Exploring Innovation for Inclusive Development Dynamics from an Innovation Systems Perspective

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DECLARATION

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ABSTRACT

The shortcomings of growth for inclusivity, has more recently created heightened interest by numerous diverse parties to address the inclusive innovation agenda. However, the largest number of policy prescriptions are still incomplete. Policies invariably focus only on certain products, certain constituencies and certain sets of actors. Each innovation agenda may outline unique policy implications that lead to successful outcomes, "what is patently missing is a systemic overview of the multifaceted character of inclusive innovation".

The aim of this research is to, through the lens of the innovation system framework create a comprehensive analytical framework to guide the process of exploring the underlying dynamics of innovation for inclusive development from a systems perspective. The thesis further extends studies focusing on the importance of innovation systems, and particular technological innovation systems that require a systemic transformation to address societal concerns through technological solutions. The conventional innovation systems paradigm requires further extension and adaption to support innovation for inclusive development, as the transformation of innovation systems to systematically develop innovations adhering to the requirements of economically excluded groups is a challenging and complex task.

Accordingly, an analytical framework was derived from innovation systems literature. The framework consists of four phases, namely: system identification, system description, system analysis and systemic interventions. In addition, the analytical framework was adapted to include the dynamics of the marginalised market.

The framework was applied and validated by means of a case study in the mHealth sector of South Africa, namely, the MomConnect project. The framework achieved the following objectives:

1. Derive a state of the art innovation system analytical framework.
2. Adapt the innovation system analysis framework to successfully determine and describe an inclusive innovation system.
3. Validate the developed innovation system framework by applying it to a case study.

The application of the developed framework, through empirical studies, proved the framework to be a comprehensive approach to identify and describe systemic problems towards inclusivity and to align systemic policy instruments with identified systemic problems, towards an inclusive innovation system. The approach further demonstrated the ability to outline a systemic roadmap towards more inclusivity for projects such as MomConnect as well as the importance for 'conventional' role players and a new set of actors to establish collaborative partnerships in order to reach more inclusivity.

UITTREKSEL

Die tekortkominge van groei vir inklusiwiteit, het onlangs meer belangstelling geskep deur talle uiteenlopende partye om die inklusiewe innovasie-agenda aan te spreek. Die grootste aantal beleidsvoorskrifte is egter steeds onvolledig. Beleide fokus meestal net op sekere produkte, sekere kiesafdelings en sekere stelle bevolkings groepe. Elke innovasie agenda kan die unieke beleidsimplikasies wat lei tot suksesvolle uitkomste, uiteensit, maar "wat kort is, is 'n sistematiese oorsig van die veelvoudige karakter van inklusiewe innovasie".

Die doel van hierdie navorsing is om deur die lens van die innovasiestelsel 'n omvattende analitiese raamwerk te skep om die proses van die ondersoek van die onderliggende dinamika van innovasie vir inklusiewe ontwikkeling vanuit 'n stelselsperspektief te begelei. Die meesters studie brei verder studies uit wat fokus op die belangrikheid van innovasiestelsels en fokus meer spesifiek op tegnologiese innovasiestelsels wat 'n sistematiese transformasie vereis om maatskaplike kwessies aan te spreek deur tegnologiese oplossings. Die konvensionele innovasiestelsel paradigma vereis verdere uitbreiding en aanpassing ter ondersteuning van innovasie vir inklusiewe ontwikkeling, aangesien die transformasie van innovasiestelsels om stelselmatig te fokus op die ontwikkeling van innovasies wat voldoen aan die vereistes van ekonomies uitgesluite groeepe, 'n uitdagende en komplekse taak is.

Gevolglik is 'n analitiese raamwerk afgelei van innovasiestelsels literatuur. Die raamwerk bestaan uit vier fases, naamlik: stelselidentifikasie, stelselbeskrywing, stelselanalise en sistemiese intervensies. Daarbenewens is die analitiese raamwerk aangepas om die dinamika van die gemarginaliseerde bevolking in te sluit. Die raamwerk is toegepas en gevalideer deur middel van 'n gevallestudie in die mHealth-sektor van Suid-Afrika, naamlik die MomConnect-projek. Die raamwerk het die volgende doelwitte behaal:

1. Lei 'n analitiese raamwerk van die nuutste innovasiestelsel af.
2. Pas die raamwerk vir innovasiestelselanalise aan om 'n inklusiewe innovasiestelsel suksesvol te bepaal en te beskryf.
3. Valideer die ontwikkelde innovasiestelselraamwerk deur dit toe te pas op 'n gevallestudie.

Die toepassing van die ontwikkelde raamwerk deur empiriese studies het bewys dat die raamwerk 'n omvattende benadering is om sistemiese probleme ten opsigte van inklusiwiteit te identifiseer en te beskryf en sistemiese beleidsinstrumente met geïdentifiseerde sistemiese probleme in ooreenstemming te bring met 'n inklusiewe innovasiestelsel. Die benadering het verder bewys dat dit moontlik is om 'n sistematiese padkaart te skets na meer inklusiwiteit vir projekte soos MomConnect, asook die belangrikheid van 'konvensionele' rolspelers en 'n nuwe stel rolspelers om vennootskapsverbintenisse tot stand te bring om meer inklusiwiteit te bereik.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

I4ID   innovation for inclusive development

AIDS   acquired immunodeficiency syndrome

BoP   base of the economic pyramid population

CHW   community healthcare worker

CSIR   Council for Scientific and Industrial Research

DALYs   disability-adjusted life years

GDP   gross domestic product

HCW   healthcare worker

HIV   human immunodeficiency virus

ICT   information and communication technology

IIS   inclusive innovation system

IISP   inclusive innovation system performance

IP   intellectual property

IS   innovation system

KPI   key performance indicator

LMIC   low- and middle-income country

M&E   monitoring and evaluation

MAMA SA   *Mobile* Alliance for Maternal Action

MDG   Millennium Development Goal

NDoH   National Department of Health

NGO   non-governmental organisation

NHI   National Health Insurance

NIS   national innovation system

NPO   not for profit organisation

PEPFAR   *President's Emergency Plan For AIDS Relief*

PEU   perceived ease of use

PU   perceived usefulness

R&D   research and development

RIS   regional innovation system

RRI   responsible research and innovation

SA   South Africa

SDG   sustainable development goal

SIS   sectoral innovation system

TB   tuberculosis

TIS   technological innovation system

WHO   World Health Organization

CHAPTER 1

It turns out that advancing equal opportunity and economic empowerment are both morally right and good economics, because discrimination, poverty, and ignorance restrict growth, while investments in education, infrastructure and scientific and technological research increase growth, creating more good jobs and new wealth for all of us. ~ William J. Clinton (2012)

Most developing countries face poverty to a certain degree (Altenburg, 2008). Poverty may be defined in different ways (Sen, 1993). Individuals or communities may be defined as poor based upon (Hall, Matos & Martin, 2014; Sen, 1993; Zohir, Rabbani & Mallik, 2008):

- material lack;
- social exclusion from society;
- the lack of certain capabilities;
- dignity, i.e. individuals surviving are still seen as poor when surviving means that they must give up self-respect; and
- according to the subjective experience, a lack of something leading to *suffering*.

From a narrow view, poverty may be seen as a lack of income. Broader views may be multidimensional. One of the most common distinctions between conceptualisations of poverty is the distinction between absolute and relative approaches (Sen, 1993). *Absolute poverty* is often characterised by severe deprivation of basic human needs, such as food, water that is safe to drink, hygiene amenities, healthiness, housing, education and knowledge (Chen & Ravallion, 2010). This view can also move beyond income, and take into consideration other aspects, such as access to social services. *Relative poverty* contrasts with absolute poverty in that it relates poverty to some reference group. Individuals or communities are seen as poor in relation to those surrounding them (Hick, 2012). The relative approach can thus imply different poverty thresholds based on geographic locations as well as over time (Hick, 2012).

Another approach to poverty classification is the *capability approach*. This refers to poverty as being absolute in the space of capabilities. The capability approach entails two core normative claims (Sen, 1993): firstly, it claims that the freedom to attain well-being is of crucial moral importance, and secondly, this freedom may be seen from the capabilities that individuals possess, in other words, concrete opportunities to complete those aspects that they have reason to value.

These varying views illustrate the multi-dimensional nature of poverty. Considering this, three definitions of poverty, which include these approaches, can be conceived, namely poverty can be defined as –

- a lack of economic and social welfare in an absolute sense;

- a lack of meeting basic needs that relate to the numerous dimensions of poverty and relative to the community in which the poor find themselves; and

- being excluded from participation in society due to a lack of certain capabilities (Hick, 2012).

Although there has been a decrease in absolute poverty internationally, wealth distributions are increasingly skewed (Hardoon, 2015; Piketty, 2014). This is also true in South Africa, with more than 42% of South Africa's wealth in 2017 in the hands of 1% of the country's population (Oxfam, 2017). Evidence suggests that inequalities are not only morally unjust, but they are also socially and economically damaging to nations, organisations and individuals (Heeks, Foster & Nugroho, 2014). Innovation is broadly associated with economic growth and is widely credited for playing a role in bringing nations out of poverty (Kraemer-Mbula & Wamae, 2010). However, innovation is also often associated with inequality, as conventional innovations often mainly serve to improve the productivity and welfare of middle- to high-income citizens (Foster & Heeks, 2013; Simanis & Hart, 2008).

There thus exist concerns regarding the shortcomings of *conventional* innovations insofar as they are often not being local need-orientated, demand-driven, focussed on non-technical innovations and aligned with local institutions and policies. These properties or *misalignments* may lead to certain groups of individuals being excluded from mainstream economic innovation benefits. It could also lead to a lack of focus on and acknowledgement of low-income consumers and demand-side actors as active participants and beneficiaries of innovations (Foster, 2013; Grobbelaar, Tijssen & Dijksterhuis, 2016). There is increased interest in supporting innovations that serve the needs of individuals who usually are not beneficiaries of conventional innovations (Chataway, Hanlin & Kaplinsky, 2014; Kaplinsky, 2011). These new trajectories are producing innovations that are more inclusively orientated.

Numerous innovation approaches explore innovative solutions aimed at improving the living conditions of those individuals and communities that do not benefit or take part in conventional innovation, who may be described through a range of terminologies such as, 'grassroots innovation', 'pro-poor innovation' (Horton, 2008), 'inclusive innovation' (Altenburg, 2008), 'innovation for inclusive growth' (George, Mcgahan & Prabhu, 2012), 'innovation for inclusive development' (Heeks *et al.*, 2014). From these terminologies, two approaches can be identified (Chataway *et al.*, 2014; Foster & Heeks 2015). The first approach is focussed on inclusivity of output where marginalised actors benefit from products and services that meet their needs (Foster & Heeks, 2014; Prahalad, Di Benedetto & Nakata, 2012). The second approach views inclusivity from a developmental perspective where individuals and communities that do not benefit or take part in conventional innovations are actively involved (as partners) in the innovation process with the aim of social and/or economic benefits (Cozzens & Sutz, 2012).

Although there is an increased interest in innovation for inclusive development and heightened interest by diverse parties to address the inclusive innovation agenda (Cozzens & Kaplinsky, 2009), the largest number of policy prescriptions still focus insufficiently on the marginalised to foster innovation for inclusive development. They invariably focus only on certain products, certain constituencies and certain sets of actors (Chataway *et al.*, 2014). Each innovation agenda may outline unique policy implications that lead to successful outcomes, but what remains absent is a systemic overview of the multifaceted character of inclusive innovation (Chataway *et al.*, 2014; Rip & Kuhlmann, 2015). Research by Chataway *et al*. (2014) and Rip and Kuhlmann (2015) argues that if a systemic overview is neglected, it may be challenging to –

- evaluate the implications of new inclusive innovation trajectories;
- develop and implement policies that are inclusively orientated;
- deliver limited resources more efficiently;
- gain the most benefit and collaboration from interactions among a set of diverse and different actors; and
- benefit from innovators specifically addressing the needs of innovation to be more inclusive.

The innovation system (IS) approach to analysing the role that actors play in supporting innovation in different contexts is well established (Edquist, 2001). The approach is based on evidence in the understanding of the innovation process (Kraemer-Mbula & Wamae, 2010). The IS approach is based on the systematic understanding of innovation processes, actors and relationships, and has been adopted as central to policy formulation to determine national innovation initiatives in various jurisdictions (Edquist, 2001; Lundvall, 1992).

An IS analysis generally consists of identifying the structural components, the relationships among structural components and the attributes of these components (Bergek, Jacobsson, Carlsson, Lindmark & Rickne, 2008; Hekkert, Negro, Heimeriks & Harmsen. 2011; Hekkert, Kuhlmann & Smits. 2007; Van der Hilst, 2012; Wieczorek & Hekkert, 2012; Woolthuis, Lankhuizen & Gilsing, 2005). In this context, *structures* refers to the operating parts of the system (the components), which may comprise actors, interactions, institutions and infrastructure. *Relationships* are the interactions that take place between structural components. *Attributes* are the properties manifesting in components (Carlsson, Jacobsson, Holmén & Rickne, 2002). Different types of ISs have been studied and each type of IS is defined by the boundary of that particular system (Edquist, 2001). Perhaps the most well-known of these are the National Innovation System (NIS), used for policymaking as well as analysis between countries (Freeman, 1995). The boundaries of the NIS are defined geographically and the NIS has a strong focus on formal institutions and governments (Edquist, 2001). ISs may also be defined 'sectorally'. Sectoral Innovation Systems (SISs) are defined in terms of a specific product, a group of products that have a similar function, a technology, or a particular industry (Carlsson *et al*., 2002). The

Technological Innovation System (TIS) is "a combination of interrelated sectors and firms, a set of institutions and regulations characterising the rules of behaviour and the knowledge infrastructure connected to it" of a specific technology (Hekkert *et al.*, 2007:416). Actors relating to a technology may be connected by different industries and across multiple country borders, where geographic boundaries have less emphasis.

Recent contributions to the IS study field – specifically in the TIS domain – acknowledge that structural analysis has proved insufficient for the analysis of technological innovations (Bergek, 2008; Wieczorek & Hekkert, 2012; Woolthuis *et al.* 2005). Thus, the functional approach emerged to highlight the processes (rather than the structure) that are important for good performance of TISs. These processes are defined as functions of ISs (e.g. entrepreneurial activities, knowledge development, market formation), where the goal is to clarify the functioning of an IS (Bergek *et al.* 2008; Hekkert *et al.*, 2007). Wieczorek and Hekkert (2012) propose that, if the functional approach is linked together into a consistent policy framework, a more complete explanation of a system under analysis and its problems may be provided, which in turn will lead to more effective policies to fast-track the processes of a specific innovation.

Complementary to functional analysis, systemic instruments are receiving increased consideration among innovation researchers and policymakers, as a novel approach that leads to processes of change (Bergek, 2008; Smits & Kuhlmann, 2004; Van Mierlo, Leeuwis, Smits & Woolthuis, 2010). Systemic instruments aim to address problems occurring at the IS level, which hinder the speed and direction of innovation processes. These problems may be outlined as systemic weaknesses, problems or systemic failures, having a negative influence on the entire IS (Wieczorek & Hekkert, 2012). They hinder the operation and development of the entire IS and are increasingly considered a new policy rationale, replacing the neoclassical market failure (Edquist, 1997). When systemic policy instruments along with functional analysis form a systemic policy framework, a decision-support tool emerges that supports a novel class of policymakers, dealing with complex systemic problems, such as the process of exclusion.

Some authors discuss the more recent IIS framework from the perspective of analysing the functions of the IS and deriving recommendations to strengthen the Inclusive Innovation System (IIS) (Altenburg, 2008; Chataway *et al.*, 2014; Cozzens & Kaplinsky, 2009; Foster & Heeks, 2015; Kraemer-Mbula & Wamae, 2010). One notable recent contribution to the IIS literature is that of Van der Hilst (2012). Van der Hilst (2012) developed a more integrated IS analytical framework approach, focussing on five steps: system boundary definition, key informant identification, structural functional analysis, systems analysis and recommendations determination. Van der Hilst (2012) specifically uses the IS analytical framework to guide innovation intermediaries and how they may strengthen the IIS, by outlying a set of ten recommendations. Van der Hilst concludes with IIS functional indicators that may assist intermediaries to strengthen IISs. Notwithstanding the importance of the work, the framework still lacks

an integrated approach firstly, to identify systemic problems, and secondly, to provide context-specific recommendations for policy interventions and instruments to strengthen the IIS, to develop innovation for inclusive development (I4ID).

Current approaches still do not provide an integrated framework that guides and aligns the identification of systemic problems and derive systemic policy instruments to strengthen the IIS on an IS level. What is patently missing is a framework that utilises and tests the appropriateness of the theoretical functional indicators developed by Wieczorek and Hekkert (2012) and Van der Hilst (2012), as these indicators are yet to be applied to an IIS to arrive at systemic policy instruments to strengthen the IIS. Contributing to this emerging debate, this research aimed to provide a state-of-the-art integration of the existing IS frameworks with the emerging IIS concepts. The specific focus of the emergent framework lies with the structured identification of systemic problems that hinder the development of I4ID in specific contexts and the structuring of systemic policy instruments that would address these problems to support the attainment of a more inclusive system.

1.1   **Problem statement**

The IS is a well-established framework to explore systematically the innovation process and the determinants of innovations as well as the relationships among the determinants. The IS has furthermore been at the core of the planning process to develop policies in various constituencies (Kraemer-Mbula & Wamae, 2010; Foster & Heeks, 2013; Van der Hilst, 2012). The conventional IS paradigm requires extension to guide systematically functional dynamic factors that drive more inclusively orientated innovations and ISs, to arrive at interventions that further the inclusivity of ISs.

This research builds on the recent literature outlining the need to understand and govern complex dynamics of innovation for inclusive development (I4ID) through mapping and analysing dynamics, by using larger frameworks that mobilise the dynamics of I4ID for innovation policy purposes. There remains a need to derive an IIS framework that utilises and adapts the analysis framework process to arrive at systemic policy interventions tailored to an IIS.

Literature calls for a more elaborated and in-depth IIS framework, by further integrating I4ID approaches within the IS framework towards an increased understanding of inclusive IS dynamics. The study thus aligns with other authors (Chataway *et al.* 2014) who highlight the need for frameworks that support a systems-level derivation of context-specific recommendations towards more inclusive systems. Here, Chataway *et al.* (2014) outline that I4ID agendas are generally specific and point to distinctive policy implications with successful outcomes. However, Chataway *et al.* (2014) emphasise that what is missing is the systemic outline of the multifaceted character of inclusive innovation, having influence on the IS level. The more recent study by Rip and Kuhlmann (2015) aligned with the study by Chataway *et al.* (2014). Rip and Kuhlmann (2015) argue that to attain an improved understanding

and to govern the complex dynamics of I4ID, mapping and analysis of the current functioning of systems are required within the context of larger frameworks. This will allow research and reflection that complements and prompts interactions among those organisations and actors, relevant to I4ID, allowing for the exchanges of good practices and exploring new collaborations, that could be mobilised for innovation policy purposes that support I4ID.

The current study aimed to extend the existing IIS frameworks by specifically augmenting them with regard to the following areas:

- structural factors that hinder I4ID;
- indicators that guide the process of analysing and explaining the functional dynamics of I4ID; and
- the identification of systemic problems and aligned systemic policy instruments to strengthen inclusive innovation in the system.

1.2   **Aim and objectives**

The aim of the current study was –

- to develop an IS framework that would enable the identification of barriers towards I4ID by guiding the process of exploring the dynamics of the IS; and
- to identify interventions that can strengthen ISs towards developing and diffusing inclusive innovations.

