer reviewed articles published from 2007 to 2017 were considered for review. The keywords, the title and abstracts were used for preliminary filter with the selection criteria to identify the relevant articles. The search strategy involved a basic search for literature related to the following terms, 'mobile health', 'developing countries' including their various used terms such as mhealth or third world nations, 'scalability and or

sustainability strategies' 'non-communicable diseases NCDs' (in certain instances specific health conditions were indicated). Duplicated literature was removed, and the obtained search string was then combined with 'AND' and 'OR' for better searching strategy. After finding a relevant article, a manual search for similar articles was conducted in the data base to ensure inclusion of any other relevant articles that could have been missed in the basic search. The collected articles were then further reviewed and those that did not meet the research inclusion compliance were removed. The final obtained articles were then reviewed in detail on the strategies for scalability and sustainability of mhealth projects for NCDs. The identified strategies were noted, summarised, and tabulated as indicated in Appendix 1 attached at the end of this document.

3.2.3 Inclusion and exclusion criteria

To be included for review and analysis the articles had to be related to mhealth or telemedicine and telehealth projects that used mobile phones or devices for management of NCDs, used certain strategies to scale up and sustain the project, and were conducted or related to developing countries. The reviewed articles were therefore expected to analyse proposed or implemented scalability and sustainability strategies used for mhealth projects for NCDs. Only articles conducted in English were included. All other articles outside the above scope were excluded.

3.2.4 Data categorisation and analysis

The inductive content analysis method was used for categorising and analysing the data. Cho & Lee, (2014) states that inductive content analysis categorisation consists of defining the research question, determination of categories and levels of abstraction, development of inductive categories from the material, revision of categories, working through text, and finally interpretation of results. The term category in this instance defines units or members of a class with common references (Krippendorff, 2013) and the categories emerge from the data being analysed (Pearson, et al., 2015). The content in terms of the full text, phrases and words were extracted from the abstracts, discussions, and conclusions of the reviewed articles. The inductive content analysis process involves deciding which data will be analysed by focusing on a selected aspect of the document, creating categories, and establishing themes within the

categories (Cho & Lee, 2014). Robson, (2002) highlights that sorting out or categorising the data is crucial in inductive content analysis approach as the categories must be 'exhaustive and mutually' exclusive. The categories must clearly define what indicators one is looking for when making any of the categories (ibid). Furthermore, one must ensure that no data falls between two categories or be placed in more than one category (Cho & Lee, 2014). The data was categories as described in content analysis method. The steps involved were as below;

1. Gathering relevant information from the reviewed articles.
2. Identifying meaningful units that were extracted from the article's texts and condensed with a code.
3. Grouping the coded units in to categories.
4. Finally identifying and outlining the main themes that emerged from analysis of the categories to show the strategies for scalability and sustainability.

The categories were revised, removed, or added in certain instances during the process. The main categories that emerged from the analysis are outlines in the results section.

3.3 Ethical considerations

Ethical approval was obtained for the Arctic University of Norway (UIT) in Tromsø before commencement of the research. The research did not involve any patients or patient's data therefore informed consent was not required. The data was collected from already published scientific articles obtained from the university library data bases.

3.4 Limitation of study

The limitation of the study was that very little documentation was found or have been reported on mhealth projects for NCDs in developing countries even more so on the strategies for scalability and sustainability of the projects. Although similar strategies for scalability and sustainability of mhealth projects for communicable diseases could also apply in this case, there is limited reported information on which strategies have worked to scale up and sustain mhealth projects in this area as well. The research was also vulnerable to selection bias as one person conducted the search and categorisation of the data. However, use of the PRISMA

flow diagram to identify the articles for inclusion could have minimised the selection bias, although this was not completely possible in the case of categorising the data.

The next section discusses the results of the study.

4. Chapter 4 Results

4.1 Introduction

This chapter presents the results of the study. The section is outlined to begin with the results obtained in identifying the relevant scientific articles to include in the study using the PRISMA flow diagram. The results from the qualitative data to show the main themes that emerged from the analysis are also defined and outlined, including their categories and sub categories.

4.2 Relevant articles identification results

The search for the relevant articles was conducted using the keywords, the title and abstract. A total number of 2321 articles were retrieved in the initial search and after removal of duplicates a total number of 2274 articles were obtained. Based on the set inclusion and exclusion criteria, further screening of the articles was conducted on which 1890 articles were excluded leaving a total of 348. A full text assessment was then conducted which obtained a final number of 48 articles that were included in the study. Figure 6 below is a PRISMA flow diagram indicating the search and selection process. The 48 articles were included for qualitative analysis. Quantitative analysis and meta- analysis was not required and was not conducted.

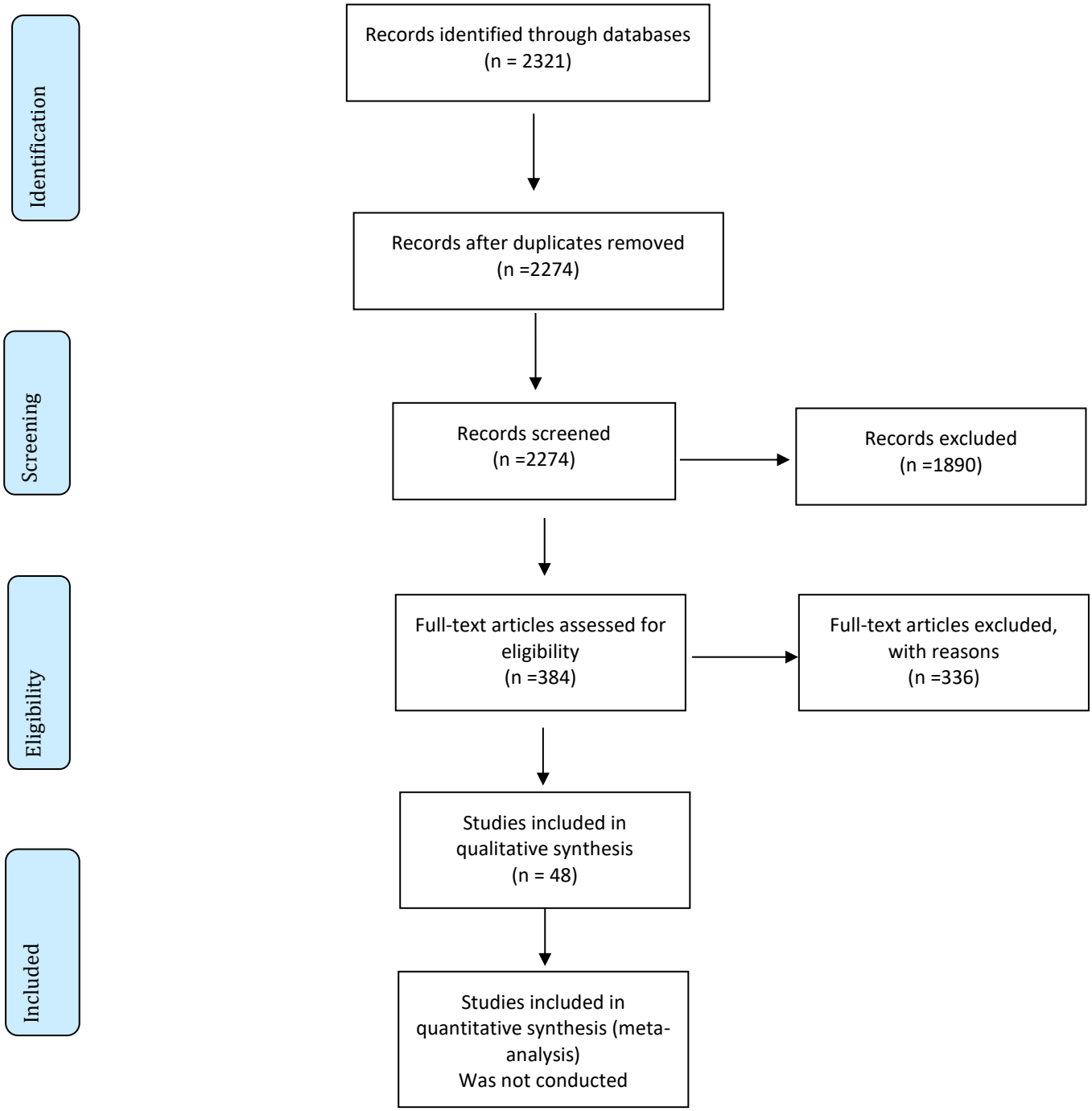

Figure 6 Results - PRISMA flow diagram

4.3 Qualitative analysis results

Five main themes emerged from the categorised and subcategorised content obtained from the 48 reviewed articles; Design strategies, Collaboration strategies, Economic strategies, Monitoring strategies, and Building Local Capacity strategies.

4.3.1 Design strategies results

This defined the strategies for designing the mhealth project or technology for scalability and sustainability. Design selection of mhealth technology and services depends on the socio-demographic characteristics of the population, culture, and local healthcare system and is vital to consider for scalability and sustainability of mhealth projects (Beratarrechea, et al., 2016). In this theme four categories of the strategies emerged; use practical designs, design to match local context, build on existing programs and design programs with data security as indicated in Table 1.

A) Use practical designs

Four subcategories emerged in this category; design for user, design basic, design for reproducibility, and cost-effective design. The results showed recommendations of use of simple and basic SMS or smartphone and devices including cost effective and easily reproducible designs. Kamis, et al., (2015) recommends basic SMS use and highlights that although smartphones use is predicted to become more common in the future, mhealth projects for NCDs that utilise smartphones could continue to have limited reach in certain population groups in developing countries. Mohan, et al., (2014) recommends that the design should be reproducible and easily scalable in low income settings. Cost effective designs such as use of low cost web-based IIs and those that use open design software for easy reusability and integration are also recommended (Gibson, et al., 2017; Blitchtein-Winicki, et al., 2017). Ali, et al., (2017) emphases that the selected design of delivery of the mhealth services should match the target group. Using an example of an elderly population group with lack of knowledge of mobile phone functions and computers, Ali, et al., (2017) highlights that using complex mhealth functions on this group may not be beneficial. Chang, et al., (2017) uses the case of self-management of NCDs, and states that self-efficacy is the patient's confidence in his or her ability to perform a variety of self-management behaviours. However, if the mhealth service is not well designed to match the target population’s technology capabilities it may create extra difficulty in learning technology-related tasks and cause additional limitations to its use, reduces acceptability of the technology, and could negatively influence uptake of the project (ibid).

Theme 1. Design strategies	
Categories	Subcategories
A) Use practical designs	1. **Design for user:** Design for the user and easy adaption for the user. 2. **Design basic:** Use basic SMSs or basic smartphones or devices. 3. **Design for reproducibility**: Design to be easily reproducible and work across multiple platforms and be replicable in other low-income settings. 4. **Cost effective design:** Use low cost web-based information structures (social networks, websites). Using open design software is easy reusability, easily integrated and reduces costs.
B) Design to match local context	1. **Cultural relevant:** Select appropriate mhealth project design to meet local needs, use appropriate software to meet local needs. 2. **User participation:** Include participants in design process. Avoid pushing unassessed or unevaluated solutions on a community or participants, use a multidisciplinary approach, involve researchers, software engineers, specialist, policy makers and others healthcare professionals to create appropriate and tangible designs. 3. **Message content**: Messages should be simple and clear and match local needs and participants (use SMS, voice, or pictorial messaging depended on participants technology capabilities). Ensure message content added for delivery is relevant to intended users or community. 4. **Message reach:** Ensure messages reach intended target group.
C) Build on existing programs	1. **Build on existing systems:** Consider the current national existing infrastructure and integrate with existing national and local mhealth projects, helpful if the technology is installed in a structure healthcare model or system. 2. **Design for integration**: Design systems that allow sharing. Advocate for integrated national health systems, design to integrate patient's health records in the system, link/ integrate the health records to allow targeted and personalised message delivery.
D) Design programs with data security	1. **Security and data back up**: Ensure data security for confidentiality to reduce stigmatisation. Data storage systems to be in place.

Table 1 Results design strategies

B) Design to match local context

Four subcategories emerged from this category; cultural relevant, user participation, consideration for message content and message reach. According to Jain, et al., (2015) the first step in designing an mhealth service for NCDs ought to be a survey of the mobile phone usage patterns, felt needs and barriers to accessing mobile phones. Analysing of the community's use of mobile phones ensures that the mhealth messages sent, reach the intended target groups (Olmen, et al., 2017). Diez-Canseco, et al., (2015) highlights that tailoring of healthcare messages must be sensitive to the cultural beliefs, values, language, literacy, and customs of the target population. In this regard an engagement phase with the end users should be incorporated in the design process (ibid). Brian & Ben-Zeev, (2014) points out that from the beginning and throughout the development process, project implementers should engage members of the target population via focus groups or individual interviews. Usability and field testing of mhealth systems can also improve understanding of how individuals interact with the system and can help identify barriers to scalability and sustainability (ibid). Raghu, et al., (2015) recommends the use of design thinking which includes participation of local communities and end-users to ensure the success of mhealth projects for NCDs. Raghu, et al., (2015) suggests that involving the users and the community enables identifying tools that are useful and are easily integrated within the workflow of the healthcare system. Aggarwal, (2012) agrees with Raghu, et al., (2015) and adds that people with NCDs should be enlisted throughout the design process as current producers and prospective consumers of content to improve the success of an mhealth intervention. Raghu, et al., (2015) highlights that design thinking approaches that involves the community differs from global mhealth projects which push or force solutions onto the community.

C) Integrate with existing programs

In this category, two subcategories emerged, build on existing systems and design for integration. Nichols, et al., (2017) suggests that for mhealth projects for NCDs to be cost effective they need to be built upon existing infrastructure. Holeman, et al., (2014) also states that building from existing IIs is preferable than developing of technologies and service delivery approaches from scratch. Furthermore, this enables use of mhealth technologies and tools that have succeeded as starting points rather than reinventing the whole system (ibid). Nichols, et al., (2017) advocates for human centred design approaches that fit unique aspects of the healthcare system and are aligned to delivery for local context. Smith, et al., (2015)

points out that the success of potential mhealth use lies in its ability to complement, rather than replace existing methods of healthcare delivery. Smith, et al., (2015) suggests that complementary methods help to facilitate the acceptability of mhealth services in a setting where mobile phone technology is relatively new. Feinberg, et al., (2017) adds that complementing the existing healthcare system with mhealth services retains the group of patients who are less familiar with mobile phone technology and would rather maintain face-to-face contact with their healthcare professionals. Raghu, et al., (2015) suggests that integrating mhealth within existing healthcare systems also reduces risk of unnecessary duplication in the process and adds to efficiency and effectiveness. Olmen, et al., (2017) recommends linking mhealth systems for NCDs with an electronic medical record system to enhance the potential of targeting and personalising messages. Peiris, et al., (2014) recommends greater engagement with policy makers in the design and implementation of mhealth services to enable effective integration with existing national and local healthcare systems.

D) Design programs with data security

In this category one subcategory emerged, security and data backup. Aggarwal, (2012) points out that measures need to be put in place to ensure that patients or users feel assured of the security of the data collected and used through mhealth services. Chandra, et al., (2014) also points out that particularly when dealing with vulnerable groups in a society, discussing and ensuring confidentiality is important before scalability of the mhealth project. Matimba, et al., (2016) suggests that specific technology and data policies that address security and confidentiality should be developed when dealing with transfers and sharing of health information and integrating healthcare IIs with existing systems. Health data management should therefore ensure quality, security and backup of data sent over mhealth networks (ibid).

4.3.2 Collaboration strategies results

This defined the strategies related to working with or among other parties internally or externally for scalability and sustainability of mhealth project for NCDs. In this theme two categories of the strategies emerged; collaboration with all stakeholders and develop strong leadership and government support as indicated in Table 2.

Theme 2. Collaboration strategies	
Categories	Subcategories
A) Collaboration with all stakeholders	1 **Stakeholder collaborations:** Collaborate with the country's government ministries (MoH, ministry of commerce and ministry of telecommunications). Collaborate with technology operators for technical support and to reduce costs. Collaborate with local community and end users. 2 **Build trust:** Build and ensure trust with all the engaged stakeholders. Engage the target group/patients understand their language. Ensure active engagement and commitment for all stakeholders.
B) Develop strong leadership and government support	1. **Ensure strong leadership and governance:** Promote target country governments to financially invest in the project. Align project with the country's national health strategic goals. Seek government support and advocate for government active involvement. In international collaborations partner with the leadership in the target country.