The objectives that supported the attainment of the aim were to:
1. Derive a state-of-the-art IS analytical framework based of the work by Wieczorek and Hekkert (2012) and the most renowned TISs literature (Bergek *et al.*, 2008).
2. Adapt the IS analysis framework to determine and describe an inclusive IS successfully by:
   - outlining factors constraining structures of the IS that hinder I4ID;
   - outlining the new orientation required towards enhanced inclusivity;
   - develop indicators to guide the process of exploring the functional dynamics of I4ID; and
   - develop a framework that supports the identification of systemic policy instruments to strengthen inclusive innovation in the system.
3. Validate the developed IS framework by applying it to an illustrative case study to successfully:
   - identify and describe structures that form part of the inclusive IS;
   - identify and describe the inclusive functional dynamics of each system function by means of the developed set of functional indicators;
   - identify and describe barriers to I4ID as well as systemic policy instruments by:

- o identifying the structural barriers that hinder the formation of adequate inclusive IS functions; and
- o developing systemic policy interventions to support the development of more inclusivity in ISs.

4. Reflect on the results from the illustrative case study to:
- identify strengths and weaknesses of the developed framework; and
- identify opportunities for further research.

1.3   Thesis structure

The thesis is structured as follows:

Chapters	Chapter outline
Chapter 1	This chapter provides a brief introduction to the thesis. Thereafter the problem statement is discussed and the aim and objectives of this thesis are outlined.
Chapter 2	Chapter 2 provides a detailed outline of the research design and methodology. An overview of the grounded theory is provided, after which a detailed outline of the thesis structure is provided.
Chapter 3	This chapter entails a brief introduction to poverty, an outline of what an innovation entails and its role in economic growth and inequalities. The chapter concludes by outlining the role of innovation in the fight against inequalities and the provision of more inclusive solutions.
Chapter 4	Chapter 4 gives attention to the evolution of the innovation model and focusses specifically on the most recent of these models, namely the ISs approach. The chapter provides a comprehensive overview of the different ISs, and explains what an IS entails. The chapter concludes by outlining the inclusive IS.
Chapter 5	Chapter 5 is dedicated to research regarding the ISs analytical framework. The chapter outlines a four-phase analytical framework. The framework is adapted to adhere to the requirements of the inclusive IS. The chapter concludes by outlining a comprehensive inclusive IS analytical framework.
Chapter 6	Chapter 6 provides a thorough outline of the mHealth landscape of South Africa and provides a brief overview of the MomConnect programme.
Chapter 7	Chapter 7 provides an in-depth analysis of the MomConnect programme. Here, MomConnect is described in terms of system structures and functions, after which the systemic problems and systemic policy instruments for the project are outlined.
Chapter 8	Chapter 8 concludes the thesis and provides a brief overview of the developed framework, objectives attained in the study, as well as the limitations of the study and future recommendations.

CHAPTER 2   RESEARCH DESIGN AND METHODOLOGY

Chapter 2 provides an overview of the research methodology and design to derive and describe an IIS framework that guides the process of exploring the dynamics of I4ID from an ISs perspective, and provides guidance for the identification of interventions towards more inclusive systems. In section 2.1, the qualitative research method as well as grounded theory is introduced. In section 2.2, the approach that Jabareen (2009) proposes for developing conceptual frameworks is discussed. Finally, in section 2.3, the methodology followed to develop the proposed framework (adapted from the proposed steps by Jabareen [2009]) is discussed.
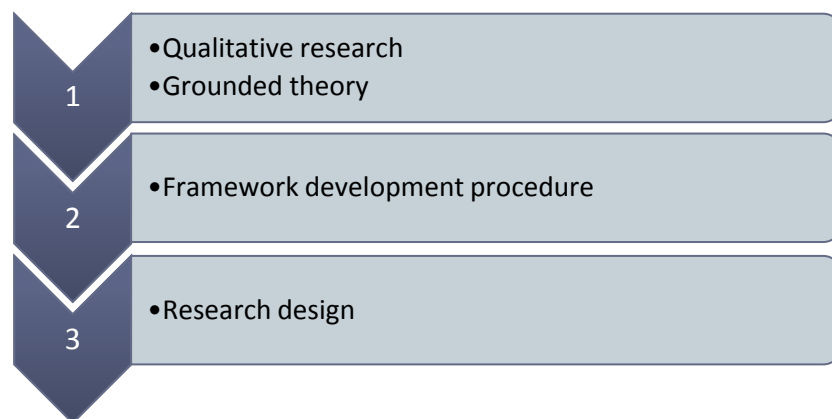
2.1   Qualitative research and grounded theory

Qualitative research comprises a variety of methods, strategies and techniques, which are grounded in a philosophical position, defined as 'interpretive', concerned with the manner in which the social world is interpreted, understood, experienced or established (Creswell, 2013). Qualitative research uses data acquisition methodologies that are flexible and sensitive to the social context (Strauss & Corbin, 1990).

Most social phenomena in present-day activities are seen as complex, requiring multiple bodies of knowledge, derived from different disciplinary fields to gain a good understanding of the particular social phenomena (Jabareen, 2009). Qualitative research serves as an adequate methodology to understand and investigate these complex phenomena better due to the following considerations regarding qualitative research (Creswell, 2013):

- qualitative research provides inductive theory building;
- multiple bodies of knowledge are necessary to understand the phenomena that are investigated;
- quantifiable measures will eliminate qualitative data richness; and
- qualitative research need to be able to see the social reality as interpreted by individuals.

Jabareen (2009) outlines the grounded theory methodology (one type of qualitative methodology) as an appropriate method to conceptualise multi-disciplinary fields of knowledge, rather than descriptive qualitative methodologies. Multiple descriptive qualitative methods such as discourse analysis, thematic analysis and content analysis to name a few, aim to identify the occurrence of words, themes or specific constructs or concepts within texts (Creswell, 2013). These methods are however very limited due to "a lack of simple routines, time-consuming data preparation, difficulties in relating textual data to other data, and a lack of a strong theoretical basis" (Jabareen, 2009:52).

These methods provide a good outline of descriptions; however, they fall short of generating theorisation, where grounded theory provides a useful base for deriving a framework linking multiple disciplinary fields of knowledge due to its primary characteristics (Creswell, 2013). The grounded theory approach builds a "context-based, process-oriented description and explanation of the phenomenon, rather than an objective, static description expressed strictly regarding causality" (Jabareen, 2009:52). Grounded theory can further be defined as "[t]heory that was derived from data, systematically gathered and analysed through the research process. In this method, data collection, analysis, and eventual theory stand in close relationship with one another" (Bryman, Bell, Hirschsohn, Dos Santos, Du Toit & Masenge, 2014:1418).

Grounded theory consists of two central features (Bryman *et al.*, 2014): the development of theory from data; and an iterative process, where the collection and analysis of data occur simultaneously, constantly referring to one another. The generation of grounded theory is an approach of deconstructing and reconstructing data through a method known as a constant comparison. Researchers must compare codes and categories and use a 'check back' method to ensure that categories are grounded in data (Bryman *et al.*, 2014). To further the discussion of grounded theory, section 2.1.1 provides an overview of some of the key tools used in grounded theory and section 2.1.2 provides a review of some of the limitations and criticisms of grounded theory.

2.1.1   TOOLS OF GROUNDED THEORY

The grounded theory methodology offers practical tools to guide data analysis and can be summarised as follows (Bryman *et al.*, 2014):

- theoretical sampling: the forthcoming theoretical considerations to select the appropriate cases and individuals to participate in the study;
- coding: which is a key aspect of the methodology, aggregating the data into parts, with a name assigned to each part;
- theoretical saturation: this is the point where no new theoretical insights emerge from data collection:
- constant comparison: it is important to maintain a close link between data and conceptualisation.

2.1.2   CRITICISMS AND LIMITATIONS

Evaluating the criticism and limitations of any methodology is required before the application of any such methodology. Limitations of grounded theory include (Bryman *et al.*, 2014; Jabareen, 2009):

- the interplay of data conceptualisation and collection is time-consuming, and it may be difficult to do a comprehensive grounded theory study practically;
- the approach is useful in creating categories, but rarely develops into theory; and
- the approach is vague in terms of establishing/defining the difference between concept and category.

Jabareen (2009) emphasises that, regardless of extensive research on methods to derive theories from text and data qualitatively, there is still a lack of systematic qualitative methodologies to arrive at frameworks that link multiple bodies of knowledge. This observation is even more visible when combining multidisciplinary literature to develop a framework. These multidisciplinary phenomena do not possess a skeletal framework, which is defined as:

> [C]haracteristics identified from previous inquiry that provides an internal structure that again provides a starting point for observations and interview questions, and for analysis. The researcher proceeds by building on these structures or categories, padding them out or "giving them flesh" and organizing the ways they fit together (Morse and Pooler, 2002:5).

To address some of these shortcomings, Jabareen (2009) developed a structured methodology for developing conceptual frameworks based on grounded theory. Section 2.2 outlines the approach as proposed by Jabareen (2009).

2.2   The framework development process

This section discusses the methodology of the framework development process as outlined by Jabareen (2009). The grounded theory methodology forms the backbone of the framework development process proposed by Jabareen.

In its simplest form, a framework is a structure comprising components formed together to support something (Fonseca, McAllister & Fitzpatrick, 2013). Every concept has components and is defined by them. Components can further be referred to as what defines the consistency of the concept; its endo-consistency; and are distinct, heterogeneous and, yet, not separable. No one concept exists containing just one component (Loudon, Deleuze, Guattari, Burchell & Tomlinson, 1994).

In order to explain social phenomena, multiple bodies of knowledge derived from various disciplines, have to be understood. A framework requires taking into consideration interlinked concepts, which explain phenomena when used together. Concepts within such a framework support one another and allow for developing a framework-specific philosophy. In general, these framework components

explain the 'way things are' or 'the nature of reality', 'how things really work' and what it can explain about the 'real' world (Jabareen, 2009).

According to Jabareen (2009), the logical steps used to develop a framework are as follows:

Phase 1: Mapping the selected data sources

The first phase entails mapping of the literature pertaining to the phenomena in question. This comprises an in-depth analysis of literature as well as mapping the influential aspects of the different disciplines (Jabareen, 2009).

Phases 2 and 3: Extensive reading and categorising of the selected data and identifying and naming concepts

The aim of phases 2 and 3 is to identify the major categories of the concepts used to develop the framework. It is important to list the importance of each discipline and the representative power to ensure the most effective inquiry as well as to ensure that each discipline carries the correct representative weight.

Phase 4: Deconstructing and categorising the concepts

Phase 4 aims to outline the attributes, characteristics, role and assumptions of the concepts included in the framework (Jabareen, 2009).

Phase 5: Integrating concepts

Phase 5 groups concepts that have similarities or which supplement each other to form a stronger or new concept. This phase usually lessens the number of concepts considerably to arrive at a manageable number of concepts (Jabareen, 2009).

Phase 6: Synthesis, resynthesis, and making sense of it all

Phase 6 serves as the integration of concepts to form an analytical framework. It is important to use an iterative process, making use of repetitive synthesis and resynthesis until an analytical framework is developed that makes sense. The importance of this phase is emphasised by Miles and Huberman (1994), suggesting that researchers using qualitative measures, should be clear on 'theory' construction as the analysis proceeds, as this construction may influence and constrain data collection, data reduction, and the drawing and verification of conclusions (Jabareen, 2009).

Phase 7: Validating and rethinking the framework

In phase 7, framework validation commences through the application of the grounded theory methodology of the qualitative research approach. The framework is applied to a sector to test the

outcomes and applicability of the framework. A theory or framework representative of multiple disciplines will seldom be complete and requires constant revisiting to adapt to newly emerged literature and opinions through data analysis. Eventually, the framework should enhance the understanding of the specific phenomenon in question. This phase also serves to rethink the framework to include all of the obtained data of the analysis process.

2.3   Research design

The research design followed for this study was based on the framework development methodology proposed by Jabareen (2009), and can be broken down into three main stages, namely: literature analysis, framework development, and framework application and validation as indicated in Figure 1. Each of the stages is expanded upon in sections 2.3.1 to 2.3.3.
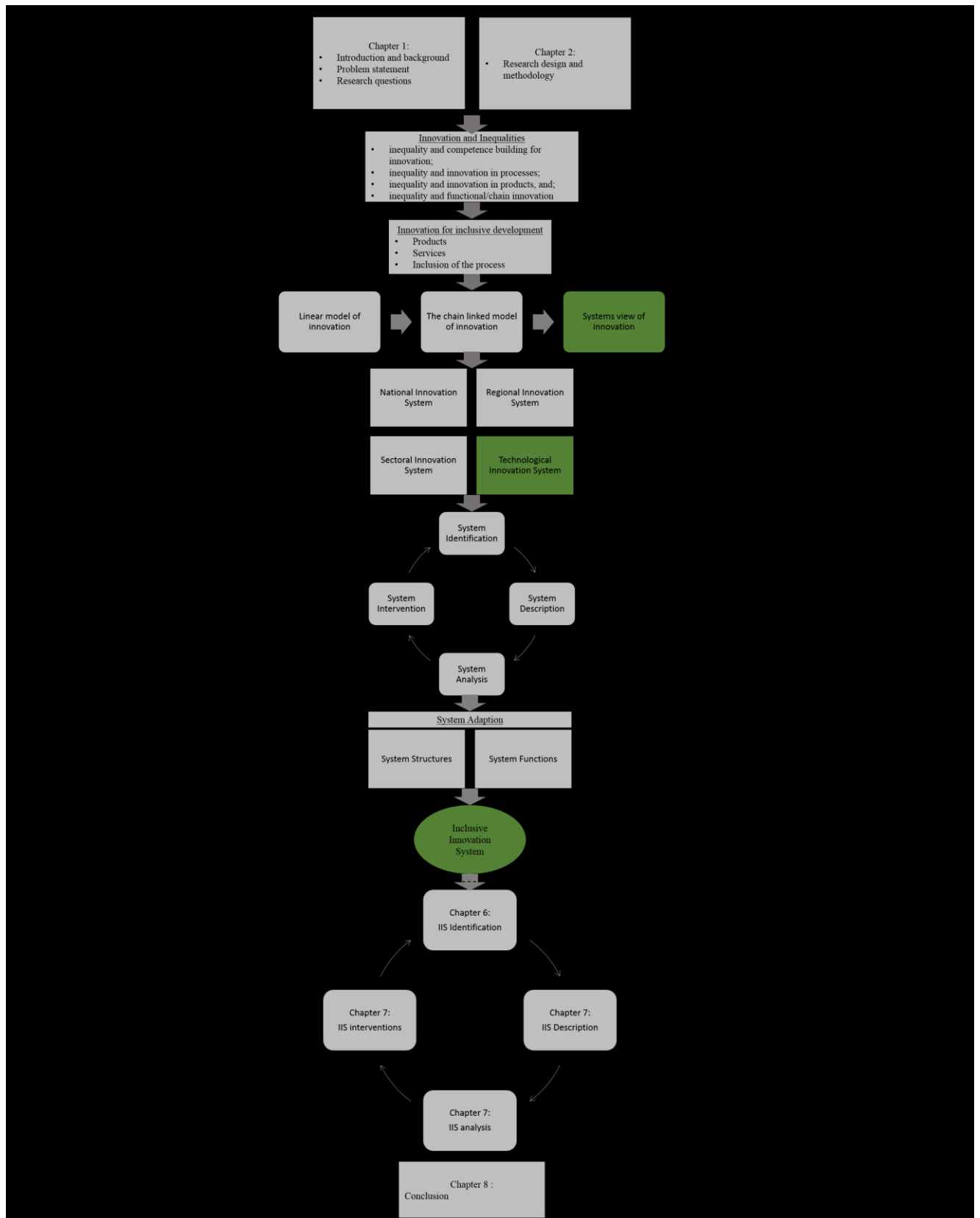
Figure 1: Thesis structure

2.3.1   STAGE 1

The goal of the first stage was to outline the background to the study and to provide an introduction to the existing literature relevant for the study.

The first stage of the research is presented in four chapters:

- Chapter 1 – the background of the study, problem identification and research question development;
- Chapter 2 – research design and methodology;
- Chapter 3 – in-depth literature review of innovation and inequalities and
- Chapter 4 – in-depth literature review of ISs and inclusive ISs.

Chapter 1 outlined the problem statement and the research questions that guided the research conducted and reported in this thesis.

Chapter 1: Introduction and background
- background of the study;   - problem statement; and   - research questions.

Chapter 2 provides a detailed outline of the research design and methodology.

Chapter 2: Research design and methodology
- qualitative research;   - grounded theory;   - framework development process;   - framework outline.

Chapter 3 continues with the background and introduction of the study and provides an overview of the role of conventional innovation in exacerbating inequality, while it also explores the potential of managing innovations better in order to promote inclusion and reduce inequality.

Chapter 3: Innovation, inequality and inclusion	
Innovation and inequalities	- innovation and competence building; - process innovation; - product innovation, and - functional and chain innovation.
Innovation and inclusion	- aspect of who to include in the innovation process; - the manner of inclusion; and - innovation methods and models aimed at I4ID.

Chapter 4 reports on the evolution of the innovation framework in literature. Thereafter, the latest IS literature is reviewed. Chapter 4 also reflects a thorough outline of the requirements to which an IS framework must adhere, to be able, if adapted, to explore the phenomenon of I4ID successfully. It has been found that the TIS framework appears to have specific potential for acting as a baseline framework to evaluate I4ID, as it encompasses the following aspects:

- The IS approach encompasses many facets of the innovation process and I4ID (Van der Hilst, 2012).
- Generally, the IS approach is a useful policy tool (Bergek *et al.*, 2008).
- The IS approach is focussed on knowledge creation and the learning process, essential for I4ID (Lundvall, 2007).
- The IS approach is a multi-stakeholder, actor-orientated approach, required for the inclusion of unconventional actors (Foster & Heeks, 2013).
- The function analysis of the TIS approach provides insight into where capacity needs to be developed to I4ID (Wieczorek & Hekkert, 2012).
- The function analysis is also a guide to identify systemic weaknesses and barriers of IISs (Bergek *et al.*, 2008; Wieczorek & Hekkert, 2012).
- The functions and structural elements make a study context-specific and concrete (Van der Hilst, 2012).
- The structural-functional analysis shows how different issues are interrelated (Van der Hilst, 2012)
- Systemic policy interventions of the TIS approach aim to strengthen innovation capacities of the system (Wieczorek & Hekkert, 2012).

Chapter 4 concludes, by outlining the differences of conventional and inclusive system structures and functions and the requirements of the system to be more inclusively orientated.

Chapter 4: Innovation and inclusive IS	
Evolution of the innovation model	- the linear model of innovation; - the chain-linked model of innovation; and - the systems view of innovation.
Innovation systems	- types of ISs; and - the make-up of the IS.
The inclusive innovation system	Comparing the IS and IIS approaches in terms of system structures and system functions.

2.3.2 STAGE 2

The second stage outlined in Chapter 5, comprises framework development and framework adaption towards an IIS framework. In the first step, a state-of-the-art IS framework is developed, drawing from

IS and TIS literature. In the second step, the content of the framework is adapted to adhere to the requirements of I4ID in order to provide a comprehensive IIS analysis framework.

Chapter 5: Inclusive innovation analysis framework	
Innovation system analytical framework	• system identification; • system description; • system analysis; and • system intervention.
Inclusive innovation system analytical framework	Reorientation of the four steps that define the IIS.

This thesis builds on the TIS literature where a growing number of research articles outline the potential of the method for analysing and evaluating outcomes of I4ID projects (Chataway *et al*., 2014; Foster & Heeks, 2013; Van der Hilst, 2012). A comparative analysis is performed in the framework development phase to derive a comprehensive framework that could serve as a guide for future empirical studies that aim to analyse I4ID projects. In this regard, research strictly using the TIS analysis framework or part thereof to strengthen I4ID was researched. The research was supplemented by the most influential authors based on citations of the TIS literature to derive a more complete IIS analysis framework. The framework comprises four phases, based largely on the work of Wiezcorek and Hekkert (2012).