Table 2 Results collaboration strategies

A) Collaboration with all stakeholders

In this category, two subcategories emerged; stakeholder collaborations and building trust. Beratarrechea, et al., (2016) states that the success of mhealth projects for NCDs in developing countries is increased by active engagement of a broad range of implementers and key stakeholders including local community organisations, and technology operators to ensure technical support, scale-up and to reduce costs. Chandra, et al., (2014) emphases that the approval and participation of local community organisations where the projects is being conducted can increase ownership and provide valuable leads for suggestions on how to minimise adverse consequences during implementation. Developing an excellent partnership with the members of the community and local organisations ensures continued support and contributes enormously to the success of the project (Mohan, et al., 2012). Ali, et al., (2017) highlights that efforts to capture a cross-section of local stakeholder's perceptions regarding identifying challenges, and any additional means to address them in practice would be of additional value. Furthermore, ensuring a continuous engagement process inclusive of

collaborative planning, implementation, and capacity strengthening also assists with successful scalability and sustainability of the project (ibid). Piette, et al., (2014) suggests that for mhealth projects to be sustainable in developing countries, it is important to engage local cell phone providers and build technical capacity through local government agencies charged with addressing NCDs management. Consequently, long-lasting commitment and building trust from a variety of stakeholders is needed to achieve scalability and sustainability of the mhealth projects (Tran, et al., 2011).

B) Develop strong leadership and government support

In this category one subcategory emerged; ensure strong leadership and governance. Rubinstein, et al., (2015) and Beratarrechea, et al., (2016) emphases that strong leadership and governance contributes to success of mhealth projects for NCDs in developing countries. Tapia-Conyer, et al., (2016) states that when paired with strong support from key authorities, mhealth projects are likely to be scaled up quickly and completely especially if closely aligned with the country's national health strategies and goals. Involvement of government leadership therefore facilitates easier uptake and dissemination of the mhealth project countrywide (Maulik, et al., 2017). Tapia-Conyer, et al., (2016) suggests that aligning with international best practices and clinical practice guidelines could be a key factor in receiving government and political support. Maulik, et al., (2017) highlights that greater involvement of the government's health sector at all levels and systems should be in place to enable scalability of mhealth project. In this regard engaging the MoH of the country from inception of the project on different aspects of the design and delivery of the mhealth services is vital (Aggarwal, 2012).

4.3.3 Economic strategies results

This defined the strategies related to financing to enable scalability and sustainability of mhealth projects for NCDs. In this theme two categories of the strategies emerged; establishing business models and business agreements as indicated in Table 3. Ruzek & Yeager, (2017) points out that to be successful, mhealth projects in developing countries need financial investments for development, evaluation, and delivery of high quality, cost-effective, and scalable services. Such investments will need to address costs of IIs for the

affected populations, and the development of adequately resourced organisations tasked with the development and maintenance of the technological infrastructures needed (ibid).

Theme 3. Economic strategies	
Categories	Subcategories
A) Business models	1. **Develop strong business models:** Analyse business models for local sustainability before implementation. Business model should match project needs. Business models should be self-sustainable. 2. **Payment plans**: Introduce payment plan for services rendered. Payment plans should be reliable and regular. Develop affordable healthcare insurance cover systems. Engage with insurance providers for negotiating affordable medical covers. 3. **Global markets:** Gain knowledge of global telecommunications markets and advancements. Address all financial cost from implementation.
B) Business agreements	1. **Develop partnerships:** Build partnerships with private sector, non-governmental organisations, and other relevant bodies. Build partnerships with technology companies. Build international partnerships, and commitment on sustainability goals. Agree on sustainability and capacity development commitment in advance. Build committed and sustainable business partnerships. 2. **Agree on business agenda:** Agree on financial issues and business agendas. In collaborations align partners with the projects business agenda. Agree or advocate for the country's government financial investment in the project. Government could encourage telecommunications companies to offer free health programs as means of corporate responsibility. Human resources financial support should be agreed upon and provided.

Table 3 Results economic strategies

A) Business models

Three subcategories emerged from this category, develop strong business models, payment plans and know global markets. Peiris, et al., (2014) and Gupta, et al., (2017) points out that viable business models are crucial for continuous delivery of promising mhealth projects. However, no single business model will work similarly for every mhealth project because

each project is different, offers different services, and operates in different environments with varied financial allocations (Gupta, et al., 2017). Gupta, et al., (2017) and Islam, et al., (2015) suggests that to develop self-sustained business models, payments should be introduced for basic mhealth services. Developing affordable healthcare insurance systems could also assist to cover mhealth service payments and adds to sustainability of a business model (Lu, et al., 2013). Jain, et al., (2015) cautions that where payments are introduced to financially sustain the mhealth project, irregular payments particularly seen in the lower socio-economic population could hinder delivery of mhealth services. Olmen, et al., (2017) suggests that it is important to be aware of the global telecommunication markets and advancements. In this way a business model that is viable and flexible enough to adapt to the local and rapidly changing environment can be effectively negotiated (ibid).

B) Business agreements

Two subcategories emerged from this category, develop partnerships, and agree on business agenda. Piette, et al., (2014) highlights that through international partnerships, collaborations that could assist with financing of a project can develop. It is therefore important to build international partnerships with organisations that will commit to goals that will lead to scalability and sustainability of the project (ibid). Aggarwal, (2012) adds that at the government level cooperation and partnerships between the MoH and telecommunications companies could advance development. Aggarwal, (2012) gives an example of that, through partnerships the government could sensitise telecommunications companies to freely offer mhealth services as a means of corporate responsibility. Peiris, et al., (2014) states that it is crucial for private - public partnerships to have aligned business agendas, and this should be done by ensuring to agree and resolve financial issues before implementation of the mhealth services.

4.3.4 Monitoring strategies results

This defines strategies related to monitoring progress of mhealth projects for NCDs and adjusting for scalability and sustainability. In this theme three categories of the strategies emerged; general assessment, evaluate local conditions and project adaptation, and community preparedness as indicated in Table 4.

Theme 4 monitoring strategies	
Categories	Subcategories
A) General assessment	1. **Operational issues:** Analyse general operations. Ensure collaborations management in private- public partnerships. Employ and engage the right people to support concept of project. 2. **Measurable metrics for assessment:** Establish definable metrics for assessment to show feasibility, cost effectives acceptability, appropriateness, and uptake of the project, evaluate previously used mhealth projects (failed and successful). 3. **Evaluate policy:** Evaluate policy level to barriers to scale up the project. Analyse consumer rights, data governance, inter-operability and standards and regulatory approvals.
B) Evaluating local conditions and project adaptation	1. **Understand local environment:** Evaluate cultural beliefs and attitudes of the community. Align implementation approaches with local expectations, habits, norms, and practices associated with mobile phone usage in the community (behaviour science). Evaluate gender sensitivity or inequity and provide support services as required. Analyse the local burden of the disease, identify the public health significance of the NCD and be flexible to respond to changes in local conditions. 2. **Explore service pathways:** Research pathways users follow to obtain health services. Explore the user's perspective before scaling. Evaluate self- management capabilities of the community or target group (patient empowerment). 3. **Effective communication:** Ensure down-up and horizontal communication flow during project evaluation. Ensure effective communication between health clinics and patients to sustain remote monitoring and support of patients with NCDs.
C) Community preparedness	1. **Awareness:** Create strong social marketing strategies. Conduct awareness programs. Awareness programs should be culturally relevant and of local context. Address the social and culture myths concerning the NCD (Anti - stigma awareness campaigns). Increasing knowledge of self- monitoring and coordinated care. 2. **Implementation:** Align with global practices. Field test the project before scaling up. Implementation should be systematic with clear goals, leadership, and accountability.

Table 4 Results monitoring strategies

A) General assessment

Three subcategories emerged from this category, operational issues, measurable metrics for assessment and evaluate policy. Majumdar, et al., (2015) states that it is important to analyse issues that will affect the general operations of the mhealth projects such as infrastructure, literacy levels and language and how to manage partnerships where it applies. An effective M&E process should therefore be in place to analyse the scalability and sustainability of mhealth projects (Beratarrechea, et al., 2016). Aggarwal, (2012) suggests establishing definable metrics for feasibility, acceptability, appropriateness, uptake, and cost-effectiveness before implementation. This ensures commitment to the project and promotes easier scalability and sustainability of the mhealth project (ibid). Peiris, et al., (2014) adds that it is important to evaluate the previous successful and failed mhealth projects to determine opportunities and constraints for scalability and sustainability. In this regard, ensure to examine policy-level barriers to scalability and sustainability (ibid). This includes analysing the country's data governance, consumer rights, interoperability, standards, and regulatory approvals (ibid).

B) Evaluate local conditions and project adaptation

Three subcategories emerged from this category; understand local conditions, explore service pathways, and effective communication. Before considering scalability and sustainability of mhealth projects for NCDs, adaptability of the project to the environment needs to be considered (Ginsburg, et al., 2014). Nahar, et al., (2017) emphases the importance of understanding the local conditions and language where the mhealth services are planned to be used. Tran, et al., (2011) points out the value of evaluating the community's cultural beliefs and attitudes as well as evaluating availability of cellular telephone coverage, and local disease burden. Brian & Ben-Zeev, (2014) emphases that both language and cultural relevancy are essential to the success of adapting of an mhealth project. It is also important to understanding the local norms and practices associated with the use of mobile phones and to align the implementation strategies as best as possible with local expectations (Ali, et al., 2017). This will also entail understanding the habits or behaviours of mobile phone use in the community and identifying core areas of local need and strength (Olmen, et al., 2017). Insights on how people use mobile phones is essential to design and deliver mhealth services suitable to the environment (ibid). In this regard it is important to explore the consumers (users) perspectives before implementation, explore service pathways (Lu, et al., 2013; Nahar,

et al., 2017), and ensure to be flexible to changes to the local conditions (Beratarrechea, et al., 2017). Nahar, et al., (2017) highlights that research on the pathways that users follow to obtain mhealth services assists in designing the kind of mhealth applications that might work. Where there are gender disadvantages, it is vital to ensure to provide support services when help or further information is sought (Chandra, et al., 2014). When it applies to self-management of NCDs, in most rural areas patient empowerment abilities are usually lacking because of assertion of medical authority and wider cultural inequalities (Nahar, et al., 2017). In such settings strategies of overcoming the barriers will have to be analysed before considering scalability and sustainability (ibid). Where applicable communication between healthcare workers (health clinics) and patients (or users) should be effective to sustain remote monitoring and support of patients with NCDs (ibid). Effective communication among various involved stakeholders throughout the implementation process is also vital. Tapia-Conyer, et al., (2016) suggests that through effective communication, mhealth programs can increase the chances of having a successful implementation process and trust can develop among those ultimately responsible for implementation of the project. A lack of clear information flow, accompanied by ineffective communication strategies, hinders the creation of a homogeneous shared vision for the project (ibid). In this regard open communication strategies both bottom-up and top-down is recommended to ensure success of mhealth projects for NCDs (ibid).

C) Community preparedness

Two subcategories emerged from this category; awareness and implementation. The importance of awareness lies in addressing socio-cultural barriers and myths concerning the targeted NCD (Ginsburg, et al., 2014). Maulik, et al., (2016) showed an awareness campaign to be useful prior to the launch of an mhealth project, not only to prepare the population about the procedures and knowledge on the NCD, but also to reduce stigma towards the disease. Maulik, et al., (2016) reports that the awareness campaign also provided important data that influenced the content of the mhealth project. Mohan, et al., (2014) highlights the importance of awareness of mhealth services to be designed for local content. Maulik, et al., (2016) suggests that through the awareness campaign, appropriate language to use for the mhealth project can be modified, therefore, placing greater emphasis on the issues highlighted by the community. Regarding the implementation process Tapia-Conyer, et al., (2015) emphases that this should be done systematically, with clear definitions of leaders that can be

accountable, and with clear goals. Gupta, et al., (2017) points out the importance of employing and engaging the right people to support the concept and daily operations of the mhealth project for it to be effective and efficient.

4.3.5 Building Local Capacity results

These defines strategies related to building local capacity such as training local staff and use of available local resources and facilities. In this theme one category of the strategies emerged; building resources and skills as indicated in Table 5.

Theme 5 Building local capacity	
Categories	Subcategories
A) Building resources and skills	1. **Consider available technology:** Use available local resources and infrastructure to maximum capacity. Establish appropriate health systems and infrastructures before scaling such as mobile communications connectivity. 2. **Training:** Train local health professionals. Introduce and integrate task shifting in care process. Use standardised protocols to facility task shifting, making the protocols easier to administer (where applicable integration with electronic decision support systems could assist). Ensure availability of technical support during training.

Table 5 Results building local capacity strategies

A) Building resources and skills

Two subcategories emerged from this category; consider available technology and training. Brian & Ben-Zeev, (2014) emphases that prior to implementation of mhealth projects, resources are needed to support mhealth infrastructure including human resources, technology development and training. Ali, et al., (2017) advocates for using to maximum capacity available infrastructures and local resources, thus enabling local sustainability of mhealth projects in developing countries. Most developing countries lack the essential infrastructures for mhealth services therefore it is necessary to first establish the appropriate healthcare infrastructures before considering scalability, and later sustainability (Maulik, et al., 2017; Tran, et al., 2011).

One of the major challenges of scalability and sustainability of mhealth projects in developing countries include shortages of technology experts with the necessary in-depth knowledge and skills (Majumdar, et al., 2015). Additionally, in rural areas finding qualified healthcare staff could be a challenge (Mohan, et al., 2012). Training of staff should therefore be an important aspect for successful scalability and sustainability of mhealth projects for NCDs (ibid). A potential approach to address lack of qualified healthcare staff especially in rural settings is to locally train unqualified healthcare workers, therefore, shifting some of the burden of providing healthcare services from trained health professionals, termed 'task shifting' (Surka, et al., 2014). Integrating task shifting within mhealth services and existing healthcare systems could be effective to build the lacking skills. However, standardised protocols should be considered for facilitating task shifting as this could make the protocols easier to administer (Maulik, et al., 2017).

The next chapter is a discussion on the topic merging the results and the theory.

5. Chapter 5 Discussion

5.1 Introduction

The high incidence of NCDs is a huge burden on the already fragmented healthcare systems in developing countries (Asiimwe-Kateera, et al., 2015). However, in recent years there has been a growth in the use of mobile phones in developing countries, thus providing a platform to use mhealth services particularly for NCDs (Bloomfield, et al., 2014). Although mhealth has shown to be beneficial in managing NCDs, most mhealth projects have been reported to fail to scale up and become sustainable (Tomlinson, et al., 2013). Factors such as lack of adequate technology and infrastructure, economic issues, and social and cultural norms have been reported to contribute to the challenges of scalability and sustainability of mhealth projects in developing countries (IBRD, 2017; Sundin, et al., 2016; O'Connor & O'Donoghue, 2015). Knowledge of effective strategies that overcome these challenges and could be used for continuous management of the diseases is therefore vital. This research reviewed and addressed the question of what strategies are used for scalability and sustainability of mhealth projects for NCDs in developing countries. The objectives were to identify, group and analyse these strategies, and to discuss the strategies drawing on approaches of implementing IIs in healthcare services. In this chapter the results of the study are discussed and correlated to the researched theory. The discussion will be categorised in to the five main themes that emerged from the results which are; Design strategies, Collaboration strategies, Economic strategies, Monitoring strategies, and Building Local Capacity strategies.

5.2 Design strategies discussion

The study results showed four categories that emerged from this theme as, use of practical designs, design to match local context, integrate with existing programs and design programs with data security. Most developing countries lack well established healthcare IIs, therefore making the use of practical mhealth designs which are dependent on the available resources applicable (Sundin, et al., 2016; Lemaire, 2013). Sundin, et al., (2016) points out that most mobile phone technologies widely used in developing countries consist of basic cell phones with limited functions mostly SMS. Designing mhealth projects or services that incorporate

use of basic cell phones increases user access and reach, and contributes to successful scalability and sustainability of the mhealth projects (Kamis, et al., 2015). It is also important to ensure to design to what motivates the end user and what leads to easier adaptability of the technology (Sahay & Walsham, 2006). In this regard assessing the technology capabilities to match the local context is vital (Lundin & Dumont, 2017). To ensure adaptability of an information system Hanseth & Lyytinen, (2010) recommends designing the system's capabilities as simple as possible and ensuring that the capabilities allow for incremental growth and changes of the system. To make certain that the design matches with local context, user participation is vital (Raghu, et al., 2015; Chandra, et al., 2014). Hirschheim, (1989) recommends participation design approach for large and complex systems as this allows the user to the take lead and control of the technology's development. Therefore as the technology expands the users are able to identify areas that may need to be addressed before it becomes fully sustainable (ibid). This aligns with Berg, (1999) who recommends step by step and iterative design approaches for information systems to ensures that the changes in the technology and work practices can develop together and the solutions to current and future problems within the system can be easily identified. Design approaches that involve user participation allow for identification of the local needs, take in to account the local settings, culture, and available resources (Lundin & Dumont, 2017). This could further increase technical capabilities of the users and increase acceptance of the technology (Sahay & Walsham, 2006). Christensen, et al., (2014) however points out that user participation varies at different points of the development process of an information system and should be analysed over time on how and when it would be appropriate to be conducted.