The four phases are as follows: system identification, system description, system analysis following a functional structural approach, and system intervention:

– The **systems identification** phase consists of the boundary selection.
– The second phase, the **system description** phase, entails step 2 (description of system structures) and step 3 (description of system functions).
– The third phase, **system analysis** (functional-structural approach), entails step 4 (systemic problem identification).
– The fourth phase, **system intervention**, entails step 5 (systemic policy goals and systemic policy instruments).

The approach is seen as cyclical as displayed in rther strengthening of the IS.

Figure 2, as the approach aims to strengthen a particular IS. After implementation of systemic policy interventions, re-evaluation of the process follows for further strengthening of the IS.
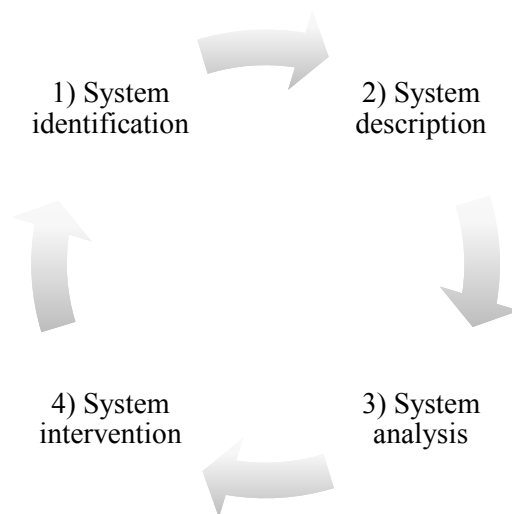
Figure 2: Innovation system analysis framework

The content of the framework is predominantly adapted for the system description stage, where the make-up and functioning of the system is adapted. This is necessary to be able to 'set up' the process of system analysis and system intervention. Firstly, the structure of the system is adapted. This updated structure comprises three steps:

- identifying the structures of the IIS and how these structures differ from conventional IS (Chapter 4);
- identifying the constraints faced by each system structure to I4ID; and
- constructing a new orientation for each system structure to be better orientated for I4ID.

Secondly, the TIS system functions are adapted to include:

- to alter the orientation and goal of the system functions (Chapter 4);
- a set of indicators are identified for each system function; and
- a set of diagnostic questions are derived for each system function.

The system analysis, system goals and system intervention phases of the framework build on the changes required from the description phase. Here specific attention is given to those factors hindering the use of the state-of-the-art TIS frameworks in the analysis of I4ID and the systemic policy interventions to overcome hindrances to I4ID and strengthen the IIS.

2.3.3   STAGE 3

Stage 3 comprises case identification (Chapter 6) and framework application (Chapter 7) and concluding remarks of this thesis (Chapter 8).

Chapter 6 provides a thorough outline of the case selection process. The application of the IIS framework is carried out by means of case study research, where the framework is applied to the

mHealth sector of South Africa. This stage outlines the grounds for case study research and case selection.

Chapter 6: Case study – MomConnect	
Case study outline	MomConnect

Case study research allows researchers to explore and understand complex issues. Case study research may be considered a rigorous research method, especially when an exhaustive investigation is needed (Zainal, 2007). This tool carries much recognition in numerous social science studies, and the role thereof becomes more noticeable when issues under study relate to education (Gulsecen & Kubat, 2006), sociology (Grassel & Schirmer, 2006) as well as community-based problems (Johnson, 2006), which may relate to aspects such as poverty and inequality. One of the aspects that contributed to the recognition of the case study as a research method, is that researchers became alarmed at the limitations that quantitative methods may have in terms of the provision of in-depth explanations of social and behavioural problems (Zainal, 2007). The case study methodology provides a study with the ability to understand behavioural conditions through the actor's perspective (Zainal, 2007).

In order to select a case to be appropriate for the study of an IIS, the following criteria had to be adhered to:

- the marginalised is defined through one of the numerous definitions that exist;
- the sector that the thesis focuses on to represent the marginalised;
- the marginalised is described in terms of product, service or economic outputs with the aim of an improved outcome on the livelihood of the marginalised;
- the aim to reduce inequality in terms of product, service of economic outputs is described; and
- it must be able to study the marginalised within the system context.

The MomConnect programme is a digital health programme that registers pregnant women and distributes directed stage-based health information via a short text message (SMS) service. The project was deemed a suitable case study as this is one of the few instances globally where a National Department of Health (NDoH) implemented an mHealth scheme and rolled it out nationwide in a low-to middle-income country (LMIC) (United Nations Foundation, 2015). The project could be defined as an I4ID project, as it serves the public health sector, serves those disconnected from formal healthcare systems (with a stated programme target of every woman in the South Africa) and strives for improved access, equity and quality to health solutions for marginalised communities as outlined in Table 1.

Table 1: MomConnect as an applicable project for IIS research.

Requirements to be selected as eligible project	Yes/No	Whom and/or how?
The marginalised is defined through one of the numerous definitions that exist	Yes	Every pregnant woman in South Africa. Serve actors disconnected from formal value chains or systems who do not have access to quality of products and/or services as in formal markets and who do not have access to basic healthcare needs.
Sector that represents the marginalised	Yes	Serve the public healthcare sector (maternal healthcare).
Service to the marginalised in terms of product, service or economic outputs with the aim of an improved outcome on the livelihood of the marginalised	Yes	Provide improved access to health solutions – SMS service.
Aim to reduce inequality in terms of product, service or economic outputs	Yes	Standardised service in formal and informal sector. Equity and quality of care in healthcare delivery across sectors.
Possibility to be studied within the system context	Yes	Rolled out nation-wide.

Interviewee process

The interviewee identification process commenced, firstly, through studying documentation of the MomConnect project. The first three interviews were conducted with some of the project leaders, after which a snowball sampling process was used to identify further respondents for interviews with some of the most influential personnel playing a leading role in the project. A total of 15 interviews were conducted. Additional information was also obtained through documentation of the MomConnect programme. Table 2 gives a summary of the background of the individuals who were interviewed and their field of expertise. The questionnaire is outlined in Appendix B. The insights gained from the interviews guided the information reflected in Chapter 7. The interviews, firstly, served the purpose to outline the system structures and functions. Secondly, the interviews provided insight into the functions of each system, guided by the developed indicators, to provide insight into each function and how these functions may be more inclusively orientated. This served the purpose to position the analysis in order to align the relevant systemic policy aims and instruments to strengthen the system towards more inclusivity.

Table 2: Interview participants

Number of individuals interviewed	Field of expertise
3	Inclusive innovation healthcare specialists
2	Mobile operator
2	University institute
2	Strategy
3	Technology
2	Training
1	Content
15	**Total**

Interviews took place in person, or where not possible in person, through Skype calls. The interview process was in the form of guided conversations rather than structured questions. To ensure the reliability of data collection and analysis, interviews were recorded and transcribed as soon as the interviews had been completed. The data analysis made use of two main sources: semi-structured interviews and secondary textual data consisting of research articles and reports containing data of the MomConnect project, as well as the mHealth sector of South Africa. Codes used for the data analysis process were based on the indicators developed for each function of the IS. The codes served as a guide to made sense of the qualitative data. The codes were flexible and adaptable in case new trends in the data analysis emerged. Theoretical saturation was assessed after every interview.

Constant comparison of data was maintained throughout the study and assessed after each interview. The indicators were constantly reviewed for every innovation system function – firstly, if they were relevant, and secondly if any new indicators emerged that might have been missed during the literature review.

Please refer to Appendix D for the following ethical documentations:

- written consent to participate in research;
- humanities rec letter; and
- letter of permission from the institution (MomConnect).

Chapter 7 comprises phases 2, 3 and 4 of the analysis framework, namely the system description, analysis, and systemic intervention phases.

Chapter 7: Framework application	
Framework application	Framework phase: • system description; • system analysis; and • system interventions.

Chapter 8 concludes the thesis, where a thorough outline is provided of lessons learned from the thesis as well as future research priorities.

Chapter 9: Conclusion	
Conclusion	• lessons learned • future research

2.4 **Chapter summary**

This chapter provided an overview of the qualitative approach followed for this study. An overview was provided of the three stages of the research study as adapted from Jabareen (2009). The three stages of the research were: introduction and background, framework development and framework application.

CHAPTER 3   POVERTY, INEQUALITIES AND INNOVATION

Innovation is associated with economic growth and poverty reduction, but is also recognised as a driver of inequalities, especially in developing countries. Section 3.1 provides an introduction to innovation and the role thereof in economic growth, poverty reduction and inequalities. Section 3.2 provides a thorough overview of innovation as a driver of inequalities. Finally, in section 3.3, the role of innovation is introduced to address the needs and interests of marginalised actors and more equity.

1 • An introduction to innovation

2 • Innovation adressing poverty and inequalities

3 • Innovation for inclusive development
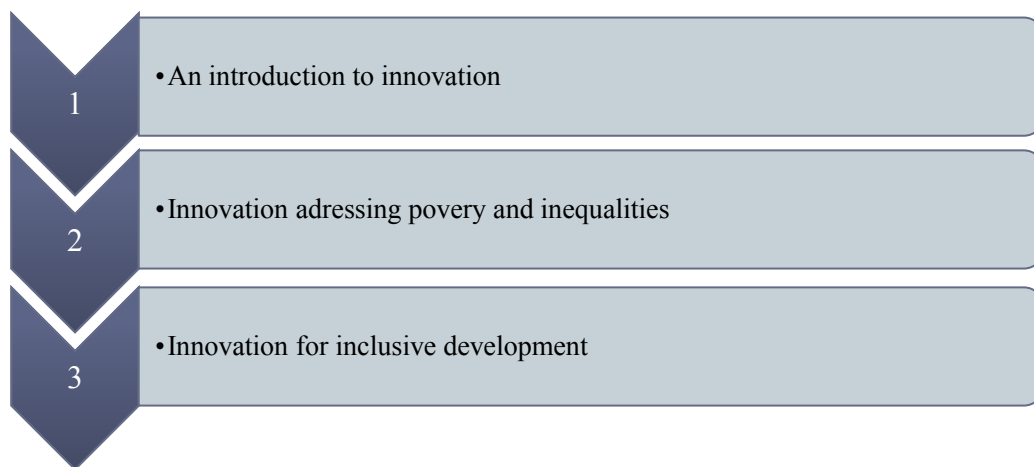
3.1   An introduction to innovation as a concept

An innovation may be defined as a process of transforming novel or existing knowledge to value that benefits individuals or communities (Edquist & Hommen, 1999). The process of innovation creates a product or process through technical processes as well as social and economic processes (Edquist & Hommen, 1999; Lundvall, 1992). The innovation process leads to new or improved products, where the 'product' refers to new (material) goods or new (intangible) services (Kraemer-Mbula & Wamae, 2010).

The term 'innovation' has numerous definitions in literature (Sonne, 2012). A definition that is still appropriate today, is the definition by Joseph Schumpeter (1934), widely regarded as the first economist to outline the importance of an innovation (Ghazinoory *et al.*, 2014). Schumpeter's five types of innovations are:

- introduction of a new product or a qualitative change in an existing product;
- process innovation new to an industry;
- the opening of a new market;
- development of new sources of supply for raw materials or other inputs; and

- changes in industrial organisations (Organisation for Economic Co-operation and Development [OECD], 1997).

Multiple scientific endeavours have led to new knowledge, but not necessarily new economic value (Kraemer-Mbula & Wamae, 2010). This led to the gradual broadening of the meaning of 'innovations', where the Oslo Manual defines innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD and Eurostat, 2005). The general notion and nature of innovations, thus emphasise 'newness' and 'applying knowledge' (Gazinoory *et al*. 2014). Recent research, recognises innovation as an enabler for growth, offering substantial potential to obtain developmental effects (Kraemer-Mbula & Wamae, 2010). Thus, innovation offers a host of opportunities to address poverty and inequality directly.

It is evident that various organisations and institutions are attempting to address the needs and interests of the marginalised through various innovation models. Despite efforts over the years, inequalities are on the rise, and effective solutions to address growing inequality are key to the stability and prosperity of developing countries (Kraemer-Mbula & Wamae, 2010). There is no doubt that innovation is at the core of economic growth supported by the economic heart of formal organisations aimed at wealthy populations (Foster & Heeks, 2013). There is also enough evidence that innovation contributes to alleviating extreme poverty, as many believe that the Industrial Revolution (1760/80s–1830/40s) was the first major revolution in the fight against poverty, causing high economic growth and the elimination of mass poverty in some areas (Ver Loren van Themaat, Schutte, Lutters & Kenno, 2013). This, however, is a very one-sided view of eradicating mass poverty through innovative activities, as the contrary is also evident in many developing countries, where innovation is one of the main drivers of inequality and exclusion (Foster & Heeks, 2013).

Innovation and ISs associated with developing countries are often characterised by large formal organisations, mostly attending to the export market and the production of products for the select few higher-income consumers within national borders (Foster & Heeks, 2013). The low-income majority tend to be neglected through these innovations, evident in major inequalities existing in developing countries. This is also seen as a process of exclusion, where innovative activities lead to an increase in inequalities (Lindberg, 2014).

3.2   The role of innovations in inequality

Innovation plays an important role in economic development, leading to large-scale technical transformations of nations (Altenburg, 2008). However, conventional innovations often focus on higher-income groups, rather than the marginalised, and economic development rather than social

development (Altenburg, 2008). The relationship between innovation and inequality is however complex, and this chapter reports on the relationship that exists between innovation and inequalities.

An improved understanding of the dynamic relationships between innovation and inequality has the potential to open pathways that shape technological change that drives greater equity, equality and social cohesion (Chataway *et al.*, 2014). It must be noted that innovation is not the sole or even most influential contributor towards inequalities; however, it is often linked to poverty and inequality through different processes such as economic, social and political processes (Piketty, 2014). The aspects of innovation and inequality co-evolve, and innovation may often reflect and drive inequalities or lessen and even erase it (Altenburg, 2008).

In general, results of the relationships between income inequality and growth remain mixed (Cozzens & Kaplinsky, 2009), as growth is not always parallel with a reduction in inequalities as studies indicate that inequality is often not reduced with economic growth (Fields, 2002). This does not exclude the role that growth in the gross domestic product (GDP) plays, as it remains an important enabler in the fight against absolute poverty (Ravallion, 2004), but not necessarily the sole contributor (the recent experiences in China, India, and South Africa are good examples).

'Inequality' is a term mostly associated with unequal distribution of income or wealth (Krishna, 2014). Some income inequalities are defined as per capita income per year, daily income, geographic regions or even entire countries (Cozzens & Kaplinsky, 2009). Inequalities are not only related to income inequalities, but may be viewed as unequal distribution of any aspect that is of value to people (Cozzens & Kaplinsky, 2009). In this regard, such examples as the unequal distribution of health services and outcomes, as well as educational experiences are aspects contributing to persistent and widening inequalities (Li *et al.*, 1998). Another reflection of inequalities may be found in economic and social structures. The distribution of economic activities in different regions may be affected by or affect innovative change that contributes to inequalities (Thomas & Fressoli, 2011). Lastly, inequalities may be due to class and power relations, linked to innovations of production (Cozzens & Kaplinsky, 2009). Here, novel innovations may establish new firms and the prosperity of these firms may displace existing firms having an influence on social and political relationships (Hick, 2012).

To address the manner by which innovation might drive, be driven by, or co-evolve with inequalities further, the current study explored four common links of innovation and inequalities as outlined by Cozzens and Kaplinsky (2009). Section 3.3.1 provides an overview of inequality and competence building for innovation, section 3.3.2 gives an overview of inequality and the innovation process, section 3.3.3 gives an overview of inequality and product innovations, and section 3.3.4 provides an overview of inequality and functional/chain innovation.

3.2.1   INEQUALITY AND COMPETENCE BUILDING FOR INNOVATION

Innovation is a dynamic process that consists of cumulative building of capabilities that occurs within system-specific technological trajectories, as learned from evolutionary economics (Cozzens & Kaplinsky, 2009). From this, the understanding of the innovation process has widened in terms of three aspects (Cozzens & Kaplinsky, 2009). The first aspect emphasises competence rather than outcomes, as competence has a more sustained effect on innovation than a certain event. Secondly, the innovation process outlines the difficulties for structures suitable to develop capabilities to innovate over time. Thirdly, the emphasis of evolutionary economics on capability building, acknowledges that capability building occurs as a systemic process (Bergek *et al*. 2008). Capability building may occur at different levels, such as a single firm, but also in multiple firms, global value chains, local ISs, National ISs and Sectoral ISs (Bergek *et al*., 2008; Freeman, 1995; Lundvall, 1992). From the above, it follows that capability building is necessary to generate income over a prolonged period and influences growth as well as income distribution in multiple ways (Hick, 2012).

3.2.2   INEQUALITY AND INNOVATION IN PROCESSES

All innovative production, relating to goods or services, involves some discrete processes. Some processes are tangible, referring to physical assets (equipment, property, labour) and others might be intangible processes referring to financial or knowledge assets (Lundvall, 2007). The effect of innovation in processes on inequalities is largely related to the effect on jobs (Kraemer-Mbula & Wamae, 2010). Currently, skills-biased technological change is a good example. Higher household incomes are often related to jobs demanding higher skills, where workers that do possess those skills receive a wage premium. This phenomenon is even more evident in developing countries where hyper-wages are paid to the few workers that have the required skills (Lundvall, 2007). It must be noted that skill biases do change over time, and the 19th century saw technical change in the United Kingdom and the United States that favoured unskilled workers, compared to the current age where skilled workers are favoured.

3.2.3   INEQUALITY AND PRODUCT INNOVATION

The nature of products has far-reaching consequences for consumer welfare, and especially in relation to different consumer groups (Hick, 2012). There exist several examples of products that are specifically developed to meet the needs of the low-income market (Chataway *et al.*, 2014; Foster, 2014; George *et al.*, 2012). Product innovation is a case where income inequalities may be predominantly shaping the innovation, rather than the other way around (George *et al.*, 2012). Products are generally developed aimed at specific income groups, and such products should adhere to their needs as well as their buying power (Kolk, Rivera-Santos & Rufin, 2013). To conclude, product innovation often remains out of reach of marginalised communities.

3.2.4   INEQUALITY AND FUNCTIONAL OR CHAIN INNOVATION

Innovation within a company may create a temporary monopoly for the firm that introduces the innovation (Kaplinsky & Morris, 2002). This is referred to as 'monopoly rent' (Woolthuis *et al.*, 2005), as for a certain period, the firm may ask escalated prices as they are the only firm offering the service or product innovation (Kaplinsky & Morris, 2002). This is not the only way to create a monopoly, as Cozzens and Kaplinsky (2009) refer to 'innovation rents'. Innovation occurring through functional or value chain innovation gives organisations the opportunity to generate rents by accessing areas that are characterised by greater and more developed barriers to entry (Lundvall, 2007). The value chain approach further allows for the identification of those key areas of rent along the value chain (Kaplinsky & Morris, 2002).

There is a clear link where innovations create rents and barriers to entry (Woolthuis *et al.*, 2005), where it should be noted that not all rents are the outcome of innovation; however, innovations do play a significant role therein (Kaplinsky & Morris, 2002). Rents make entry into and benefit from innovations difficult to those (often the marginalised groups) outside of these value chains, and play a major role in distributional outcomes. Rents generate wealth to those who are participants of innovations therein, meaning that inequality and poverty are mostly unaffected by the accumulation of wealth through rents. However, it is important to emphasise and outline here that the accumulation of resources in a specific geographic region may lower the unemployment rate, as service jobs are created which will lead to a reduction in income poverty (Kraemer-Mbula & Wamae, 2010).

3.3   Innovation for inclusive development

Concerns about the shortcomings of mainstream innovation as listed earlier in the Chapter 3.2 have led to a search for alternatives. From a political and academic perspective, interest in these alternative methods of innovation is growing due to the wide acknowledgement of the negative effects of rising inequality on nations (Kolk *et al.*, 2013). This is further driven by the recognition of the negative effect of inequality on the long-term success of social and economic development (Kolk *et al.*, 2013). The past decade (i.e. 2003–2013) has witnessed numerous changes, justified through numerous novel approaches that addressed the issues of inequalities through new methods of innovation aimed at development (Heeks, Amalia, Kintu & Shah, 2013). Various labels exist for innovation aimed at development such as 'pro-poor innovation', 'below-the-radar innovation', 'grassroots innovation', ' base-of-the pyramid innovation', 'inclusive innovation', 'I4ID' (Chataway *et al.*, 2014:page).

These new models of innovation are focussed on 'inclusive development' or 'shared prosperity' due to the aspect mentioned earlier, namely that mainstream innovation is associated with increasing inequality while I4ID is associated with reduced inequality (Cozzens & Sutz, 2012). In its simplest form, I4ID is "the means by which new goods or services are developed for and/or by the poor" (Foster

& Heeks 2013:333). A broader definition of I4ID is, "the development and implementation of new ideas which aspire to create opportunities that enhance social and economic well-being for marginalised members of society" (George *et al.*, 2012:663). From this definition, it is clear that I4IDs should focus on those members of the community who are not part of the formal activities taking place within that community. This is where the following definition summarises both of the prior definitions as, namely "the means by which new goods and services are developed for and/or by those who have been excluded from the development mainstream; particularly the billions living on the lowest incomes" (Foster & Heeks 2013:337).

At its root, I4ID sees development in a different light to conventional views of innovation (IDRC 2011): Conventional notions of innovation see development as widespread economic growth (Kolk *et al*., 2013). I4ID contrasts this view, as I4ID sees development as the active inclusion of those individuals or groups who remain excluded from the mainstream of development. Differing in its foundational view of development, I4ID sees the inclusion of groups who are currently marginalised in some part of an innovation or innovation process (Foster & Heeks 2013). The definition of I4ID used in this study, however, requires further discussion.

The first issue is that of identity, i.e. where a group is defined as historically excluded and now requires to be included through new approaches to innovation (Kolk *et al*., 2013). There also should be a clear definition of poverty levels, e.g. extreme, moderate and relative poverty, urban versus rural locations, or the extent of isolation from formal markets (Chataway *et al*., 2014; Kolk *et al*., 2013).

The second issue is the manner of inclusion, i.e. how marginalised communities will be included in the process of innovation (Heeks *et al.*, 2014). Authors acknowledge that inclusiveness in terms of only products and services for marginalised groups, i.e. viewing such groups only as customers, should be supplemented with the active inclusion of the marginalised in the process of innovation where possible (Barrett, Carter & Little, 2006; Pitta, Guesalaga & Marshall, 2008). Marginalised groups should be able to share in the benefits resulting from the innovation process, or as far as the specific innovation permits it. Here, different views exist in literature. The narrow view of inclusion considers inequality and poverty reduced through improved income (George *et al.*, 2012). A broader view emphasises the provision of rights to the marginalised, a voice and capabilities and incentives to be actively involved in the processes of development and innovation (George *et al.*, 2012). Cozzens and Sutz (2012) point out that, for an innovation to be inclusive, it needs to be inclusive in at least two ways: "inclusive in terms of the process by which it is achieved and inclusive in terms of the problems and the solutions it is related to".

In order to illustrate this concept, the steps of the 'inclusive innovation ladder' developed by Heeks *et al*. (2014), recognise inclusiveness to be multi-dimensional, and further provide a differentiated view

with six levels, where each level represents increased inclusiveness (Heeks *et al.*, 2014). The six levels of inclusion are defined as:

- intention of innovation;
- consumption (if innovations is adapted to the requirements of the excluded group and used by the group to fulfil their needs);
- influence of the innovation;
- the marginalised included in the process;
- a structure is in its core inclusive; and lastly
- post-structure (an innovation is inclusive if it is created within a frame of knowledge and discourse that is itself inclusive).

There is no right or wrong level on which to focus; rather, an endeavour should consider the particular group's requirements as the requirements of the groups will differ and have particular implications (Heeks *et al.*, 2014). This is especially important as groups will have different historical backgrounds and thus the poverty situation within which they find themselves will require different inclusive solutions for particular situations (Kolk *et al.*, 2013). The six levels of the I4ID ladder are explained below in more detail as adapted from Heeks *et al*. (2014):

- Intention: this is not based on action, but mainly on the idea behind the innovation with the target group of marginalised individuals in mind. This is the stepping stone for I4IDs to come.
- Consumption: an innovation is seen as inclusive if the specific innovation is adopted in such a way that the use of the product or service suits the requirements of the specified group. This will also include the aspect that the innovation should be affordable and accessible by the excluded group.
- Impact: an innovation can only be seen as inclusive if it has a positive influence on the daily lives of the excluded group. This can be considered from different perspectives. In an economic setting, this could refer to greater productivity and welfare. On the other hand, it can be seen as an effect in terms of well-being, livelihood and the capabilities of the excluded group.
- Process: in this step, it is impossible to include the entire group, but an innovation is seen as inclusive if at least certain members of the group are involved. In this category, the involvement should be broken down into the different stages of innovation, namely invention, design, development, production and distribution. Here again, the level of involvement should be determined in each of these steps and different levels of involvement should exit such as being informed, being consulted, collaborating, being empowered and controlling.
- Structure: an innovation is inclusive if it is created within a structure that is itself inclusive. This is necessary as some inclusive processes are often short-lived or has little influence. Lasting, deep inclusion requires institutions, organisations and relationships of the IS to be

inclusively orientated themselves. Here, ISs might require substantial structural reform or establishment of new, more inclusive ISs.

- Post-structure: the argument here is that for an innovation to be inclusive, the frame of knowledge and discourse that created the innovation should be inclusive itself. Only when the framings of key actors who are participants of the innovation makes space to include the excluded may an innovation truly be inclusive.

Important to note from the inclusive ladder is that what is understood or defined as an innovation that is inclusive will depend on the level of the ladder. The lower levels see innovation in the light of the conventional product or process innovations (Heeks *et al.*, 2014). As we move up the ladder, a broader scope is applied to the innovation, and moves beyond the product/process innovation approach that incorporates organisational and marketing changes as innovations in their own right. At the top levels of the inclusive innovation ladder, innovation may be broadened to acknowledge the necessity for change in social structures, social discourse and frames of knowledge (Heeks *et al.*, 2014).

3.4   Conclusion

This chapter outlined the different concepts of poverty and the relationship of innovation and inequalities was explored. It was evident that a reorientation is required from the conventional view of innovation to foster more inclusive innovation trajectories. Numerous innovation approaches address poverty and inequalities, where differing levels of inclusion exist as explained by the 'ladder of inclusive innovation'. The next chapter explores the innovation model and how this may be reoriented towards fostering innovations for inclusive development.

The thesis now moves to report on how conditions may be created that are conducive to implementing I4ID. The thesis deliberately did not reflect much about the IS approach thus far although some mention to the approach has been made in this chapter. The next chapter reports on the IS approach.

CHAPTER 4   INNOVATION SYSTEMS LITERATURE

This chapter introduces the evolution of innovation models in section 4.1, after which special mention is made of the IS framework. This is followed by section 4.2, which provides a thorough outline of the description of the IS. Section 4.3 provides an introduction of the inclusive IS, and section 4.4 outlines the IS and more specifically the technology IS (TIS) as an appropriate framework to guide the analysis and conceptualisation of I4ID. Lastly, section 4.5 draws a comparison between system structures and functions of conventional ISs and the inclusive IS.

1   •Innovation and innovation systems

2   •Components and functions of the innovation system

3   •The inclusive innovation system

4   •The inclusive innovation system requirements
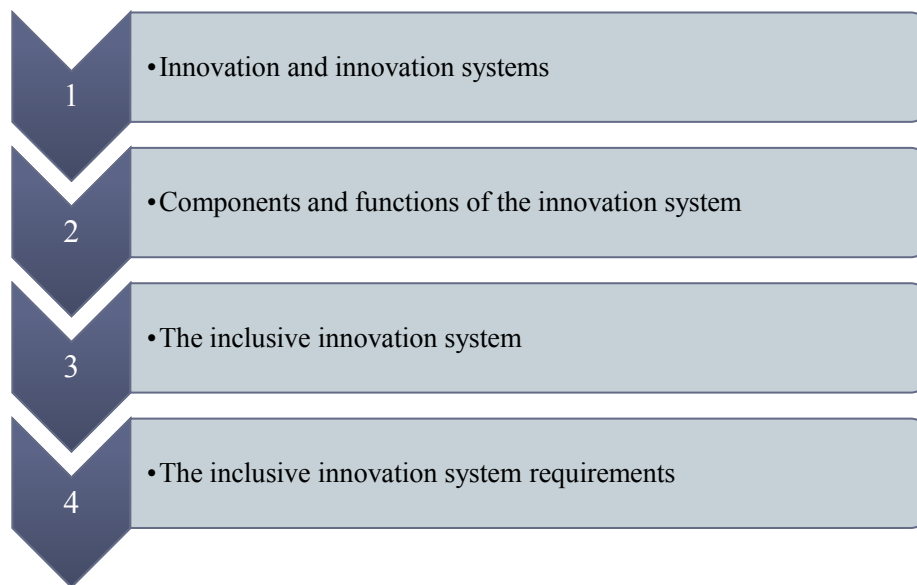
4.1   Innovation and innovation systems

The innovation model has continually evolved over the years. As such, five generations of the innovation model can be identified in literature (Rothwell, 1994). The first two generations of innovation models are both known as the 'linear model of innovation' (Rothwell, 1994). The first generation (technology push) of this model was established in the 1950s and early 1960s as a result of fast economic growth, and this led to the so called 'black hole demand', characterised by strong 'technology push' and industrial expansion in the West, as well as in especially Japan. This led to companies focussing mostly on scientific breakthroughs (Godin, 2006).

The second generation (market pull) (Rothwell, 1994), from the mid-1960s to the early 1970s, saw market shares under pressure, which forced companies to move development focus towards more 'need-pull' strategies. The linear model of innovation received some criticism as it ignores feedback loops, market signals and iterative learning (Godin, 2006). This led to the third generation of innovation

models, namely the chain-linked model which allowed for feedback loops (Godin, 2006). The fourth-generation model (the parallel model) came about in the 1980s when the innovation process moved to innovation as a parallel process of development, and emphasised the relationships required in order to innovate (Rothwell, 1994).

Thereafter, there was increased recognition that a more holistic approach to innovation was required as the preceding models of innovation did not provide a way to improve the entire innovation process (Rothwell, 1994). This led to the fifth generation of the innovation model, focussing on systems integration and networking with the end goal of guaranteed 'flexibility' and 'continuous development' (Rothwell, 1994).

The next section briefly describes the evolution of the linear model towards the systems view of innovation, before moving towards an in-depth overview of ISs. Section 4.1.1 provides an overview of the first and second generation of the innovation model, namely the linear model of innovation, section 4.1.2 provides an overview of the third generation of the innovation model, namely the chain-linked model of innovation, and section 4.1.3 discusses the fourth generation of the innovation model, namely the IS.

4.1.1   THE LINEAR MODEL OF INNOVATION

One of the first theoretical frameworks to understand science and technology and the relationship thereof with the economy has been the 'linear model of innovation' (Godin, 2006). The linear model of innovation postulates that innovation originates from basic research, which moves to applied research and development (R&D) and ending off with production and diffusion (Hekkert & Negro, 2011):

Basic research → Applied research → Development → Production and diffusion

The model, however, has received criticism as it ignores feedback loops, market signals and iterative learning and because it narrowly equates R&D with innovation (Godin, 2006). The model has also been criticised for failing to acknowledge the complex interactions between involved groups in innovative activities (Rothwell, 1994). The merits for this model were based on science-push and market-pull strategies. The market-pull models were, however, criticised for being too simplistic to define the market as a causal mechanism (Godin, 2006). The science-push models on the other hand failed to acknowledge the role that markets play (Rothwell, 1994). Thus, both models were criticised for their lack of recognising complex interactions among involved groups (Rothwell, 1994).

4.1.2   THE CHAIN-LINKED MODEL OF INNOVATION

In essence, the chain-linked model of innovation can be seen as an improvement on the linear model as it acknowledges instructiveness and feedback between stages (Lundvall, 2007). This model does not only rely on current knowledge to innovate, but also acknowledges that innovation may lead to the

creation of new knowledge (Rothwell, 1994). This model is a representation of the feedback loops among research, the existing body of scientific and technological knowledge, the potential market, invention, and the various steps in the production process (Kline & Rosenberg, 1986).

4.1.3   THE SYSTEMS VIEW OF INNOVATION

The study of innovation, however, moved to the most recent model to understand the innovation process, namely the IS approach. The IS framework recognises that the system consists of a network of interrelated actors, where the actors of the system interact and exchange both codified and tacit knowledge to perform innovative activities (Lundvall, 2007). In the IS, knowledge is the main commodity, where networks are necessary for the provision of knowledge channels that allow knowledge flows (Edquist & Hommen, 1999). The system consists of complicated relationships that comprise learning, a critical process of innovation. The IS occurs inside a specific environment where actors interact. These environments are shaped by history, culture and social relationships (Rothwell, 1994). The dynamics that are the result of the specific environment within which an IS exists, define the IS (Rothwell, 1994).

The key components of an IS are defined as organisations, institutions and the relationships that connect them (Edquist, 2001). The systemic approach of innovation is based on the perception that innovations are ultimately brought about by the various components, institutions and the relationships between them (Hekkert & Negro, 2011). When the three previously named components form a sound whole, it creates an environment for collaborative learning, where the process of collaborative learning is fundamental to produce innovations (Hekkert & Negro, 2011).

The concept of the IS originated at national level, but two main variants have emerged in the literature (Lundvall, 2007):

- spatial systems, which include national ISs and regional ISs; and
- sectoral and technological systems.

The variations in the IS approach coexist and supplement one another. Lundvall (2007:98) refers to this coexistence of the variants of the IS as "an intricate interplay between micro and macro phenomena where macro-structures condition micro-dynamics and … new macro-structures are shaped by micro-processes".

It is important to refer to where the conversion of knowledge to value occurs in the IS. Firms play a central role as the main unit of analysis in this regard. Within and among firms, a learning process occurs that ultimately influences the direction and degree of innovations (Lundvall, 2007). This learning process leads to the attainment of numerous capabilities necessary to develop inter alia product and service innovations (Edquist, 2001). This is where the IS framework acknowledges that a firm does not

innovate in isolation, but rather forms part of a system where other organisations and institutions play a role in the type of knowledge generation and the capability of firms to innovate (Lundvall, 2007).

ISs also change over time due to variations in the social, economic and political environment (Freeman, 1995). The study of this change is referred to as the 'evolutionary approach' (Kraemer-Mbula & Wamae, 2010). This approach studies the change in organisations and institutions, which in turn changes the interactions and innovation processes (Freeman, 1995). This evolutionary nature of innovation leads to heterogeneity across sectors, regions and countries (Kraemer-Mbula & Wamae, 2010). It is therefore important to understand the different modes of innovation within the micro-structures as well as between micro- and macro-structures in order to better identify the adaptations required within institutions and organisations to support the conversion of knowledge to value (Lundvall, 2007).

Different delimitations of ISs exist and these are discussed in the following sections. Section 4.1.3.1 provides an overview of the national IS framework, section 4.1.3.2 introduces the regional IS framework, section 4.1.3.3 discusses the sectoral and technological IS frameworks and section 4.1.3.4 concludes by outlining the main differences among the different IS approaches.

4.1.3.1   NATIONAL INNOVATION SYSTEM

The national innovation systems (NIS) concept is based on the principle of understanding the linkages between those actors involved in innovations that are essential to improve technology performance (Freeman, 1995). Innovation and technological change are brought about through the complex set of relationships between the actors that produce, deliver and apply a diverse set of knowledges. Innovative performance of a country is largely dependent on the manner of interaction among involved actors and relationship among these actors as a collective system of knowledge creation and sharing that leads to the application of technologies and innovations (Lundvall, 1992). Actors are primarily private enterprises, universities and public research institutes and the people contained within these entities (Lundvall 1992). Linkages may include joint research, worker exchanges, patent sharing, acquisition of equipment and many other channels. Numerous definitions of the NIS exist. Below we refer to the three definitions by the 'fathers' of the NIS framework:

- "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1995);
- "the elements and relationships which interact in the production, diffusion and use of new and economically useful, knowledge … and are either located within or rooted inside the borders of a nation state" (Lundvall, 1992);
- "a set of institutions whose interactions determine the innovative performance … of national firms" (Intarakumnerd, Chairatana & Tangchitpiboon, 2001).

4.1.3.2   REGIONAL INNOVATION SYSTEM

The regional innovation system (RIS) notion is a more recent construct that is similar to the NIS concept (Hekkert & Negro, 2011), but is considered a subsystem of the NIS (Fulgencio & Lefever, 2016). The major difference is that the RIS unit of analysis is on the regional level (Cooke, Uranga & Etxebarria, 1997; Saxenian, 1991). Regions are referred to as areas smaller than the provinces in which they exist; mostly in built metropolitan areas (De la Mothe & Gilles 1998; Fulgencio & Lefever 2016). Here proximity plays a role, meaning that distance matters in the sense that the distance among actors has a significant effect on a region's innovative performance (Hekkert & Negro, 2011). The RIS framework places emphasis on the micro-orientation of innovations such as firm and organisation networks (Hekkert & Negro, 2011).

4.1.3.3   SECTORAL AND TECHNOLOGICAL INNOVATION SYSTEMS

The NIS and RIS frameworks in general do not place emphasis on the detailed analysis of the technological innovation processes (Hekkert & Negro, 2011). This is where the notion of SIS and TIS plays an important role. Unlike the NIS approach, the SIS analysis approach emphasises the dynamics of technology growth, and technology flows among organisations and institutions in a specific sector (Hekkert & Negro, 2011). SISs are defined by Breschi and Malerba (1997:145) as "the system (group) of firms developing and making a sector's products and generating and utilising a sector's technologies". To summarise, the SIS approach provides an analytical framework that identifies the performance of technological change at industrial sector level (Gao & Lente, 2008). The NIS and RIS rely on spatial dimensions to define their boundaries, as SIS and TIS adopt a certain technology or sector as the system boundary (Cooke *et al*., 1997).

The TIS approach allows the study of the characteristics of the system related to a specific technology to identify strengths, weaknesses and dynamics (Fulgencio & Lefever 2016; Jacobsson & Johnson 2000). The TIS can also be referred to as "a dynamic network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilization of technology" (Carlsson & Stankiewicz, 1991:142). The TIS approach includes the regional or local dimension in its analysis approach and emphasises the importance of identifying the dynamics of an IS to understand technological change (Hekkert & Negro, 2011).

4.1.3.4   SUMMARY OF THE INNOVATION SYSTEM FRAMEWORKS

Gao and Lente (2008) outline the difference among the main actors, institutions and interactions of the different ISs. Their findings are outlined in Table 3.

Table 3: IS framework summary

	NIS	RIS	SIS/TIS

Main actors	• Industry • Government • Education and research organisations	• Universities • Industrial enterprises • Public research organisation	• Firms • Non-firm organisations • Individuals
Institutions	• National policies • Laws • National finance supports	• Informal institutions dependent on trust and reliability among the actors	• Standards • Regulations
Main interactions	• Joint industry activities • R&D collaboration • Technology diffusion • Personnel mobility	• Inter-firm interactions • External interactions for firms with research organisations • R&D collaboration	• Inter-industry interactions • Interactions among firms and non-firm organisations

4.2 Component and functions of the innovation system

An IS is made up of structural components and the relationships among these components (Freeman, 1995; Lundvall, 1992). According to Foster and Heeks (2013), Freeman (1995) and Suurs (2009), the four structural components consistently used in literature are:

- actors;
- relationships;
- soft and hard institutions; and
- physical, financial and knowledge infrastructure.