The results of the study also recommended designing or building mhealth projects from already exsting infrastructures thus allowing for easy reproducibility and cost effectiveness (Nichols, et al., 2017; Raghu, et al., 2015). Aanestad & Jensen, (2011) recommends building large scale IIs from the installed base as it reduces costs and allows for easy integration of systems. In developing countries where there is lack of, or fragmented information systems, building on already existing IIs could also enable use of available resources which is a huge advantage when considering scalability and sustainability of mhealth projects (Asiimwe-Kateera, et al., 2015; Aanestad & Jensen, 2011). Building on already existing IIs could also provide for easier integration of the healthcare systems, and particularly for NCDs this further allows for effective management of the diseases, easier data collection and monitoring (BHBM, 2016). Aanestad, et al., (2017) however cautions that as an II is growing, its fitted

parts are also transforming thus creating a paradox where new developments to the system need to fit with the installed base and simultaneously transform. Consequently, the design strategies will need to consider future evolvement of the II to be effective (ibid).

Designing mhealth programs with data security is also essential for mhealth project for NCDs especially for diseases that are attached with stigmatisation (Chandra, et al., 2014; Aggarwal, 2012). Applications in mhealth involve information transfers and sharing of data between users and healthcare professionals as well as among healthcare professionals in integrated health systems (Arora, et al., 2014; Luna, et al., 2014). In this regard it is vital to design systems with security and confidentiality measures in place particularly when dealing with stigmatisation of the NCD in vulnerable groups (Matimba, et al., 2016; Chandra, et al., 2014; Aggarwal, 2012). Mhealth services for NCDs usually involves collection of big data which needs to be secured to ensure data safety and confidentiallity as the mhealth project scales up (Luna, et al., 2014). Security capabilities of the information systems should therefore be a priority in the design process particularly as it becomes scalability and eventually sustainability (Hanseth & Lyytinen, 2010).

5.3 Collaboration strategies discussion

The results of the study showed two categories that emerged from this theme; collaboration with all stakeholders and develop strong leadership and support. To increase the success of scalability and sustainability of mhealth projects, collaboration with a broad range of key stakeholders, including community organisations, and technology operators locally and internationally is essential (Beratarrechea, et al., 2016; Sundin, et al., 2016). Therefore all the various stakeholders have to work with the mhealth technology and with each other for the project to succeed. Monteiro, (2000) uses ANT and suggests that in such a scenario each actor (both humans and technology) is affected by the behaviour of the other and affects the development of the information system. During the process of scaling up mhealth projects or information systems, all the various involved stakeholders or actors should negotiate and work in a coordinated effort for the system to succeed and achieve the required goals (Ali, et al., 2017; Ellingsen & Obstfelder, 2007). The achieved goals are therefore a result of negotiation of the actors' interests to agree on a unified goal (Walsham, 1997). Walsham, (1997) however cautions that due to different actor's negotiation of interests and actions that are conducted during building and expanding the network, different outcomes of the same

implemented information system can be obtained in similar settings. To therefore achieve unified or desired goals, strategic partnering is recommended (Mangone, et al., 2016; Sundin, et al., 2016). For strategic partnerships to work, the various partners must work together through coordination of their actions, in a collective manner such that the intended purpose is actualised (Ellingsen & Obstfelder, 2007). Collective action can only be achieved when all stakeholders view the scalability and sustainability of the mhealth project as a collective action rather than looking at individual interests. To avoid the problem of stakeholders concentrating on individual interest (free riding) during partnerships, trust has to be built among the stakeholders (Ellingsen & Obstfelder, 2007;Vanni, 2014). A key strategy in partnerships is to align the mhealth project with the country's existing healthcare strategies (Lundin & Dumont, 2017). This adds to sustainbility and ensures effective scale up as it promotes support of all stakeholders (ibid).

5.4 Economic strategies discussion

Two categories of the strategies emerged in this theme, establishing business models and business agreements. Most developing countries do not have the financial capabilities for scalability and sustainability of mhealth projects (Sundin, et al., 2016). In this regard financial partnerships or business agreements with essential stakeholders may be useful (Piette, et al., 2014; Peiris, et al., 2014). Viable business models which consider local processes, catering to the actual healthcare needs of individuals and the public are recommended for scalability and sustainability of mhealth projects for NCDs in developing countries (Olmen, et al., 2017; Lundin & Dumont, 2017). To maintain and ensure provision of continuous healthcare services for IIs Larsen & Ellingsen, (2010) recommends that users and designers work closely together in designing the services because this provides services that the users will be willing to pay for. This could be done by offering immediate and direct usefulness of the services to the users, thus creating a large user base adequate to cover costs of operating the II (Aanestad & Jensen, 2011; Hanseth & Lyytinen, 2010). The II therefore attains economic stability as the users acknowledge its meaningfulness and are willing to pay for the services rendered (Hanseth & Lyytinen, 2010). The challenge in developing countries however is that mhealth projects fail to be self-financed due to reliance on wealthy donors who usually discontinue finances after the pilot stages (Sundin, et al., 2016), and unaffordability of direct payment from consumers who are usually too poor to pay for the mhealth services (Mangone, et al., 2016). Using concepts by Aanestad & Jensen, (2011) and Hanseth & Lyytinen, (2010) of

persuading the users to use the services by offering immediate and direct usefulness of the services and including the users in the design process could increase the user numbers that can cover the service costs and possibly creating a more affordable service. This is contrary to Sundin, et al., (2016) who suggests that telecommunications operations costs exponentially increase as the mhealth project expands to include more users which in turn increases the overall cost of mhealth services. The author is inclined to believe in this case that initial expansion could be costly, however as the information system gains more users and stabilises, an affordable service could be attained. Creating business agreements or local and international partnerships with relevant organisations could assist with financing the mhealth projects (Piette, et al., 2014; Peiris, et al., 2014). However, in this case the various partners or stakeholders need to work in a collective manner to achieve mutual goals (Ellingsen & Obstfelder, 2007; Walsham, 1997).

5.5 Monitoring strategies discussion

The results showed three categories of the strategies that emerged from this theme, general assessment, evaluate local conditions and project adaptation, and community preparedness. A full evaluation of the environment where the mhealth project is planned to be implemented needs to be conducted before considering scalability and sustainability (Lemaire, 2011). Majumdar, et al., (2015) and Aggarwal, (2012) recommends that the project's operational environment should be fully assessed through involvement of the community or target group to ensure success of scalability and sustainability. Evaluation of previously successful and failed mhealth projects and examining the country's policies concerning implementation of mhealth projects, should be conducted to understand opportunities and limitations for scalability and sustainability (Peiris, et al., 2014). Flexibility to changes to the local conditions and considering the needs of the consumers (users) during scalability should also be maintained to allow for easier adaptation of the mhealth project (Nahar, et al., 2017; Beratarrechea, et al., 2017; Lu, et al., 2013; ExpandNet-WHO, 2010). Analysing the target community's mobile phones behaviour patterns also ensures adaptation of the mhealth project (Olmen, et al., 2017). Tapia-Conyer, et al., (2015) recommends that the implementation process of mhealth projects for NCDs in developing countries should be done systematically, with clear definitions of leaders that can be accountable, and with clear goals. This aligns with Berg, (1999) who suggests that design and implementation of a planned information system in healthcare services should run concurrently and move in an iterative manner with users

involved in the feedback of the process as the system develops. According to Walsham, (1997) this creates a continuous system of design, analysis, and evaluation which could be effective in successful implementation of healthcare information systems. The information system will therefore undergo a process of continuous negotiation between various actors both humans and non-humans until it begins to function in unison or become aligned (ibid). When the agendas and interests of the various actors pull in the same direction and serve the same purpose an aligned or sustainable network is achieved (ibid). Consequently, using iterative and adaptive development approaches with ongoing awareness, monitoring, and interventions can reveal and enable solving of problems in the development of the information system (Aanestad & Jensen, 2011). This could also assist to identify and implement strategies that take account of the current and future developments of the II (Aanestad, et al., 2017).