These structural components form the foundation that facilitates functions of the IS. Relationships among structures form the functions of the IS and shed light on the dynamics of the system. In more recent literature, specific attention has been given to functions of ISs (Alkemade & Hekkert, 2009; Suurs, 2009). The TIS literature introduced the concept of system functions and argues that a system can be better described through its functions. The idea behind this approach is that the system is considered to have a purpose, and that this purpose can be served through the fulfilment of a set of functions (Jacobsson & Bergek, 2004). An important purpose of the IS is to induce innovation processes (Suurs, 2009). Activities that contribute to the creation and diffusion of innovations are considered system functions (Alkemade & Hekkert, 2009; Suurs, 2009). System functions can be understood as types or sets of activities that contribute to the overall innovation process of a system (Wieczorek & Hekkert, 2012). The performance or functioning of the system can then be expressed in how well the individual functions have been fulfilled (Bergek *et al.*, 2008). Literature is still not in agreement regarding a definite list of functions;, however, seven system functions have emerged within the literature (Bergek *et al.*, 2008; Suurs, 2009; Wieczorek & Hekkert, 2012):

- knowledge development;
- knowledge diffusion;
- entrepreneurial activities;
- market formation;

- guidance of search;

- creation of legitimacy; and

- resource mobilisation.

Section 4.2.1 explores system structures and section 4.2.2 provides a thorough outline of system functions.

4.2.1   SYSTEM STRUCTURES

System structures and functions are the building blocks of any study to understand a specific IS. This section will contribute to a better understanding of the different concepts involved and which serve as the building blocks towards the proposed analytical framework. The four structures identified are explained in this section, namely actors, interactions, institutions and infrastructure.

– **Actors**

Actors are the components that produce innovation activities. It is important to identify the relevant actors who have an influence on the system (Wieczorek & Hekkert 2012). Actors are seen as civil societies, government, non-governmental organisations (NGOs), companies (start-ups, small and medium-sized enterprises [SMEs], multinationals, large firms), knowledge institutes (universities, technology institutes, research centres, schools), and other parties such as legal organisations, financial organisations/banks and intermediaries (Bergek *et al*., 2008; Hekkert *et al*., 2007).

– **Interactions**

Linkages develop among actors, institutions and technologies, and when structural factors form a configuration it is called a network (Suurs, 2009). Networks become an essential part of any system, as they are the base for knowledge development, learning and knowledge diffusion as captured by the following quote, "the fundamental uncertainty involved in innovation leads to a process of search, experimentation, and satisfying behaviour – in short, a learning process" (Suurs, 2009:213).

Dynamics within ISs form through a combination of structural tensions (divergence among actors, institutions and innovations) and synergies (complementarities), represented through various relationships within and between networks (Suurs, 2009). Networks may have a specific task, such as public–private partnerships (PPPs) or standardised networks, or they may be informal towards a specific industry such as university–industry links or buyer–seller relationships (Bergek *et al*., 2008).

– **Institutions**

Institutions or institutional structures are identified as the rules and norms of the system, including culture, regulations and routines, and are at the core of any IS (Suurs, 2009). Institutions outline the humanly invented constraints that form human interaction (Edquist & Hommen, 1999).

Two types of institutions exist, namely formal and informal institutions (Edquist & Hommen, 1999). Formal institutions are rules enforced by authorities, while informal institutions are rather a tactic nature formed organically through the interaction of actors (Bergek *et al.*, 2008). Alignment of institutions is essential and will not manifest on its own; the contrary is true (Jacobsson & Lauber, 2006). Institutional alignment is important as it indirectly influences the presence and skills of enactors. It plays an important role towards interventions, as it is a key factor in government policies and business strategies (Suurs, 2009).

– **Infrastructure**

Infrastructures is not limited to physical infrastructure, but also takes into consideration intangible infrastructure, which entails the skills and know-how produced and accumulated through in the system. Infrastructure may be viewed according to a three-pronged approach: physical, knowledge and financial (Wieczorek & Hekkert 2012). **Physical infrastructure** entails for instance buildings, roads, machines, mobile networks and harbours. **Knowledge infrastructure** entails for instance knowledge of the system, strategic information and expertise for a specific sector. **Financial infrastructure** may entail all forms of financial support which may be realised through programmes and grants.

4.2.2 FUNCTIONS OF THE INNOVATION SYSTEM

Functions describe and map current functioning of systems regarding key processes and provides a picture of the current functional pattern (Bergek *et al.*, 2008). The central idea of the approach is that the system purpose is achieved through the fulfilment the functions of the system (Woolthuis *et al.*, 2005). Suurs (2009) emphasises that the most important purpose of the IS is to stimulate innovation processes, and that the activities that develop the innovation may be labelled 'system functions'.

System functions are more evaluative than system structures as they are useful to explore the performance or dynamic patterns exhibited by the system (Wieczorek & Hekkert 2012). System functions represent the system at a specific moment. The next section expands on the seven system functions identified by Wieczorek and Hekkert (2012).

– **F1: Entrepreneurial activity**

An IS cannot be without entrepreneurs, as they are essential for ISs to function (Hekkert *et al.*, 2007). The role of an entrepreneur is to turn the potential of new knowledge, networks and markets into actions that generate as well as take advantage of novel business opportunities (Hekkert *et al.*, 2007).

Entrepreneurs may be new entrants in new markets, or existing companies that expand their business strategy to utilise new developments (Suurs, 2009).

- **F2: Knowledge development**

This function is concerned with the process of knowledge development and learning. It is at the core of an IS as it forms the base for the functioning of the system. The function analyses and portrays the breadth and depth of the knowledge base (Wieczorek & Hekkert, 2012a). Knowledge may be generated through research or by 'learning-by-doing' (Bergek *et al.*, 2008). The system approach towards innovation substantiates the fact that a broad approach to knowledge development is required where knowledge is not only developed, but also put to use. Bergek *et al.* (2008:12) outline the difference between type and source of knowledge development:

- "Type: scientific, technological (e.g. system integration), production, market, logistics, application specific, design, etc."
- "Source: R&D, learning from new applications, imitation, import, etc."

– **F3: Knowledge diffusion**

Knowledge diffusion is concerned with the diffusion and availability of knowledge to system actors (Wieczorek & Hekkert, 2012). Networks bind an IS, and one of the main functions of a network is that of facilitating the exchange of knowledge between all the actors involved in the system (Wieczorek & Hekkert, 2012). Knowledge diffusion takes place through engagement between actors. In the instance where knowledge diffusion takes place, a mutual understanding will evolve and, in turn, enable institutions to gradually adjust innovative solutions, and vice versa (Suurs, 2009).

– **F4: Guidance of search**

'Guidance of search' relates to activities in an IS that guides actors with the aim of future support of an innovation (Wieczorek & Hekkert, 2012). 'Guidance of search' refers to choices of individual actors supporting an innovation, and may include hard institutions, such as policy regulations. It also includes the different promises and expectations from actors within the system (Bergek *et al*., 2008).

A lack of concrete direction for knowledge development, knowledge diffusion and entrepreneurial activities is bound to lead nowhere (Hekkert *et al.*, 2007). The fulfilment of the guidance of search function is an interactive process including governments, technology producers, technology users and NGOs, and the promises and expectations of the developing innovation (Suurs, 2009).

– **F5: Market formation**

Markets may be greatly underdeveloped or not exist at all for emerging ISs (Van der Hilst, 2012). These uncertainties may prevail in a wide variety of dimensions as market places do not exist if prospective customers may not have expressed their demand, or if they do not have the necessary platform or expertise to do so or the performance and price of the new technology may be uncompetitive due to the lack of market understanding (Suurs, 2009). This function is mainly concerned with the formation of markets for emerging innovations.

– **F6: Resource mobilisation**

'Mobilisation of resources' refers to the allocation of financial, material and human capital (Suurs, 2009). There is a need to understand the extent of a system to mobilise its resources, as resource mobilisation represents a basic economic variable (Bergek *et al*., 2008) . The importance of it is evident in the following quotation, "An emerging technology cannot be supported in any way if there are no financial or natural means, or if there are no actors present with the right skills and competences" (Suurs, 2009:47).

– **F7: Creation of legitimacy**

Legitimacy is social acceptance and compliance of the relevant innovation with existing institutions (Zimmerman & Zeitz, 2002) to mobilise resources and create a demand to acquire political strength for the emerging system, should the proposition of a system be considered suitable and sought after by active actors in the system (Bergek *et al.*, 2008). Legitimacy is not a given, and especially not for emerging innovations, which is still a very new concept. The legitimacy process is formed through mindful actions by institutions and actors to overcome the burden of newness that usually exists for a novel innovation (Zimmerman & Zeitz, 2002).

4.3 The inclusive innovation system

A large number of innovations in developing countries take place in informal settings. Research on innovation in informal settings outlines several fundamentally different features of the innovation process (Chataway *et al.*, 2014). A detailed outline of these features follows.

First, innovations occurring in informal settings are regularly initiated through a strong demand from those individuals and communities with the goal of improved welfare or quality of life (Chataway *et al.*, 2014). The reason is the absence of provision of products or services by conventional actors (public and private)(Lizuka, 2013). Second, a large number of skills obtained in informal settings are often gained not from the formal education and training system, but rather from an informal learning process (Kraemer-Mbula & Wamae, 2010). This means that aspects of the IS, such as the institutional set-ups that enhance knowledge flow (local knowledge, such as traditional knowledge, culture, routine), institutions (tradition, custom, routine) and learning networks differ from what is known as conventional formal settings (Lizuka, 2013). Important to note here is that these differences are local and context-specific. Third, interactions among informal and formal settings remain limited (Cozzens & Sutz, 2012). Fourth, there is increased acknowledgement of the role of intermediary organisations or actors as knowledge diffusers between informal and formal settings (Mair, Martí & Ventresca, 2012). This is necessary to generate increased diffusion of knowledge that is required to innovate for inclusive development and sustainable scaling up of innovation activities in informal settings and acts as a link between the formal and informal market (Van der Hilst, 2012). Fifth, innovations in developing countries are dominated by non-technological innovations and rely on incremental and organisational innovation (Cozzens & Sutz, 2012). Finally, policies that benefit and improve the welfare of marginalised communities differ from a formal orientation and require effective design and implementation that take into account the local and specific context of knowledge (Cozzens & Sutz, 2012; Foster & Heeks, 2015; Kraemer-Mbula & Wamae, 2010).

The changes outlined for the process of I4ID are characterised by a shift in the role, the capacities required, conditions for interactions and the inclusion of non-traditional actors in the learning process

to obtain knowledge and understanding of the informal environment (Rip & Kuhlmann, 2015). There is a different focus to knowledge flow, aimed at improving 'non-economic' aspects, started through users or communities that are often not directly linked (if linked at all) to the market (Lizuka, 2013). There is also an increased focus on non-technological innovations that rely on incremental and organisational innovation (Lizuka, 2013). This may often require new capabilities for actors to access and develop new networks as well as knowledge production networks (Carlsson *et al.*, 2002). I4ID places emphasis on the central role of the process of knowledge creation and collaborative learning required to take place among various actors to enable I4ID (Rajalathi, Janssen & Pehu 2008). Caution is required to how and when to develop linkages, how and when to access knowledge and how and when learning should be established (Van Mierlo *et al.*, 2010).

To understand the above narrative, the work of Rip and Kuhlmann (2015) highlights the critical aspect of the IS framework to agree on the development process and a new type of IS. Rip and Kuhlmann (2015) outline the emergence of a 'new constellations of actors' aiming to address society's greatest challenges that require new forms of engagement and capabilities of actors as outlined above for these new types of innovation to take place constructively and productively. These new types of innovation drive the formation of capability development, institutions and networks in response to societal concerns and challenges rather than the traditional method of technology-push (Rip & Kuhlmann, 2015).

Numerous scholars recognise the role that the IS approach plays in addressing the concerns of inequalities and the fight against poverty (Altenburg, 2008; Chataway *et al.*, 2014; Foster & Heeks, 2013; Kaplinsky *et al.*, 2009). There is increased importance to understand systemic solutions where a systemic understanding could have a profound effect on policymaking (Rip & Kuhlmann, 2015). However, as discussed above, the IS requires slight adjustments to adhere to these new demands of inequalities and poverty.

The IS framework has been proved useful to explain the innovation process considered from a formal perspective, where firms are recognised as the enablers and driving forces of the innovation process (Lizuka, 2013). The IS framework has a sound methodology to outline how and why some firms, countries or regions experience increased economic growth in comparison to others (Hekkert *et al.*, 2011). This was done through identifying existing actors, linked to the market, and studying interactions and the process of knowledge flows among actors (Suurs, 2009). The system uses a systemic approach to identify blockages to knowledge flow, enabling an effective strategy to formulate policies that enhance effective knowledge flow, which enables economic development within national boundaries (Hekkert *et al.*, 2007).

Currently, ISs is faced by numerous challenges to 'solve non-market problems' in less-understood informal settings (Kraemer-Mbula & Wamae, 2010). The system requires to reconsider and broaden its focus to include unconventional actors and to make room for different circumstances, environments and interactions (Chataway *et al*., 2014; Foster & Heeks, 2015). There is a need to identify the local specificities and common features that enable the understanding of a changed focus on policy elaboration and frameworks that consider local markets (Chataway *et al.*, 2014; Foster & Heeks, 2015). The IS is an appropriate framework to address these new requirements as it gives attention to the institutional setting, policy and actors, where all of these points are considered critical in emerging types of innovation, but require adaption (Lizuka, 2013). This outlines that problem solving remains in the domain of innovation as outlined by Schumpeter (1934). Although the new focus of innovations differs from conventional innovation in its focus, it is interesting to note that these emerging innovations do not differ much in their foundation, when referring back to the original definition by Schumpeter (1934), as outlined earlier in this chapter. For clarity, the five groups where reference is made to the emerging innovation focus are outlined again:

- a new or improved product (I4ID);
- a new or improved process (I4ID);
- the opening of a new market (informal settings, marginalised communities);
- the acquisition of a new source of raw materials or semi-manufactured goods (acknowledge marginalised as partner); and
- an organisational change (new methods of business, acknowledging the marginalised as partner).

The IS framework that originated from Schumpeter's definition continues to be a useful 'focussing device' for the 'problem-solving' process. However, careful consideration and understanding of the new context are required, where further research into the adjustment of the framework is required (Altenburg, 2008; Chataway et al;., 2014; Foster & Heeks, 2013). This requires a renewed focus to which Rip and Kuhlmann (2015) refer as the 'grand societal' experiment, which is summarised as follows:

- aim of innovation, real requirement for innovation to be inclusive;
- driving force of innovation;
- engage and support a new constellation of actors (Foster & Heeks, 2013);
- a new range of institutions is required and a 'reinvention of the commons' (Foster & Heeks, 2015);
- actors to engage in new ways;
- understanding of knowledge flow (Chataway *et al*., 2014);
- the policy needs effective design and implementation (Van der Hilst, 2012); and

- new capabilities, which have implications for the type and form of learning that needs to take place are required (Cozzens & Kaplinsky, 2009).

These points are explained in detail below.

- The aim of innovation shifts from 'improving the productivity of the firm' to 'solving a problem for better quality of life for the community'

Innovations are local need-orientated, demand-driven and has a focus on non-technical innovations. There exists a process of multi-partner collaborative problem solving that leads to innovations that have a focus solving local problems, which includes the marginalised in the innovation output and process. The role of reverse engineering is important, especially in terms of diffusion and incremental innovation improvements (Chataway *et al.*, 2014).

- Self-organising users or community as new driving force for innovation

User innovation focuses on the user as the driving force or starter of the innovation, contrasting the conventional method where producers or firms are the driving force (Heeks *et al*., 2014).

- Include non-conventional actors in knowledge networks

Understanding the knowledge flow of emerging innovations requires the inclusion of non-conventional actors (such as informal shop owners, NGOs and local communities) (Tello-Rozas, 2015). These actors are often not directly acknowledged but are ignored in knowledge networks.

- The institutional settings

A multifaceted institutional set-up is required, which takes into consideration the effect of informal institutions at local level (Foster & Heeks, 2013 Rip & Kuhlmann, 2015). Institutions are a complex mix of informal and formal institutions where regulatory environments are crucial to apply novel approaches (Cozzens & Kaplinsky, 2009). There is a need for 'reinvention of the commons', such as new approaches to intellectual property formulation.

- Actors to engage in new ways

Spaces and places: for informal socialised relationships with deep-rooted partnerships with unconventional actors (Foster & Heeks, 2013 Rip & Kuhlmann, 2015).

- Incorporate multiple dimensions of the knowledge network and its diffusion process

It is necessary to understand knowledge flow patterns in order to understand the IS (Foster & Heeks, 2013). The quality of networks and the type of network, defined by trust and social capital, have a profound influence on the trajectory of knowledge flow as well as on the speed of diffusion, and this

influences the innovation process (Lizuka, 2013). This is essential to take into consideration and to extend networks to non-market networks and the informal context in order to gain knowledge of the dynamics of the innovation process in less formalised settings (Heeks *et al.*, 2014).

–   The policy needs for effective design and implementation, search for alternative solutions

Conventional innovations and ISs focus attention largely on R&D and technological innovation of the firm (Lundvall, 2007). The new variants of innovation acknowledge technology as playing a supportive role to address problems (Kraemer-Mbula & Wamae, 2010). A clear example is improving the health of citizens' where solutions may look beyond technological innovation in medicine, but rather focus on alternative innovative policies that have an influence on improved health, such as subsidies to sports facilities, medical check-ups and dietary advice (Heeks *et al.*, 2014).

–   New capabilities have implications for the type and form of learning that needs to take place

A new set of capabilities is required from formal and informal actors. These new capabilities must have a focus on fostering novel interactions, novel knowledge development and diffusion as well as the capability to put knowledge to use to develop I4ID and move beyond product and service output innovation with an increased focus on inclusivity in the innovation process (Rip & Kuhlmann, 2015).

For the purposes of this study, the renewed focus of structural components of the IS needed to be identified, as well as the functioning of an inclusive IS. The IS had to be adapted to incorporate the requirements and interests of the marginalised groups through integrating multidisciplinary concepts, supporting one another, to be able to incorporate the 'new' set of needs of the marginalised. There are noticeable changes to the capabilities and capacities required to guide various system structures to be inclusive of non-traditional actors in the process of learning and knowledge creation of the marginalised environment and the manner in which new interactions must take place (Rip & Kuhlmann, 2015). The process of knowledge creation and collaborative learning existing among the 'new' set of diverse actors is an essential enabler for effective I4ID. A IS is unlikely to be exclusively traditional or inclusive; thus, we move on to make a distinction between these systems drawing from the above literature analysis and mainly the studies by Rip and Kuhlmann (2015), Foster and Heeks (2013) and Lizuka (2013).

4.4   **The inclusive innovation system requirements**

Table 4 and Table 5 provide a brief comparison of the conventional IS and the IIS in terms of system structures and functions.

Table 4: Comparison of conventional and inclusive IS structures

Structures	Conventional IS	Inclusive systems of innovation
Broad system focus and goal	Development as economic growth – macro level analysis	The IIS has a socio-economic and micro-level focus that strives for better livelihoods and quality of life, specifically aimed at the marginalised. The system strives for social innovation and challenge-based approaches. The system responds to societal concerns that were voiced and articulated through the voices of a diverse set of actors, which included a bottom-up process.
Innovation	Located innovation before and after production. - growth-orientated innovation - supply-driven innovation - technical innovation	Innovations are local need-orientated and demand-driven and has a focus on non-technical innovations (Foster & Heeks, 2013). There exists a process of multi-partner collaborative problem solving that leads to innovations that have a focus on solving local problems, include the marginalised in the innovation output and process (Altenburg, 2008). Reverse engineering plays an important role, especially in terms of diffusion and incremental innovation improvements.
Learning	Main focus: higher-income markets/consumers formal supply-side organisations in industrial sectors innovation intermediaries as R&D brokers	Learning takes into consideration context-specific knowledge with an increased focus on diffusion and requirements of the marginalised market. There are increased learning of social processes and the inclusion of marginalised actors sustainably (Chataway *et al.*, 2014). There exist increased knowledge of the informal markets and the process of inclusive development (Foster & Heeks, 2014).
Actors	Formalised, relatively static, direct impact overarching institutions	Broadens participation of the 'new range' of actors: including non-traditional demand-side actors (intermediaries, marginalised, demand-side innovators) (Foster & Heeks, 2013; Ismail *et al.*, 2012; Rip & Kuhlmann, 2015). This increases the focus on inclusion of marginalised actors and community participation.
Interactions	Learning by doing plus using and interacting: Learning about production and implementation Learning about technology Coherence and profit maximisation as guides	Spaces and places: for informal socialised relationships with deep-rooted partnerships with unconventional actors (Foster & Heeks, 2013; Rip & Kuhlmann, 2015). Needs to be open and socialised and includes participants of the entire IIS.
Institutions	Preference for formal,	Multifaceted institutional set-up, takes into consideration the effect

	close relationships	of informal institutions at local level (Foster & Heeks, 2013; Rip & Kuhlmann, 2015). Institutions are a complex mix of informal and formal institutions where regulatory environments are crucial to apply novel approaches. There is a need to 'reinvent the commons' such as new approaches to intellectual property formulation.