5.6 Building Local Capacity strategies discussion

The results showed one category in this theme, building resources and skills. A huge challenge for most developing countries is the lack of adequate infrastructure for mhealth services (Asiimwe-Kateera, et al., 2015). It is therefore necessary to establish the available infrastructures before scaling up and using to the maximum capacity of what is available (Maulik, et al., 2017; Tran, et al., 2011; Ali, et al., 2017). Shortages of skilled man power is also a huge factor that effects scalability and sustainability of mhealth projects in developing countries and should be considered at initial stages of implementation (Majumdar, et al., 2015). Consequently, building up the relevant skills using approaches such as task shifting have been recommended and have shown to be effective (Surka, et al., 2014). However, since task shifting utilises untrained staff, standardised operational procedures should be developed for use (WHO, 2007). Monteiro, (2000) suggests that from the initial stages of design of information systems, plans for programs of action and defined roles and competencies for the users, should be incorporated in the system. The various roles and competencies of the users need to be developed and standardised to assist with the effective function of the information system (ibid). Through testing a sequence of various required skills, the desired skills could be identified and incorporated in the information or mhealth system and delivery processes to achieve the desired outcome (Hanseth & Monteiro, 1996).
The next and final chapter is the recommendations and conclusion of the research.

6. Chapter 6 Recommendations and conclusion

6.1 Introduction

This research reviewed the strategies that are used for scalability and sustainability of mhealth projects for NCDs in developing countries. The objectives were to identify the strategies for scalability and sustainability of mhealth projects for NCDs in developing countries, group and analyse the strategies, and discuss the strategies using approaches of implementing IIs in healthcare systems. This chapter concludes the findings of the study with some suggested recommendations for future research.

The need to address the increase of NCDs in developing countries has become a priority for the WHO as well as individual countries. Mhealth promises to assist in successful delivery of healthcare services for NCDs in developing countries therefore effective strategies for scalability and sustainability of the mhealth services are important to consider. The research reviewed the strategies that could be effective to use in developing countries and tries to explain the strategies using approaches of how IIs are implemented in healthcare services. Understanding the approaches of how IIs are implemented, become scalable and sustainable could give practical methods for organisations who are thinking of expanding their mhealth services for NCDs in developing countries. Drawing on approaches from implementation of IIs could also assist to identify strategies of how an information system could be monitored and strategically built for future use.

6.2 Findings and implications of the study

The study showed use of Design strategies, Collaboration strategies, Economic strategies, Monitoring strategies, and Building local capacity strategies when considering scalability and sustainability of mhealth projects in developing countries. The scalability and sustainability of mhealth projects in developing countries goes beyond building the technology. Other factors such availability of technical and human resources, long term financing of the project, and acceptability of the project across cultural traditions and norms contribute to scalability and sustainability of the mhealth projects. The research highlights strategies that could be used to overcome some of these barriers and lead to successful scalability and sustainability of the

mhealth projects for NCDs. The research can be used as a guide on what has worked and what should be avoided during plans for scalability and sustainability of mhealth projects for NCDs in developing countries.

6.3 Recommendations

A general view of the strategies that could be used for scalability and sustainability of mhealth projects for NCDs in developing are analysed in this study. However, different countries will face different challenges in their provision of mhealth services. The political and economic environment, cultures, and available resources to implement mhealth services will vary in different countries and regions. A more centred study to analyse strategies that have worked in one country or region would be recommended for research on this topic. This could give a more broader view on what strategies worked within that region with the available resources. A comparative case study between a developing and a developed country to determine social and behaviour patterns that influence mhealth technology and services uptake for NCDs is also recommended to understand the effective scalability and sustainability strategies.

6.4 Conclusion

The research has shown strategies that could be used for scalability and sustainability of mhealth projects for NCDs in developing countries. Approaches used in implementation of IIs in healthcare can assist to understand and explain the strategies.

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Appendix 1: Raw data collected

Coding:

D= Design strategies E = Economic strategies BLC = Building local capacity strategies

M&E = Monitoring and evaluation strategies C = Collaborative strategies

Author	Year	Country/ries Or region	Study Type	NCD Type	Description of Project	Outlined strategies for scale up and sustainability
1.Aggarwal	2012	Asia	Review	Mental health disorders	Applying mobile technologies to mental health service delivery	Develop and design health programs that provide secure data transfers to reduce stigmatisation (D) Involve all stakeholders, end users and the community (C) Cooperation and collaborations with the government's ministry of health and ministry of tele-communications (C) Ministries of commerce and revenue could also provide tax incentives for companies that demonstrate tangible health improvements through mobile applications (C) The government could sensitise telecommunications

						companies to freely offer health programs as a means of corporate responsibility (E) Non-profit and private organizations may be able to promote design and dissemination (C) At the medical level, clinicians would need to agree that this technology could serve their purposes rather than burden them. (D) Researchers could partner with software engineers and specialists in biomedical informatics to create, test, and refine appropriate interfaces. (D) Definable metrics should be established for feasibility, acceptability, appropriateness, uptake, and cost-effectiveness at all stages of projects (M&E)
2. Ali et al	2017	LMICs	Exploratory	NCDs	Formulating and administering Mobile Phone Surveys of NCD risk factors in	Agree upon sustainability and capacity development commitments in advance (E)

					LMICs.	Integrate with existing programs and approaches where available (D) Use to maximum capacity available local resources and infrastructure (BLC) Engage all stakeholders (C) Understanding local norms and practices associated with the use of mobile phones (M&E) Aligning approaches as best as possible with local expectations (M&E) Identifying the social, cultural, legal, and public health significance of the NCD risk factor information being collected to anticipate and mitigate avoidable informational risks and maximize potential benefits (M&E) Select appropriate design to match local use (D)

3.Beratarrechea et al	2016	Latin America Argentina, Guatemala, and Peru.	Review	cardiometabolic conditions + other NCDs	Review of 9 mhealth projects to analysis success factors	Use of appropriate designed software to match local use (D) Building local capacity (BLC) Include participants in design (D) Train local health professionals (BLC) Be flexibility to respond to changes in local conditions (M&E) Ensure valuation and monitoring of process (M&E) Ensure strong leadership and governance (C) Ensure active engagement of key stakeholders (C) Collaboration community local organisations and technology operators to ensure technical support (C)
4 Blitchtein-Winicki et al	2017	Peru	Survey	NCDs	To evaluate the feasibility and acceptability of an SMS text message cognitive behavioural	Design use of low cost web based (social media and websites for user uptake) (D)

					program for smoking cessation among young people	Involve end users in design of project (D) Content added in messaging important (add relevant content) (D)
5.Brian & Ben-Zeev	2014	Asia	Review	Mental health disorders		Design Using open source software has the potential to help lower costs for start-up mhealth programs by reusing and repurposing high cost software code (D) Language and cultural relevancy are both essential to the success of adapting mhealth programs. (M&E) Engage members of the target population from implementation to scale via focus groups or individual interviews to better assess these differences (C) Usability and field testing of programming can also improve understanding of how individuals interact with an mhealth system, and can help identify barriers to utilisation prior to full clinical implementation (D)