Source: (Chataway *et al.*, 2014; Cozzens & Kaplinsky, 2009; Foster & Heeks, 2013; 2015; Van der Hilst, 2012)

Table 5: New orientation of system functions for inclusive systems of innovation

Functions	Conventional IS	Inclusive systems of innovation
F1: Entrepreneurial activities	Mainly focussed to generate opportunities for businesses to exploit ideas aimed mostly at high-income markets.	The inclusion of unconventional actors as knowledge enablers and diffusers and inclusion in the entire process of innovation development (Rip & Kuhlmann, 2015). From a formal business side, there are business models aimed at the marginalised community. There exist opportunities for the marginalised to be included in the innovation process as far as a particular system allows (Chataway *et al.*, 2014).
F2: Knowledge development	Knowledge development takes place through formal R&D or informal knowledge production activities.	Knowledge that has a combination of market pull and push strategies (Foster & Heeks, 2013). Pull strategies adhere to the requirements of the marginalised, while push strategies are orientated at those sectors of most value to the marginalised. Focus on knowledge, capacities, development and collaboration (Cozzens & Kaplinsky, 2009). Formal knowledge orientation towards information richness of marginalised livelihoods (Van der Hilst, 2012).
F3: Knowledge diffusion	Supply-side and demand-side support mechanisms that enhance the flow of knowledge enabling innovative activities to be suitable to its target market.	The focus here is orientated towards diffusion, capacity for diffusion and the ability of information to be absorbed and incorporated in I4ID (Lizuka, 2013). There is a new focus of knowledge diffusion channels.
F4: Guidance of search	Provision of guidance to identify and invest in the appropriate technology or project.	The system requires belief in growth potential, clear, achievable, structured targets, incentives to drive forward emerging markets and government policies towards inclusive development (Hekkert *et al.*, 2011).
F5: Market formation	Mechanism where innovations are developed and	There is a shift to move from a product-centric approach to a focus on business model innovation, of which the product is but a subset (Van der Hilst, 2012). Systems thinking is a

	introduced to the markets.	prerequisite for success in marginalised markets (Rip & Kuhlmann, 2015). Further, the marginalised market requires a renewed emphasis on building a system as an integral part of innovation. Government may play an important role to create spaces and places supporting IIS and I4ID to be market-ready (Kraemer-Mbula & Wamae, 2010).
F6: Mobilisation of resources	Provides guidance to have appropriate access to human, physical and financial resources to foster mainstreamed innovation.	Mobilising and developing infrastructure, technologies and innovations to the unique constraints and requirements of the marginalised (Foster & Heeks, 2014). There is access to sufficient capital and human resources for I4ID.
F7: Creation of legitimacy	Creates structures supporting the legitimisation of resources that gain commitment from government and the private sector enabling the support of innovations.	Important to form legitimacy around a market and, more importantly, around the effect of interventions in marginalised markets. Engagement with marginalised community and sustainable relationships. There is a focus on evidence-based interventions to enhance the legitimacy of the IIS.

4.5   Conclusion

This chapter reported on the evolution of the innovation model and provided a thorough outline of the latest model, namely the innovation system (IS). The IS may have different focus areas, and a brief introduction and overview were provided of the NIS, RIS, SIS and TIS. The chapter further introduced the inclusive IS and the different orientations required to be able to innovate for inclusive development. The chapter further identified the TIS as an appropriate method to explore the IIS further. The chapter concluded by drawing a comparison between the different focus areas of the IS and IIS in terms of system structure and functions. It is clear from the comparison that a different structural orientation is required that may achieve changed system functions. The next chapter introduces the IS framework and the adaption thereof in order to outline an inclusive IS.

CHAPTER 5   ANALYTICAL FRAMEWORK DEVELOPMENT

This chapter outlines a practical IS analysis approach. The chapter firstly reports on the IS and IIS analysis method to outline an IS analytical framework, mainly based on the work of Wieczorek and Hekkert (2012). Section 5.1 presents a discussion on what a TIS analysis framework entails and outlines the four phases of the proposed framework. Section 5.2 provides a thorough description for each of the four phases of the framework. Section 5.3 adapts the framework to outline the inclusive IS analysis framework.

1	• The technological innovation system framework
2	• Description of technological innovation system analysis framework
3	• System analysis: functional-structural approach
4	• Inclusive innovation system analysis framework
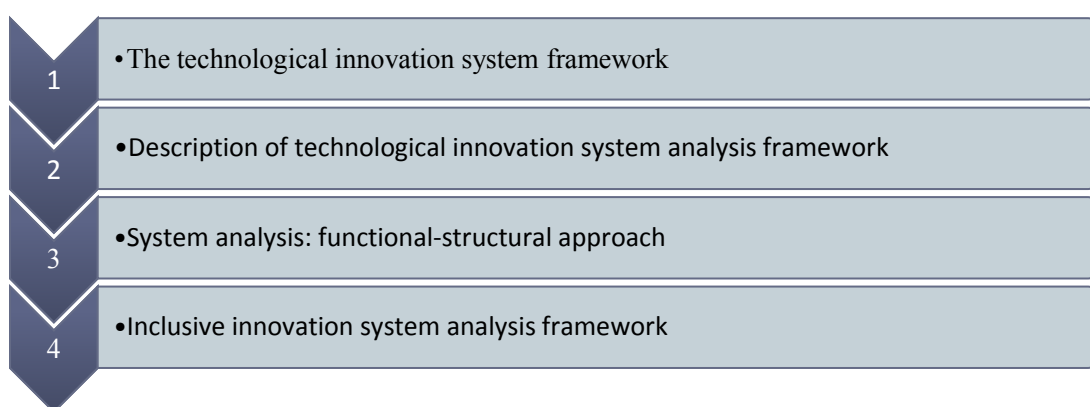
5.1   Technological innovation system analysis framework

To develop the proposed state-of-the-art IIS framework, the existing leading frameworks in the IS and IIS literature were reviewed. Table 6 provides an outline of the major steps included in the reviewed frameworks. From this analysis, eight notable steps and four phases of the IS analytical approach were identified. Some works addressed only one or a few of these eight steps in isolation, while others included all eight identified steps. To ensure the development of a holistic framework, all eight steps and all four phases were incorporated in the proposed framework. A short description of each the eight steps of the proposed framework is provided in Table 7. Furthermore, a discussion of the four phases follows.

Table 6: Major analytical methods for different IS paper

Author	Step 1: Defining the IS in focus	Step 2: Structural approach	Step 3: Functional approach	Step 4: Functional-structural approach	Step 5: System Failures/problems/blocking mechanisms	Step 6: Assessing functionality	Step 7: Systemic policies	Step 8: Systemic instruments	Empirical/ theoretical
Wieczorek and Hekkert (2012)	No	Yes	Yes	Yes	Yes	No	Yes	Yes	T
Bergek *et al.* (2008)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	T
Van der Hilst (2012)	Yes	Yes	Yes	Yes	No	No	No	No	E
Foster and Heeks (2015)	No	No	No	No	No	No	No	No	T
Foster and Heeks (2013)	No	Yes	No	No	No	No	Yes	No	E
Foster (2013)	No	No	No	No	Yes	No	Yes	No	E
Padilla-Pérez and Gaudin (2014)	No	Yes	No	No	Yes	No	Yes	No	T
Foster and Heeks (2011)	No	Yes	No	No	Yes	No	Yes	No	E
George *et al.* (2012)	No	Yes	No	No	Yes	No	No	No	E
Hekkert *et al.* (2012)	No	Yes	Yes	No	Yes	No	Yes	Yes	T
Woolthuis (2005)	No	Yes	Yes	No	Yes	No	Yes	No	E
Mostaf *et al.* (2015)	No	Yes	Yes	Yes	Yes	No	Yes	No	E
Van Mierlo *et al.* (2010)	No	Yes	No	No	No	No	No	Yes	E
Van Alphen, Van Ruijven, Kasa, Hekkert and Turkenburg. (2009)	No	No	Yes	No	No	No	No	No	E
Edquist (2001)	Yes	Yes	Yes	No	No	No	Yes	No	E
Breukers, Hisschemöller, Cuppen and Suurs (2014)	Yes	No	Yes	No	No	No	No	No	E
Lamprinopoulou, Renwick, Klerkx, Hermans and Roep (2014)	Yes	Yes	Yes	Yes	No	No	Yes	No	E

Table 7: Description of IS analysis framework steps

Step of analytical approach	Description of approach
1) **Defining the IS in focus**	This is not a straightforward approach. Analysts have numerous choices when deciding on the unit of analysis or the focus of the study (Bergek *et al.*, 2008). A particular IS may be defined through a product or technology or particular sector (e.g. healthcare). Boundaries may be selected based on a specific target group (e.g. women) or a specific geographic region (e.g. South Africa).
2) **Structural approach**	These are the actors, institutions, networks and technology that make up the system and bring about the innovation under study (Edquist, 2001; Van der Hilst, 2012; Wieczorek & Hekkert, 2012) .
3) **Functional approach**	The functional approach places emphasis on the processes that are of importance for the IS to perform well (Bergek *et al.*, 2008; Wieczorek & Hekkert, 2012; Woolthuis *et al.*, 2005). These processes are called 'functions of the IS', and they clarify the dynamics of the system.
4) **Functional-structural approach**	This is an integrated form of the functional and structural approaches. Scholars identified shortcomings in using the preceding steps in isolation for system analysis purposes (Bergek *et al.*, 2008). After the functional pattern of a system has been established, each function is examined from the perspective of the four structural elements (Bergek *et al.*, 2008). This is used for either explanatory or policy reasons. This means that the reasons for a system function being absent or weak may be due to structural shortcomings of the IS (Wieczorek & Hekkert, 2012). Similarly, when the structural elements are changed, policies may produce conditions where the functions are 'strengthened'. This means that the structures of the IS make functions meaningful. The coupled functional–structural analysis provides a rich overview of what happens in the systems and which problems exist and why. This analysis also moves beyond the classic functional analysis to suggest policies to strengthen an IS.
5) **Systemic problems: system Failures/weaknesses/blocking mechanisms**	IS literature refers to problems that alter the development of ISs as 'systemic problems', 'failures' or 'weaknesses' (Bergek *et al.*, 2008). Systemic problems occur in the structure of the IS.
6) **Assessing functionality/phase of development**	To assess system functionality means that the analysis considers not how, but how well a particular system is functioning. This approach evaluates the relative 'goodness' of a particular functional pattern (Wieczorek & Hekkert, 2012).
7) **Systemic policies and key policy issues**	Policies aim to strengthen poor functionality of the TIS through the approach of strengthening/adding inducement mechanisms and addressing the identified system weaknesses and blocking mechanisms (Bergek *et al.*, 2008).

8)	Systemic instruments	This phase requires the identification of systemic problems before selecting strategies and tools to influence the overall functioning of the IS, called 'systemic instruments' (Bergek *et al.*, 2008a; Wieczorek & Hekkert, 2012).

The eight steps in Table 7 can be divided into four phases (Wiezcorek et al. 2012), namely system identification, system description, system analysis following a functional structural approach, and system intervention.

The system identification phase consists of the boundary selection (as outlined in step 1 above). The second phase, the system description phase, entails step 2 (description of system structures) and step 3 (description of system functions). The third phase, system analysis (functional-structural approach), entails step 4 (systemic problem identification). The fourth phase, system intervention, entails step 5 (systemic policy goals and systemic policy instruments).

This approach is seen as cyclical as displayed in Figure 3 as the approach aims to strengthen a particular IS. After implementation, re-evaluation of the process follows for further strengthening of the IS. The five phases and accompanying steps require a detailed explanation. The thesis now moves to provide an in-depth explanation, before exploring the adaptation of the state-of-the-art IS framework to the IIS domain.
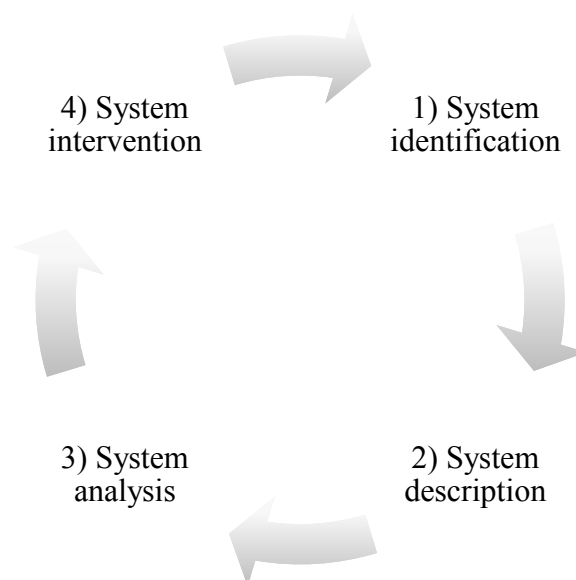
Figure 3: IS analysis framework

5.2 Description of technological innovation system analysis framework

This section describes the IS framework as developed and reported in section 5.1 in more detail. Section 5.3 then outlines the adaptation of this framework to be more suitable for I4ID. Section 5.2.1 describes the system identification phase, section 5.2.2 outlines the system description phase, section 5.2.3 outlines the system analysis (functional structural approach) phase and section 5.2.4 outlines the system intervention phase.

5.2.1 SYSTEM IDENTIFICATION (BOUNDARY SELECTION)

The system boundaries capture reality through features relating to the societal problem (Suurs, 2009). System boundaries may be defined in terms of a product or technology or particular sector, a specific target group or a specific geographic region (Bergek, 2008). Geographic boundaries are not strictly defined to actors present within the boundaries. Activities of actors that are orientated towards the specified innovation within a geographically defined area, should be included in the system (Lundvall, 2007). It must be noted these actors may still interact with actors in the system, and even influence the system, but this is seen as an exogenous influence on the system (Lundvall, 2007). The system boundary may eventually be broadened as the system is better understood, to include aspects that have an indirect influence on the system.

5.2.2 SYSTEM DESCRIPTION

Section 5.2.2.1 outlines the description of system structures, while section 5.2.2.2 outlines the description of system functions.

5.2.2.1 SYSTEM STRUCTURES

The starting point of analysis is to define the system as related to a specific set of core structures associated with the societal problem (Suurs, 2009). To summarise, the definition of a complete system is as follows, "the total system, at whatever level in the hierarchy, consists of all relevant components, attributes, and relationships needed to accomplish an objective" (Blanchard & Fabrycky. 1998:358).

The thesis considers the four structural components outlined in Chapter 4, namely actors, institutions, interactions and infrastructures.

Table 8 outlines the system structures and provides a brief description of their subcategories. This step should allow a researcher a clear description of all the structures of the system, their roles, relationships and attributes (Bergek *et al*., 2008).

Table 8: System structures and their subcategories

Structures	Subcategories (Bergek *et al.*, 2008; Wieczorek & Hekkert, 2012a; Woolthuis et al., 2005)
Actors	- Civil society - Companies: start-ups, SMEs, large firms, multinational companies - Knowledge institutes: universities, technology institutes, research centres, schools - Government - NGOs - Other parties: legal organisations, financial organisations/banks, intermediaries, knowledge brokers, consultants
Institutions	- Hard: rules, laws, regulations, instructions - Soft: customs, common habits, routines, established practices, traditions, ways of conduct, norms, expectations
Interactions	- At level of organisations - At level of individual contacts
Infrastructure	- Physical: artefacts, instruments, machines, roads, buildings, networks, bridges, harbours - Knowledge: knowledge, expertise, know-how, strategic information - Financial: subsidies, financial programmes, grants.

5.2.2.2   SYSTEM FUNCTIONS

This step identifies the functional pattern of the IS and aims to describe the functions for later analysis of the behaviour of the IS in terms of key processes (Bergek *et al*., 2008). This approach is considered to have two key advantages, as IS analysis studies generally take into consideration only a static view of a system, through system components (Wieczorek & Hekkert, 2012). Firstly, the functional analysis of an IS allows for mapping events and activities over time and provides the researcher insight into the system dynamics (Hekkert *et al.*, 2007; Suurs, 2009). Functions further have an influence on one another, as feedback loops exist among functions (Suurs, 2009). When relationships and feedback loops among functions exist, opportunities arise to identify how an IS may be orientated to reach a state of self-strengthening, or what is called cumulative causation (Suurs, 2009). Secondly, it offers a way to analyse the performance or functioning of the system and may be expressed by how well the functions are performed (Suurs, 2009). To be able to map the functional pattern of a system thoroughly and to show how well the system is functioning, indicators and diagnostic questions are required (Suurs, 2009; Van der Hilst, 2012; Wieczorek & Hekkert, 2012). The development of a set of indicators and diagnostic questions for a system acts as a guide for functional identification as well as the system analysis phase of the IS (Van der Hilst, 2012; Wieczorek & Hekkert 2012).

5.2.3   SYSTEM ANALYSIS: FUNCTIONAL-STRUCTURAL APPROACH

The IS literature is clear on defining those factors hindering the development of an IS as systemic problems, weaknesses or failures (Alkemade & Hekkert, 2009; Bergek, 2008; Wieczorek & Hekkert, 2012; Woolthuis *et al.*, 2005). There seems to be consensus in the literature that, even though empirical research is very limited, systemic failures can be used as an innovation policy rationale for supporting

the development of an IS (Bergek *et al.*, 2008). Although limited research exists on defining and classifying these problems, the foundation for policy interventions can be argued to be necessary when some sort of market or systems failure exists in an IS (Bergek *et al.*, 2008; Chaminade & Edquist, 2010; Klein Woolthuis *et al.*, 2005; Wieczorek & Hekkert, 2012). IS failures are seen as failures of processes and may be due to an uncertain articulation of market demands, overemphasis on the perception of risk, or a lack of strategic capabilities among actors leading to the innovation not being implemented or produced or being insufficient and ineffective for the proposed purpose (Edler & Georghiou, 2007). Failures may also occur in the output of the innovation, where the innovation is produced and implemented, as, in the case of I4ID, the price may not return its intended social value, meaning the innovation is outside the reach of the marginalised (Bergek *et al.*, 2008).

It is important and necessary to understand and define clearly the rationale of systemic problems from the systems perspective when a system is made up of structures, relationships and their attributes (Bergek, 2008; Edquist, 2001; Suurs, 2009; Wieczorek & Hekkert, 2012). Systemic problems occur in the structures of an IS as aspects hindering the formation of adequate system functions for a given IS (Chaminade & Edquist, 2006). A system, for instance, will not produce its intended outputs if there are shortcomings in system structures, their attributes and the relationships that exist between them (Carlsson *et al.*, 2002). In short, an IS may not function well if there is a problem with one or more of these structures as captured in the following quotation (Wieczorek & Hekkert, 2012:79), "factors that negatively influence the direction and speed of innovation processes and hinder the development and functioning of innovation systems".