6.Chandra et al	2014	India	pilot qualitative study	Mental health disorders	Acceptability and feasibility of mobile text messages for promoting positive mental health and as a helpline among young women	Community preparation for introducing project (M&E) Ensure data security (for confidentiality) (D) Gender sensitivity: where there are gender disadvantages providing authentic and reliable support services when help or further information is sought (M&E)
7.Chang et al	2017	Taiwan	Qualitative (interviews)	Diabetes	To describe experience of home telehealth technology in older Patients with Diabetes	Design for end user and tailored to their needs to increase participants uptake and acceptance of technology (D) Ensure cost effectiveness of the technology (E)
8.Diez-Canseco et al	2015	Latin American countries: Argentina, Guatemala, and Peru.	Experimental/ survey	Hypertension	Using Mobile Technology (SMS) to Prevent Progression of Pre-hypertension	Developing simple mhealth technology designs (D) Collaboration of end users (C) Content of message used (simple and clear) (D)
9.Feinberg et al	2017	Kerala, India	survey	CVDs	Investigating acceptability of mhealth for delivery of health promotion and CVD	Design: to local conditions (D) Message content (e.g local Language, (pictorial SMS though

					prevention.	not explored here) voice messaging) (D) Participants easily adapted mhealth due to assured data security and confidentiality (D) Integrate with existing health systems (D)
10.Fottrell et al	2016	Bangladeshi	RCT	Diabetes	Ongoing study at print: A three-arm cluster RCT in mhealth and participatory community group interventions conducted to prevent intermediate hyperglycaemia and diabetes type 2 and to improve control of diabetes type 2.	Community engagement and participation (C) Partnerships and with government, private and relevant companies (E)
11.Gibson et al (a)	2017	LMICs: (Bangladesh, Tanzania, and Uganda)	Survey	NCDs	Ongoing at Print: optimizing delivery of interactive voice response (IVR) and computer-assisted telephone interviews (CATI) for NCD risk factor data collection in LMICs	Cost effective design (D) Involvement of all key stakeholders in design (D) Include end users in design plan (D) Community involvement (C)
12.Gibson et al (b)	2017	LMICs	Survey	NCDs	Cognitively test and identify	Analysis of local country specific

					challenging questions in a noncommunicable disease (NCD) risk factor questionnaire administered via an IVR platform and assess the usability of the IVR platform.	adaption to the project (conducted through focus groups or key informant interviews) (M&E) Involve participants in design (D)
13.Ginsburg et al	2014	Bangladesh	RCT	Breast Cancer	To demonstrate proof of concept for a smart phone empowered community health worker (CHW) model of care for breast health promotion, clinical breast examination (CBE), and patient navigation	Community trust through engagement (C) Introduce community to the project through awareness i.e (motivational video) (M&E) Addressing socio-cultural barriers and myths concerning the targeted NCD. (M&E) Rigorous evaluation before scale-up needed. (M&E)
14.Gupta	2017	India	Feasibility	Chronic otitis (otology pathologies)	To demonstrate the efficacy of telemedicine by remote screening of ear diseases by trained technicians using a telemedicine device.	Training of health staff right people to support that concept and make the everyday running of the program efficient and effective (M&E) Engage health workers with good community knowledge and understand local language (C)

						Implement a robust business model (E) No single business model that will work for every program because every program offers different services operates in different environments and relies on different amounts of external funding. (E)
15.Holeman et al	2014	LMICs	Commentary report	Cancer	A commentary report on priorities for research and development of mhealth for cancer in LMICs	Design for local context (D) Coordinated financing and procurement can reduce prices and expand access (E) Build on existing mhealth projects (D) Engagement with designers, implementers managers, and community members. (C) Use interdisciplinary approach collaborations in design process (D) Develop partnerships with technology companies (E)
16.Hyder et al	2017	LMICs	Review	NCDs	To present the potential for mobile phone	Design for users (D) Engage end users in design process (D)

					surveys (MPS) to collect such data,	
17.Islam et al	2014	Bangladesh	RCT	Diabetes type 2	Ongoing: To measure the impact of a mobile phone SMS service on treatment success of newly diagnosed type 2 diabetes	Engage end users in design process (D) Simple design (D)
18.Islam et al	2015	Bangladesh	RCT	Diabetes type 2	To investigated mobile phone use and factors associated with willingness-to-pay (WTP) for diabetes SMS among patients with type 2 diabetes in Bangladesh.	Develop self-sustained business model for basic mhealth services (E) Introduce payment plan for services to sustain projects (E)
19.Jain et al	2015	India	Survey	Mental disorders	To understand the opportunities and barriers in relation to service delivery through mobile phones (mhealth) for severe mental illness (SMI)	End user involvement (i.e patients) in design process leads to better design (D) Introduce reliable and regular payment plans (E)
20.Kamis et al	2015	Bolivia	Survey	NCDs	To describe the penetration of mobile technologies among patients with noncommunicable diseases (NCDs)	Use of simple design of mhealth SMSs or basic smart phone that are available interventions (Complex and advanced phones still have limited reach) (D)

					to inform research on mhealth interventions	
21.Khoja et al	2016	Afghanistan	Cross sectional	Mental health disorders	Preliminary report on impact of simple conventional and telehealth solutions on improving mental health	Design simple cost effective and for local context (D) Community involvement during implementation (C) Conduct awareness programs. (M&E) Collaborations local and international partners (C) align project with country's health strategic goals (C)
22.Lu et al	2013	Taiwan	Qualitative	NCDs	To describe use of home telehealth care as an alternative for chronic disease management from users' perspective.	Design to be user friendly for end user and to local context (D) Explore the consumers (users) perspectives before implementing (M&E) Cost effective (E) Business models-develop affordable insurance systems (E) Advocate for Government involvement (C)

23.Matimba et al	2016	Zimbabwe	Cross sectional	Diabetes (eye care)	To demonstrate the applicability and need for tele-ophthalmology for diabetes retinopathy screening by providing mobile handheld fundus cameras and training for nurses and other health professionals	Collaboration with public and private institutes (C) Training of staff (BLC) Task shifting (BLC) Train and engage local ophthalmologist (BLC) Development of specific technology and data policies for tele-ophthalmology that address issues of security and confidentiality of clinical image transfer and sharing (D) Integration of results (Health record) into existing health information systems (D)
24.Maulik et al	2016	India	Mixed methods qualitative and quantitative	Mental health disorders	To development and test a mobile based electronic Decision Support System and Formative Research to Understand Perceptions about Mental Health	Engage end users in design process (D) Involve key stakeholders (C) Involve local community in design process (village leaders prior to the formative research and this helped them understand the need for such a project

						and receive the local administration's support for the programme. (D) Design for local context (D) Training of staff for effective use of technology (BLC) Developing a collaborative network with the government to enable the government staff to work on the project (C) Seek government support (C) Awareness programs (incorporate some of the culturally relevant issues) (M&E) Developing a system to share information (D)
25.Maulik et al	2017	India	Mixed methods qualitative and quantitative	Mental health disorders	To evaluated task shifting and mobile–technology based electronic decision support systems to enhance the ability of primary care health workers to provide evidence–	Relevant Training of health care professionals (BLC) Integrate task shifting using the mhealth projects and existing health systems (BLC) Integrating standardised protocols into algorithm based electronic

					based mental health care for stress, depression, and suicidal risk	decision support systems (EDSS) could facilitate task shifting, by making the protocols easier to administer (BLC) Design with end users in mind (D) Establish appropriate health systems and infrastructures (BLC) Build from existing health systems (D) Involvement of government and all relevant stakeholders (C) Awareness campaign (Anti stigma campaign) (M&E)
26.Mohan et al	2012	India		Diabetes	To implement a comprehensive diabetes screening, prevention and treatment using a combination of telemedicine and personalised care	Support and collaboration of all stakeholders (C) Building local capacity, staff training. (BLC) Involvement of the Community (C) Design for local conditions (D)

						Awareness campaign designed for local content (M&E) Private public partnerships. (E)
27.Mohan et al	2014	India		Diabetes	Tele-diabetology to Screen for Diabetes and Associated Complications	Involvement of community (C) Train staff from the local community (BLC) Designed for practical use, easily reproducible and cost effective (D) Infrastructure support should be in place before scaling (BLC)
28.Mujumdar et al	2015	India	Review	NCDs	To explore the current possibilities and future scope of mobile health for NCD prevention and control	Analyse general operational issues i.e as available infrastructure and social issues like illiteracy and language (M&E) Ensure data security and proper data backup (D) Analyse how to manage private-public partnership (M&E) Technical demands i.e develop platforms that will work across multiple platforms (D)