Only considering the structural components of an IS, provides insight into the composition of the system but it has various shortcomings:

- when analysing structures alone, the dynamics of the system cannot be captured;
- structural configurations differ across sectors, nationalities and technologies, making it very difficult for system comparison, whereas innovative function outcomes can be more comparable; and
- the structural analysis does not provide insight into system dynamics (Bergek *et al.*, 2008; Carlsson *et al.*, 2002; Suurs, 2009; Van der Hilst, 2012)

Some progress towards analysing the dynamics of ISs developed mostly within the TIS approach, provides some answers to the above shortcomings of the structural approach. Functions have been defined (Suurs, 2009) to explore the performance of a system, which means that system weaknesses may be identified through studying system functions. The central benefit of the functional approach is the ability to break up the structure from content to create policy goals and identify problems through the functional terms of a system (Bergek *et al.*, 2008; Carlsson *et al.*, 2002; Suurs, 2009; Wieczorek & Hekkert, 2012).

By analysing system functions and linking this back to system structures, a coupled functional-structural assessment can be done to perform a complete analysis to arrive at systemic policy instruments (Bergek *et al*., 2008a; Van der Hilst, 2012; Wieczorek & Hekkert, 2012). The identification of systemic performance and problems is a precondition for deriving systemic instruments where systemic policy instruments are tools that will target and alter the components of the IS to have a positive influence on the functional dynamics of the system. To summarise the approach, we firstly relate to Table 2 as adapted from Wieczorek and Hekkert (2012). The table summarises the approach as follows:

- identify system functions inadequate for their intended purpose through a set of indicators;
- relate the inadequate functions to problems in specific structures;
- identify the type of systemic problems;
- identify the goal of systemic instruments to overcome structural problems; and
- develop systemic instruments to strengthen structures, which in turn will strengthen the function of the system.

Table 9 provides a summary of structures and their related structural problems. Table 10 provides an outline of systemic instruments as adapted from Wieczorek and Hekkert (2012). Table 11 provides and outline the coupled functional-structural analysis process as adapted from Wieczorek and Hekkert (2012).

Table 9: Outline of structural problems and their properties

Structural problems	Structural problems (Chaminade & Edquist, 2007; Hekkert & Negro, 2011; Jacobsson & Johnson, 2000; Klein-Woolthuis *et al*., 2005; OECD, 1997; Wieczorek & Hekkert, 2012).
1. Actor presence problem 2. Actor capabilities problem	1. Relevant actors absent. 2. Actors may lack competence, capacity to learn or exploit resources, recognise and articulate consumer requirements and lack developing goals and strategies; transition problems of actors.

1. Institutional presence problem
2. Institutional capacity problem
3. Institutional flexibility problem
	1. Institutions supporting an IS are absent.
	2. When there is a problem with institutional capacity/quality:
	   • hard institutional problems: rules, laws, and regulations are hindering I4ID; and
	   • soft institutional problems: customs, common habits, routines, established practices, traditions, ways of conduct, norms and expectations are hindering I4ID. Another soft institutional issue is a hierarchy or silo approach present in formal actors, not open to new innovative ways of developing knowledge, as these organisations are set in their current business processes.
	3. Too strict institutional problems favour incumbent actors, where a weak institutional set-up hinders innovations, by insufficiently supporting new technologies or developments.

| 1. Relational presence problem
2. Relational quality problem
3. Relational myopia problem | 1. Relationships are absent due to 'distance' between actors, conflicting objectives, assumptions, capacities or lack of trust.
2. There is a problem with the quality/intensity of the relationships:
  • strong network problems – strong networks among current actors hinder knowledge sharing and development; and
  • weak network problems may hinder interactive learning and innovation.
3. Internal orientation favours incumbent set-up and relationships, blocking the necessity to open up to external forces ('new constellation'). |
| 1. Infrastructure presence problem
2. Infrastructure quality problem

All related to physical, knowledge and financial infrastructure. | 1. Presence-related when specific infrastructure is absent.
2. Quality-related when infrastructure is inadequate or malfunctioning to support the IS. |

Table 10: Systemic instruments

Systemic instruments description	Systemic instruments
The fundamental concept behind systemic instruments is that they address problems at an IS level having an undesirable influence on the speed and trend of innovative developments.	1. encourage and organise involvement of a wide variety of influential actors (NGOs, companies, government) 2. establish spaces and methods for actor capability development (e.g. through learning and experimenting); 3. motivate interaction opportunities between diverse actors (e.g. by managing interfaces and building a consensus); 4. avoid networks being either too strong or too weak for the specific requirements; 5. the presence of (hard and soft) institutions; 6. avoid institutions being either too strong or too weak for the specific requirement; 7. motivate physical, financial and knowledge infrastructure; and 8. ensure infrastructure quality to be sufficient.

Wieczorek and Hekkert (2012) identified a list of eight systemic instruments through thorough literature analysis as follows:

Table 11: Analysis phases of the IS (adapted from Wieczorek & Hekkert, 2012)

Functions	Functional dynamics (absent, weak, too strong, etc.)	Reason for functional dynamics		Systemic instruments
F1: entrepreneurial activities	**Indicators**	**Systemic problems**	**Type of systemic problems**	**Goal of systemic instruments**
F2: knowledge development **F3: knowledge diffusion** **F4: guidance of search** **F5: market formation** **F6: mobilisation of resources**	Function-specific indicators to guide function evaluation	Actor problems	Presence? Capability?	1. encourage and organise involvement of a wide variety of influential actors; 2. establish spaces and methods for actor capability development;
		Interactions problems	Presence? Capacity?	3. motivate interaction opportunities between diverse actors; 4. avoid networks being either too strong or too weak for the specific requirements;

58

F7: creation of legitimacy		Institutions problems	Presence? Intensity?	5. presence of (hard and soft) institutions the specific innovation in focus; 6. avoid institutions being either too strong or too weak for the specific requirement;
		Infrastructure problems	Presence? Quality?	7. motivate physical, financial and knowledge infrastructure; and 8. ensure infrastructure quality to be sufficient.

5.3 Inclusive innovation system analysis framework

This section outlines the adaptions to the conventional IS framework, in order to derive an ISS framework. Section 5.3.1 outlines the changes to the first phase of the inclusive framework, namely system identification, section 5.3.2 outlines the changes to the second phase of the inclusive framework, namely system description, section 5.3.3 outlines the changes to the third phase of the inclusive framework, namely system analysis and, lastly, section 5.3.4 outlines the changes to the fourth phase of the inclusive framework, namely system intervention.

4) System intervention

1) System identification

3) System analysis

2) System description
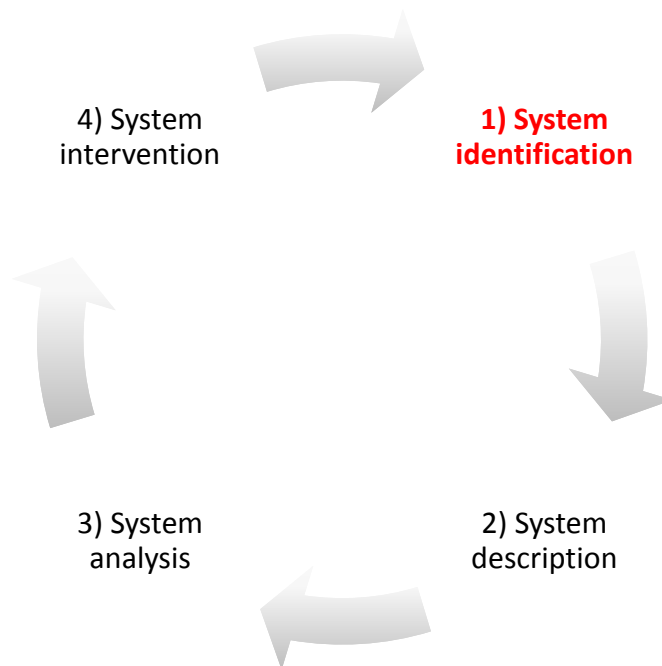
5.3.1 SYSTEM IDENTIFICATION

Clear boundaries must be set for any IS under study, even more so for IISs where many uncertainties are present. It is important to define the target market clearly, have a clear system goal and have a thorough knowledge of the specific requirements of the target market. The steps are cyclical and require revisiting as the understanding of the system increases.

Individual and/or group definition

A precise definition of who is 'in' and who is 'out' is necessary. It is impossible to target every actor, and targeting a specific group will make the system goal more specific and orientated towards tailored solutions. Table 12 outlines the individual and/or group definition of the target group.

Table 12: Individual and or group definition (who is targeted and how)

Individual and or group definition (who is targeted and how)
• Poverty line as starting point;   • women, children, rural farmers, community healthcare workers;   • disconnected from formal value chains or systems;   • not having access to quality of products and/or services as formal markets; and   • not having access to basic needs such as sanitation and healthcare.

Sources: Bergek *et al.* (2008), Chen and Ravallion (2010), Cozzens and Kaplinsky (2009), Foster (2013), Kolk *et al.* (2013), Kraemer-Mbula and Wamae (2010)

Careful consideration is vital when defining who is targeted. The marginalised may live in urban, peri-urban or rural communities as the buying profile of individuals living in peri-urban locations are almost five to ten times more than those living in rural (village) areas (Kolk *et al.*, 2013). Infrastructure and reachability may differ significantly, as some rural areas are difficult to reach with limited infrastructure (Kolk *et al.*, 2013).

Table 13 outlines aspects to consider for the selection process of the appropriate marginalised project sites.

Table 13: Selection of appropriate marginalised project site(s)

Selection of appropriate Marginalised project site(s)
Focus: community, regional or national.   Residing area: rural (village), peri-urban, urban.

Making sense of the community needs, requirements and constraints

The requirements of the marginalised may differ from formal markets (Altenburg, 2008; Chataway *et al.*, 2014). There is a need to define the demands of the specific group clearly through thorough analysis. A system cannot be defined as inclusive if solutions do not adhere to its users' needs (Foster & Heeks, 2013; Heeks *et al.*, 2014; Van der Hilst, 2012).

Table 14 outlines aspects to consider in the search to identify the marginalised requirements and constraints.

Table 14: Making sense of the community needs, requirements and constraints

Making sense of the community needs, requirements and constraints
Walk the streets of the community, build trust, and use local partners to understand what the needs and demands of the target group are. This is the first step of co-creation. Take into consideration: national or regional, culture requirements, economic aspects, local business practices, local infrastructure requirements, understand constraints, a lack of education and skills, proximity (isolated, dispersed and distant locations), corruption playing a role in emerging countries, non-existent distribution channels, lack of robust and enforceable legal frameworks, keep in consideration the informal market regulating practices in these settings, religious or racial conflict (Prahalad & Hart, 2002; Prahalad *et al*., 2012; Ver Loren van Themaat *et al*., 2013).

Product/service/industry of choice

I4ID as outlined in this thesis may be in terms of goods and/or services, or the inclusion of the marginalised in the innovation process and the creation of mutual benefit. It is important to re-visit and consider the 'vertical' and 'horizontal' aspects of I4ID (Lundvall, Joseph & Chaminade, 2009). 'Horizontal' expansion of I4ID entails sectors most relevant to the marginalised and providing solutions in these areas that meet their requirements (Lundvall *et al*., 2009). Sectors seen as 'horizontal' are healthcare, education, basic sanitation, clean drinking water as well as small-scale agriculture (Foster & Heeks, 2015; Lundvall *et al*., 2009). 'Vertical' expansion refers to innovators, entrepreneurs and consumers at marginalised level (Foster & Heeks, 2015; Lundvall *et al*., 2009). The 'vertical' link includes the orientation of formal organisations to conduct business in marginalised settings, and more importantly, creating solutions for the marginalised as a bottom-up process, with the possibility of the marginalised as co-creators through mutual value creation.

5.3.2   SYSTEM DESCRIPTION

This section outlines the description of an inclusive IS. Section 5.3.2.1 describes the inclusive system structures, and section 5.3.2.2 describes the inclusive system functions.
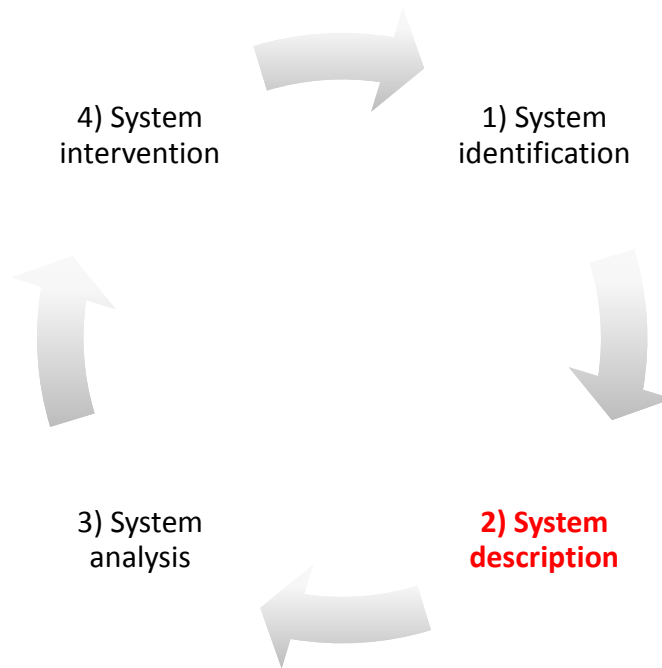
5.3.2.1   SYSTEM STRUCTURES – INNOVATION FOR INCLUSIVE DEVELOPMENT

The current study explored a set of constraints and a new orientation for formal IS structures to be more inclusively orientated.

– **Actors**

IISs differ from conventional ISs in terms of actors. References refer to a need to incorporate and support a new range of actors (Chataway *et al*., 2014; Cozzens & Kaplinsky, 2009; Foster & Heeks, 2013; Rip & Kuhlmann, 2015). Formal actors require a new set of capabilities, capacities and a changed mind-set to adhere to the multi-dimensional requirements of I4ID (Rip & Kuhlmann, 2015). This requires careful reconsideration of technological push and market pull innovations in marginalised settings.

Traditional interests of innovation studies outline that conventional ISs focus on large formal organisations, mainly on the supply side, emphasising formalised and technical R&D, mainly being supply-driven (Altenburg, 2008). Studies emphasising I4ID, mostly in developing countries, are especially focussed towards non-traditional demand-side innovators. Another non-traditional actor increasingly receiving attention in research are innovation intermediaries, playing a facilitating role between formal innovators and end-users (Foster & Heeks, 2013). There exists a mismatch between formal developers on the one hand, and the needs and interest of marginalised individuals on the other. This is where intermediaries become important as information and knowledge brokers (Van der Hilst, 2012).

The focus on informal actors calls for focussing on and including non-traditional, demand-side innovators in developing countries, including informal sector workers, informal entrepreneurs and lead users (Foster & Heeks, 2013).

The range of actors to take into consideration is of particular importance for the formation of adequate system functions to provide I4ID solutions having a profound influence on marginalised individuals and the broader community. Through literature, empirical cases and interviews have identified five 'ranges' of actors to take into consideration when innovating for inclusive development. These actors are:

- government;
- formal actors and organisations;
- intermediaries (formal orientated);
- embedded intermediaries (embedded in local communities and/or actors from the local community); and
- informal consumer/user/partners (Foster & Heeks 2013; Rip & Kuhlmann 2015; Van der Hilst, 2012).

– **Government**

The informal sector is an important sector in developing countries, and so is the role that government plays. Developing countries, and more so the least developed, may have a weak functioning market or they may lack some of the institutions that make up and support the IS in developing countries (Kraemer-Mbula & Wamae, 2010). This emphasises the importance of the role that government has to create favourable framework conditions that support I4ID. This may include providing an independent judiciary and property rights, a well-functioning financial system, a well-run and affordable higher education system, a supportive information and communication and technology (ICT) infrastructure, as well as roads, ports and transport services, to name a few (Lundvall *et al.*, 2009). The public sector is often more relevant and present in developing countries, where a need exists to understand better how innovative activities are fostered in that sector (Kraemer-Mbula & Wamae, 2010).

Table 15: Constraints and new orientation for governments

Constraints for governments	New orientation for governments
• Institutional capacities to support I4ID generally lack; • lack of resources; • lack of knowledge; • major inequalities; and • policy barriers and government rules and norms exclude marginalised actors from innovation and from economic and social activity.	• Creating the appropriate framework conditions for more inclusively orientated innovations; • building government capacities for innovation; • institutional capacities, measuring innovation, policy analysis, formation and implementation, require high priority; • a renewed priority to development; • converting knowledge towards policy development and implementation; • catching-up process, steering resources to the most technologically progressive sectors of the economy; • important role to determine the speed and orientating the direction of technological change; • government promotion of new market entrants; and • removing barriers to support marginalised sector development.

  – **Formal actors/organisations**

In general, formal actors are focussed on growth-orientated, supply-driven and technical innovations, where the main focus lies with higher income markets and formal supply-side organisations (Foster & Heeks, 2013). There is a need for formal actors to reorientation towards a more local needs-orientated, demand-driven non-technical innovations for more informal actors (Chataway *et al*., 2014). Here the focus shifts towards marginalised consumers, non-traditional, informal, demand-side innovators and intermediaries. Formal actors require new capabilities and capacities to align their focus towards I4ID (Heeks *et al.*, 2014). Formal actors also require change management to break down silos within organisations to take into consideration the constraints and a new orientation of doing business with the marginalised. Private formal sector actors may include local firms, foreign firms and multi-national corporations (MNCs). There also exist non-private sector actors, such as academia, knowledge institutes, not-for-profit organisations (NPOs), intermediaries and public authorities. Civil society is another actor that should be taken into consideration. The largest number of IISs are situated in developing countries, where local markets are frequently dominated by a large number of informal private actors, and these informal actors need to be taken into consideration by formal actors (Foster & Heeks, 2011).

Table 16 summarises constraints and a new orientation required from actors in the IIS.

Table 16: Constraints and new orientation for formal actors

Constraints for formal actors	New orientation for formal actors
• Lack of knowledge and internal capabilities; • assumptions; • traditional thinking; • partnerships and coordination among actors; • scaling and sustainable business models; and • Absence of mutual learning.	• Identify the new set of actors and establish new relationships among these actors; • new knowledge – through immersion into the lives of the marginalised; • new channels for knowledge diffusion and co-creation; • risk creation – burden of uncertainties, develop for and by the marginalised; and • demand-side innovations.

– **Intermediary organisations (formal)**

Intermediaries stand between formal suppliers and final consumers, and are mainly conceived of as information and knowledge brokers, typically connecting to formal R&D organisations (Foster & Heeks, 2013). Innovation intermediaries aim to strengthen the IS and play an important role in building and maintaining networks in an IS. The role of innovation intermediaries moves beyond bridging alone; they are also involved in one-on-one support to a whole range of actors in the IS (Van der Hilst, 2012). Innovation intermediaries may therefore be defined as organisations that have the ability to assist others to innovate (Foster & Heeks, 2013). This may be achieved in both a direct and indirect manner (Van der Hilst, 2012). Direct contributions enable the innovativeness of one or more firms, where more indirect influence refers to enhancing the innovative capacity of regions, nations or sectors.

In an IIS, the primary objective of the innovation intermediaries is to strengthen the IS to enable I4ID, and to contribute to influence the marginalised by producing sources of income and extending product and service offerings, specifically towards the marginalised market (Foster & Heeks, 2011). Intermediary institutions, such as business associations, community organisations, NGOs and donors, have an important role to stimulate interaction in the IIS and to strengthen the innovation capacity of IIS in marginalised settings in developing countries (Kraemer-Mbula & Wamae, 2010). The multi-dimensionality of innovation and the complexity to integrate numerous types of knowledge in developing countries, emphasise the importance of the role of intermediaries as knowledge brokers in collecting, packaging and transmitting relevant knowledge to establish effective policy formulation for I4ID (Kraemer-Mbula & Wamae, 2010).

Table 17 summarises constraints and a new orientation required by intermediary actors in the IIS.