						Ensure or provide availability of technical experts (BLC) Advocate for integrated national health systems (D)
29.Muralidharn et al	2017	India	RCT	Diabetes type 2	Ongoing: To implement and evaluate the feasibility, cost-effectiveness, and sustainability of a reality television–based lifestyle intervention program delivered via a mobile phone app (mDiab)	Design tailored to local and cultural conditions (D) Engage users in design process (D)
30.Nahar et al	2017	India	Qualitative	Diabetes + depression	To examines challenges facing implementation of likely mhealth programmes	Understand the local conditions where mheath is planned to operate. (M&E) Understand habits of mobile phone use in the community (M&E) Research on the pathways that patients follow to obtain treatment (this will assist in design of what kind of mhealth applications might work) (M&E) Communication between healthcare

						workers (health clinics) and patients should be effective to sustain remote monitoring and support of patients with chronic conditions (M&E) Take note self-management in rural settings not usually applicable assertion of medical authority and wider cultural inequalities mean that aspirations to patient empowerment are lacking (M&E)
31.Nichols et al	2017	Ghana	Mixed methods quantitative and qualitative	Hypertension (stroke)	To explore the barriers, facilitators and recommended mhealth intervention strategies to control hypertension in post stroke survivors.	Design should be culturally relevant (D) Integrate mhealth services with task shifting (used a nurse led navigational model) (BLC) Project should be Cost effective (E) Build on existing infrastructures (D) Engage support of end user (C) Address cost, training, and continuity of connectivity before

						large scale implementation (BLC)
32.Noubiap et al	2014	Cameroon	Commentary	CVDs	To describe a telecardiology device which provides advantages in terms of cost, ease of use, autonomy and reduced technology requirements	Inco-operate telehealth systems with task shifting in to existing heath systems (BLC) Design tailored to local community (D)
33.Olmen et al	2017	LMICs: (Democratic Republic of Congo (DRC), Cambodia, the Philippines		Diabetes	Evaluation of an mhealth intervention to improve diabetes self-management through SMS	Design delivery to tailor to local environment (D) Engage community (C) Analyse community use of mobile phones and ensure technology used enables messages are reached to intended targets. (M&E) Ensure easy reach of patients or participants in project (M&E) Insights from behaviour science on how people use mhealth interventions essential to design and deliver a project and interpret the effects. (M&E) Linkage with an electronic medical

						record system would greatly enhance the potential of targeting and personalising messages (thus tailor delivery and to link different health and other information systems) (D) Evaluate technology capabilities (M&E) Gain knowledge of the global and contextual telecommunication markets and advancements as to negotiate a sustainable and adaptable business model. (E)
34.Pariyo et al	2017	LMICs	Report review	NCDs	To highlight potential benefits of mobile phone surveys (MPS) for developing, implementing, and evaluating NCD prevention and control policies	Employ public private partnership to be successful (C) Community engagement is key (C) Engage all other stakeholders i.e political leaders, technical experts, researchers, academics, and representatives of professional Groups (C)
35.Peiris et al	2014	LMICs	review	NCDs	To determine the impact of	Examine policy-level barriers to scale up (M&E)

					mhealth interventions on health care quality for NCDs in low- and middle-income countries and to identify knowledge gaps	Analyse: mobile network coverage (M&E) Analyse country's data governance (M&E) Analyse consumer rights (M&E) Analyse patient identifiers (M&E) Analyse interoperability (M&E) Analyse standards and regulatory approvals (M&E) Analyse possible sustainable business models (E) Engage policy makers in design and implementation (D) Integrate interventions with existing national and local initiatives (C) Engage with private sector including insurance providers (C) Ensure partners align with business agendas (E)

						Evaluations of effective and failed interventions to determine contextual opportunities and constraints for scale-up. (M&E)
36.Pfammatter et al	2016	India	Cohort study	Diabetes	To examine the feasibility and initial evidence of effectiveness of mDiabetes, a text messaging program to improve diabetes risk behaviours	Design for local and culture tailored and low cost (D)
37.Piette	2014	LMICs (Bolivia)	Mixed research Survey and interviews	NCDs	To describe the deployment and testing of an m-health platform for non-communicable disease (NCD) self-management support	Involve all relevant stakeholders ie phone companies, and government (C) In public- private partnerships ensure to agree and resolve financial issues and differences in organisational structures (E) In international collaborations ensure to partner with leadership in the target country (C)
38.Praveen et al	2013	India	RCT	CVDs	Proposed at publication: Development of a novel comprehensive	Planned designed project for local content (D)

					CDSS to facilitate Systematic Appraisal Referral and Treatment of CVD risk in rural India (SMARTHealth India)	Design and integrate business component with existing health systems (D) Plan to engage end users and community in design process (C)
39.Praveen et al	2014	India	Mixed methods (survey and interviews)	CVDs	To develop a mobile clinical decision support system (CDSS) for CVD management and evaluate it for use by public non-physician health care workers and physicians	Build on existing health systems (D) Design for local context (D) Collaboration with local cell phone providers for adequate connectivity (C) Incorporating task shifting in system (BLC) Human resource financial support must be incorporated (staff remuneration) (E) Training of local work force (BLC) Closer collaboration with the ministry of health at the national, state, and district levels (C)

40.Raghu et al	2015	LMICs	Action research	CVDs	To development and pilot testing of a mobile-based, point-of-care Clinical Decision Support (CDS) tool to assess and manage cardiovascular disease (CVD) risk	Engage end users in design process (D) Involve local community in design process (avoid pushing solution to the targeted community or participants) (D) Relevant infrastructure should be established (BLC) Use open source platforms (to increase inter-operability between processes) (D)
41.Ramachandran et al	2015	India	Survey	NCDs	To assess mobile phone availability and knowledge regarding operation of mobile phones and assess willingness to receive health-related information among patients attending a chronic clinic	Design to tailor to local context (D) Assess the mobile phone behaviour (how people use mobile phones) in the community (M&E)
42.Rubinstein et al	2015	Argentina	RCT	CDVs	RCTs of 3 projects that included one mhealth project for preventing the progression of prehypertension	Use web-based application for delivery (cost effect and better integration) (E) Use task shifting (BLC)

						Strong leadership and governance (C) Active engagement of a broad range of implementers and key stakeholders, including local community organizations (C) Engaged the National Ministry of Health from the outset on different aspects of the design and the delivery of the intervention. (C)
43.Ruzek and Yeager	2017	LMICs	review	Mental health disorders	To review Internet and mobile technologies, addressing the mental health of trauma survivors in less resourced communities	Design for local and culture context (D) Government or countries should consider financial investment (E)
44.Smith et al	2015	India	Qualitative	CVDs	To investigate the perceptions of three different stakeholder populations in order to assess the potential for using mhealth for CVD management	Build on existing health systems i.e mhealth should be a complement to other chronic care delivery services. This helps acceptability of the mhealth project (D)
45.Surka et al	2014	South Africa	Mixed methods qualitative and quantitative	CVDs	To develop a mobile phone CVD risk assessment	Design to be easily replicable in similar low-income settings (D)

					application and to evaluate it's impact on CHW training and the duration of screening for CVD in the community	Use open source software design reduces costs and easily replicable (E) Integrate Task shifting in system (BLC)
46.Tapia-Conyer	2015	Mexico	Report	NCDs: CVDs, chronic kidney disease (CKDs), diabetes	To describe an innovative model in health-care that leverages international best practices and uses innovative technology to deliver NCD care, control and prevention.	Implementation should be done systematically, with clear definitions of leaders that can be accountable, and with clear goals (M&E) Crucial to have a robust social marketing strategy in the clinic to engage the health workers in the adoption of the solutions (M&E) Design from existing health systems (The solutions must be implemented within the whole NCDs model. (D) Technology should be deployed within a structured health-care model (D) Build sustainable partnership (C)
47.Tapia-Conyer	2016	Mexico	Mixed methods (qualitative	NCDs	To find and assess relevant enablers	Gain political support (align with national strategy) (C)

			and quantitative)		and inhibitors of the Implementing a healthcare model that used innovative technology to deliver NCD care, control and prevention	Align project with current global practices (M&E) Assess available technological resources (BLC) Build from existing health systems for easy adaption and technical support (D) Involve all relevant stakeholders (C) Generate a shared vision for the project (C) Effective downward and horizontal communication flows during improvement process. (increase the chances of having a successful implementation process) (C) Build trust among those ultimately responsible for the implementation of a healthcare innovation (C) Be open to change and adaptability (M&E)
48.Tran et al	2011	Egypt	RCT?	Skin diseases-Dermatology	To demonstrate the feasibility of	Commitment of all stakeholders (C)

					tele-dermatology using newer-generation mobile telephones with specialised software and wireless connectivity in a developing country.	Collaboration of all stakeholders including private and public organisation (C) Consider the nation's existing public health infrastructure (BLC) Support from its national MoH. (C) Evaluate community cultural beliefs and attitudes (M&E) Evaluate availability of cellular telephone coverage, and local disease burden (M&E)