Table 17: Constraints and new orientation for intermediary organisations

Constraints for intermediary organisations (formal)	New orientation for intermediary organisations (formal)
• Misalignment of formal actor goals; • lack of trust in low-income communities; • adaptive capacities limited due to push–pull strategies from formal and informal actors; • lack of recognition; and • lack of spaces and places to interact.	• Shared goal (formal and informal); • awareness of interests (formal and informal); • actively involved in the local community (trust); • focus broader than just the product and/or service (systems approach); • facilitating training in product development and business skills, and access to knowledge regarding good practices; • development of innovative financial schemes that encourage investments which are often beneficial to the marginalised as a whole; • providing a platform for formal and informal actors to co-ordinate their activities, exchange information and increase I4ID; and • representing the informal sector in its dealings with local governments, and constituting the base of political mobilisation in the marginalised sector.

- **Intermediaries embedded in the local community**

Locally rooted partners are invaluable. They understand the sensitivities, such as chiefs not seeing eye to eye or family feuds, and immerse themselves in the community (Ismail, Ansell & Kleyn, 2012). The question 'how do you place value on this kind of capital', indicates the value that these actors have on intervention if integrated in the correct manner (Ismail *et al.*, 2012). It is necessary to keep in mind that time-consuming and intensive business support and education are required when outsourcing to locally rooted partners (Swaans *et al.*, 2014). Little chance of success is possible in these markets if there is a lack of partnerships with local people who know the areas (Swaans *et al.*, 2014). These new partnerships must be used to develop business solutions that benefit the formal and informal side (Ismail *et al.*, 2012). Partners may serve the following roles:

1. being ambassadors for the brand of an organisation;
2. serving as distributors, agents and salespersons; and
3. assisting as data capturers and knowledge providers (Swaans *et al.*, 2014).

Table 18 outlines constraints and a new orientation for informal intermediary organisations.

Table 18: Constraints and a new orientation for informal intermediary organisations

Constraints of intermediaries embedded in the local community	New orientation for intermediaries embedded in the local community
• Low-income; • lack of education and skills (illiteracy and a lack of education);	• Acknowledgment of local actors; • must understand the use of the new products and services and how it will improve their livelihood; and • must have credibility in the community.

69

- proximity (isolated, dispersed and distant locations);
- cultural, lifestyle and language barriers; and
- poor infrastructure.

– Informal actors

Informal actors require different orientations regarding innovations and delivery channels (Altenburg, 2008). It is important to consider the actual requirements of these consumers and understand the constraints of their everyday lives. It is alarming that formal markets still innovate for the needs of their 'formal consumer', but lack market information of 'informal consumers' (Rip & Kuhlmann, 2015). The aspect of marginalised (informal) actors was addressed in Chapter 3, and Table 19 provides a summary of the constraints and new orientation for informal actors.

Table 19: Constraints and new orientation for informal actors

Constraints for informal actors	New orientation towards informal actors
- Delink from formal value chain; - lack basic skills, knowledge and capital; - lack of broader market place – little diffusion and development channels; - the process is resource- and labour-intensive; - proximity (isolated, dispersed and distant locations); - cultural, lifestyle and language barriers; and - it is a tedious and timely process to include the marginalised actors.	- Demand-side actors: understand behaviour of recipient of consumers; - requires active participation in development and evolution of the business offering; - partake in the innovation process, from invention to implementation; - act as knowledge enablers as local actors will provide information blindingly obvious; and - marginalised involvement gives improved benefits to marginalised communities.

– Institutions

'Institutions' refers to the routines, culture, norms and regulations that direct and influence the actions of IS actors as well as the IS as a whole (Woolthuis *et al*., 2005). It is important to consider that formal institutions may be present in developing countries in theory, but are not practically enforced (Kraemer-Mbula & Wamae, 2010). This requires taking into consideration informal institutions, defined as the behavioural norms surrounding local social relationships endogenously enforced rather than exogenously imposed (Foster & Heeks, 2013). This may give invaluable insight into micro-level activities critical in I4ID. This is the new range of institutions required to 'reinvent the commons' (I4ID). Therefore, the following statement supports these ideas (Foster & Heeks, 2013:350):

> [F]ormal state institutions do play a role in I4ID, but much less directly; those formal institutions are also less forceful within marginalised markets, partly because of implementation gaps, and partly because of the rich informal institutional system that shapes behaviour in and around these markets.

Table 20 outlines constraints and new orientations for institutions of the IIS.

Table 20: Constraints and new orientation for institutions

Constraints for institutions	New orientation for institutions
- Formal actors have insufficient focus on low-income settings, informal actors delinked to formal value chains; - weak adaptive capacity as low-income users lack adequate knowledge to use interventions for the intended purpose; - inadequate amount of inclusive innovations developed; - innovations mismatch and lack of inclusive innovations scale; and - interventions not used for the intended purpose.	- Orientate formal ISs towards the marginalised; - encourage grassroots innovations – support knowledge and innovation flows; - improve the capacity of low-income groups to absorb technologies for more efficient use of innovations among low-income groups; and - mitigate the structural barriers blocking effective inclusive innovations.

  – **Interactions**

Lundvall (1992) is clear that the interactivity of actors within the system, and more specifically changing relationships and learning reorient innovation trajectories over time. Learning in an IS may take place from the following perspectives:

- learning by doing;
- learning by using; and
- learning by interactions (Lundvall, 1992).

Kraemer-Mbula and Wamae (2010) outline the importance of learning through interactions to serve marginalised markets. ISs in general have placed emphasis on learning by doing and direct production and implementation. This differs from learning about diffusion and the wider social context of a system surrounding the marginalised community, necessary to diffuse goods and services in marginalised communities (Chataway *et al.*, 2014). It is well recognised that interactions among actors in the IS play a critical role in the manner in which the different learning dynamics in the system occur (Lundvall, 1992). The inclusive landscape calls for new relationships and knowledge to build better sustainable relationships among formal and informal actors to bring solutions for I4ID (Chataway *et al.*, 2014). Table 21 outlines constraints and a new orientation required for interactions in the IIS.

Table 21: Constraints and new orientation for interactions in the IIS

Constraints for formal/informal interactions	New orientation for formal/informal interactions
- Acknowledgment of the value of marginalised interaction; - lack of 'on-the-ground' interactions - collaboration and co-creation are few and far between; - lack of inclusion in the entire innovation process; and	- Necessity (but also limitations) of informal, loose but socialised relationships; - contextualised (supply, demand, other) learning by interacting and using and doing; - learning about diffusion (sales and support) and use; - learning about wider social processes, including non-instrumental procedures; and

• sharing and mutual learning culture absent.	• survival and utility-maximisation as guides.

– **Infrastructure**

Infrastructure is one of the challenging areas when innovating for inclusive development (Foster & Heeks, 2011). Here we refer again to the three aspects of infrastructure, namely financial, physical and knowledge infrastructure. There is a need to provide innovative financial and physical infrastructure to adhere to the requirements of the marginalised communities, while taking into consideration knowledge of local settings in order to successfully I4ID (Foster & Heeks, 2011). Table 22 outlines the constraints and new orientation required for innovation in the IIS.

Table 22: Constraints and a new orientation for infrastructure in the IIS

Constraints for infrastructure	New orientation for infrastructure
• Physical – spaces and places to interact, research institutes focussing on marginalised knowledge creation, the marginalised setting having fragmented infrastructure with which to work. • Financial – lack of financial schemes, business models, taxes and subsidies to support I4ID. • Knowledge – does not include the marginalised in value offering, lacks capabilities and capacities to understand the needs of the market, lacks opportunities to include the marginalised to benefit economically.	• Physical – create spaces and places to interact, tailor technologies to suit the needs of the marginalised, research institutes must orientate themselves to applied research for marginalised settings. • Financial – business models that scale and are sustainable to include the marginalised. Provide incentivised products and services to render solutions cost-effective. • Knowledge – bottom-up knowledge creation with the active participation of local actors.

5.3.2.2 **SYSTEM FUNCTIONS - INNOVATION FOR INCLUSIVE DEVELOPMENT**

The seven system functions as identified and explained in the literature analysis in Chapter 4 serve as an appropriate background to describe the functions of a TIS and more specifically for this study, an IIS. However, to gain a complete picture of an IIS it is required to take into consideration indicators that define IIS functions. This serves as guidance to have an inclusive focus from the start of the study and will aid data richness during the analysis phase. A set of indicators is developed for each function and serves two purposes. Firstly, they describe system functions, and secondly, they analyse individual system function dynamics.

The set of indicators was developed through the 'lenses' of conventional ISs. This was done to ensure that the indicators developed, although they are for I4ID, still adhere to the requirements of system dynamics (Hekkert *et al*. 2007; Van der Hilst 2012; Wieczorek & Hekkert 2012). The set of indicators were developed from studies referring to the marginalised. It is well known that studies researched 'different' marginalised communities due to the fragmented classification of the marginalised market.

Furthermore, where it was noted that the studies related to different sectors, the lists of indicators developed for this study served as a general list. **Error! Reference source not found.** outlines the eferences for the development of indicators for the seven system functions.

F1: Entrepreneurial activities

A well-functioning IS provides entrepreneurial opportunities to its actors, as entrepreneurial activities underpin the performance of an IS, which is often accompanied by human and financial resources to pursue such opportunities (Hekkert *et al*., 2007; Van der Hilst, 2012). A well-functioning IIS is by extension postulated to create opportunities for marginalised individuals in both formal and informal markets and settings (Foster & Heeks 2013). Well-functioning system functions around entrepreneurial activities will ensure that marginalised actors are linked into the IS and have access to loans and funding. There will also be a promotion of incentives for successful scaling of entrepreneurial activities and programmes/business models that will promote the capabilities and capacities of local entrepreneurs to be active participants of the IIS (Chataway *et al*., 2014). These considerations and indicators are outlined in Table 23.

Table 23: Indicators and diagnostic questions for entrepreneurial activities

Function 1: Entrepreneurial activities	**Indicators**	**Diagnostic questions** Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	1.1 Marginalised involvement	Are entrepreneurial opportunities created and what are the requirements for involvement?
	1.2 Depth of involvement	What is the extent of involvement of the marginalised (e.g. users, producers) and which barriers exist towards the inclusion of marginalised actors (e.g. lack of literacy, institutional support)?
	1.3 Business involvement	Marginalised business models – what is the extent of business involvement and business models, considering inclusion of the marginalised?
	1.4 Incentivised plans	Are there incentives for the involvement of local entrepreneurs (e.g. discounted prices, tax benefits)?
	1.5 Plan to scale	Are there scaling initiatives for entrepreneurial projects and is the end goal sustainable inclusive entrepreneurship?

F2: Knowledge development

Information poverty has been argued to be one of the biggest stumbling blocks to sustainable development (Prahalad & Hart, 2002). Organisations operating or planning to operate in marginalised

73

markets need to take into consideration how information and knowledge, relevant to the participation of marginalised communities, will be incorporated in the design and development of innovations (Kaplinsky, 2011). The worldviews of formal companies differ from those in informal communities, making it important to immerse themselves in the lives and contexts of the marginalised to explore how best to incorporate marginalised communities in the innovation process and provide products and services adhering to their needs (Ismail *et al.*, 2012). Indicators and diagnostic questions for knowledge development are outlined in Table 24.

Table 24: Indicators and diagnostic questions for knowledge development

Function 2: Knowledge development	Indicators	Diagnostic questions Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	2.1 Local knowledge	Which level of knowledge (insight) into the 'marginalised livelihood' in terms of level of literacy, capabilities and capacities exist? Which processes are in place to develop such insights? How may this be included in the innovation process? Which type of knowledge exists in terms of the risks and areas of risk for marginalised individuals? How is this documented? And how is it included in the inclusive value offering? (Responsible innovation is essential)
	2.2 Research capacity	Is the generated knowledge sufficient in quality and quantity?
	2.3 Research collaboration	Does collaboration exist among formal and informal research organisations?
	2.4 Origin of knowledge	What are the major sources of knowledge? Do system actors possess the capabilities and capacities to acquire relevant contextual knowledge? Are the marginalised actors/beneficiaries utilised as knowledge providers? If so, how, and how do they benefit?
	2.5 Focus of knowledge development	Are marginalised solutions developed considering push/pull market strategies? What is the level of insight into the 'pull' environment for innovation? Is this documented? How is this incorporated in the value offering in terms of acceptability, accessibility and affordability?
	2.6 Training and development of capabilities/capacity	Are there technical training and guidance initiatives for marginalised groups or businesses or individuals who may want to engage with marginalised solutions?

2.7 Institutional empowerment	Are there existing I4ID policies and institutions to provide empowerment and capabilities for marginalised actors?

F3: Knowledge diffusion

Knowledge diffusion is generally concerned with the flow of knowledge among actors within the IS, from producer to user. Knowledge diffusion in informal markets is of the essence to achieve the intended benefit of I4ID (Chataway *et al.*, 2014). There exists numerous examples of failed innovations in low-resource settings due to a lack of knowledge diffusion (Ismail *et al.*, 2012). Novel knowledge diffusion channels require exploration where local actors are actively involved as they are respected and known by the local community. Indicators and diagnostic questions for knowledge diffusion are outlined in Table 25.

Table 25: Indicators and diagnostic questions for knowledge diffusion

Function 3: Knowledge diffusion	**Indicators**	**Diagnostic questions** Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	3.1 Knowledge platforms and boundary spanning	Are there established linkages and environments where spaces and places exist for informal sector actors and formal sector actors to engage (e.g. roundtables, intermediaries)? Important, as pockets of knowledge often exist that remains in isolation. Which knowledge diffusion channels exist for marginalised knowledge and research? Knowledge channels for I4ID?
	3.2 Depth of knowledge	Does the knowledge correspond to the need of the system?
	3.3 Knowledge-influence trajectory	Is knowledge of the marginalised community making it to top decision-makers?
	3.4 Marginalised-centred knowledge	What is the extent of knowledge diffusion to the marginalised? Which quality and quantity of knowledge are available to empower the marginalised to use the innovation effectively for its intended use? What is the extent of use of marginalised members to distribute knowledge and business models for compensation?
	3.5 Local language incorporation	Is there provision of knowledge in local language? Does the system allow for removing inhibiting factors in communication?

F4: Guidance of search

There exist multiple constraints to resources relating to the requirement to identify appropriate areas and plans for future investments (Hekkert *et al.*, 2007). This issue is certainly also true in IISs and developing countries, and I4ID efforts and investment strategies often remain fragmented without appropriate higher-level planning (Van der Hilst, 2012). Furthermore, major uncertainties exist in emerging markets (Altenburg, 2008; Kraemer-Mbula & Wamae, 2010), which makes activities to support and inform the guidance of search an important enabler of I4ID. Here, a lack in direction of knowledge development, knowledge diffusion and entrepreneurial activities are bound to be major risks to success (Suurs, 2009). Indicators and diagnostic questions for guidance of search are outlined in Table 26.

Table 26: Indicators and diagnostic questions for guidance of search

Function 4: Guidance of search	Indicators	Diagnostic questions
		Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	4.1 Clear shared vision and goal	Is this generic or specific? Is there a structured nation-wide approach? What is the focus of government? Is it orientated to induce I4ID?
	4.2 Supportive legislation	Which institutional and legislative support exists for the emerging innovation? Is it supported by specific programmes? Is the objective inducing government activities?
	4.3 I4ID expectation	What is the expectation around the specific innovation targeting I4ID?
	4.4 Outcome indicators	Which indicators are used to measure the outcomes of the specific innovation?
	4.5 Recognised constraints	What are the major constraints for the innovation?

F5: Market formation

I4ID is not just about innovation and a focus on supply-side factors (e.g. developing solutions or funding for innovation projects) but also on the demand-side where markets need to be created for goods or services. Conventional markets and innovation approaches often tend to focus on products and services, while I4ID requires thinking beyond a product-centric approach. IISs provide a framework for a systemic approach to formal and informal markets which may be stimulated for goods produced by or

for the marginalised (Kraemer-Mbula & Wamae 2010; Prahalad *et al.* 2012). Indicators and diagnostic questions for knowledge diffusion are outlined in Table 27.

Table 27:Indicators and diagnostic questions for market formation

Function 5: Market Formation	Indicators	Diagnostic questions
		Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	5.1 Define target market	What does the market look like? What is the size? Who are the users?
	5.2 Institutional barriers	What are the institutional constraints/barriers for I4ID?
	5.3 Existing market interventions	Which current market interventions exist to shape the market towards inclusion concerns (e.g. interest free loans, reduced prices)?
	5.4 Market structures supportive of I4ID	What are current and future opportunities of inclusion of I4ID solutions through market structures?
	5.5 Institutional incentives	Which institutional incentives exist?

F6: Resource mobilisation

Resource mobilisation sheds light on the available financial, physical and human resources available to the IS. Emerging markets are often constrained in terms of financial or human resources for I4ID (Foster, 2014). This function is traditionally focussed on the availability of resources, but requires adaption for IISs, where it should make specific provision for the ease of accessibility and usability of resources (Van der Hilst, 2012). Indicators and diagnostic questions for resource mobilisation are outlined in Table 28.

Table 28: Indicators and diagnostic questions for resource mobilisation

Function 6: Resource Mobilisation	**Indicators**	**Diagnostic questions**
		Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)

	6.1 Financial mechanisms	Are there financial and supportive mechanisms that provide guidance and support for marginalised actors involved in and creating I4IDs (e.g. group financing, business development support)? Do these resources correspond to system needs?
	6.2 Access to resources	Is there sufficient access to resources? (e.g. donor funding, government funding and private sector funding)
	6.3 Investment security	What are the investment time frames and how secure are they? Are the size and time frame of funding adequate to drive projects?
	6.4 Technological capabilities	Technological capabilities – which current technological infrastructure exists in the marginalised space that supports the innovation being implemented?
	6.5 Access to informal communities	What are the major barriers to gain access to target marginalised actors? What are the main infrastructural barriers and methods to overcome these?
	6.6 Assessment of business plans	Are there sufficient knowledge and capabilities to assess and adapt business plans towards I4ID?
	6.7 Public funding	Is there adequate public funding? Is it spent in the right areas?

F7: Creation of legitimacy

The introduction of novel solutions or innovations are often marked by resistance and uncertainties (Bergek *et al*., 2008). I4ID is no different where scepticism exists on the side of formal actors regarding the influence of innovations in marginalised communities, often along with a lack of trust from informal users (Chataway *et al*., 2014). Indicators and diagnostic questions for creation of legitimacy are outlined in Table 29.

Table 29: Indicators and diagnostic questions for creation of legitimacy

Function 7: Creation of Legitimacy	**Indicators**	**Diagnostic questions**
		Altenburg (2006), Bergek *et al.* (2008), Cozzens and Kaplinsky (2009), Kraemer-Mbula and Wamae (2010), Van Mierlo *et al.* (2010), Foster and Heeks (2011; 2013), Mair *et al.* (2012), OECD (2012; 2014), Ratanawaraha (2012) Van der Hilst (2012) Wieczorek and Hekkert (2012), George *et al.* (2012), Hick (2012), Ismail *et al.* (2012), Lizuka (2013), Pansera (2013) Foster (2013), Piketty (2014), Chataway et al. (2014) Rip and Kuhlmann (2015)
	7.1 Reputation of investments for I4ID	What is the reputation surrounding a certain innovation? (for example, is there any ethical or environmental challenges surrounding the specific innovation?)
	7.2 Resistance to change	Where is the resistance to change coming from? Who is the main contributor to the resistance?
	7.3 Awareness of intention	Is there awareness among the marginalised actors of the intentions of the entering organisation to I4ID for mutual benefit?

7.4 Government involvement/commitment	To what extent is the innovation part of government delivery (e.g. specific ICT forming of government services)? Government often provides legitimacy around projects when involved and may serve as an important actor from which to draw resources.
7.5 Private sector commitment	Is the private sector showing commitment to advance the sector?

5.3.3   SYSTEM ANALYSIS APPROACH
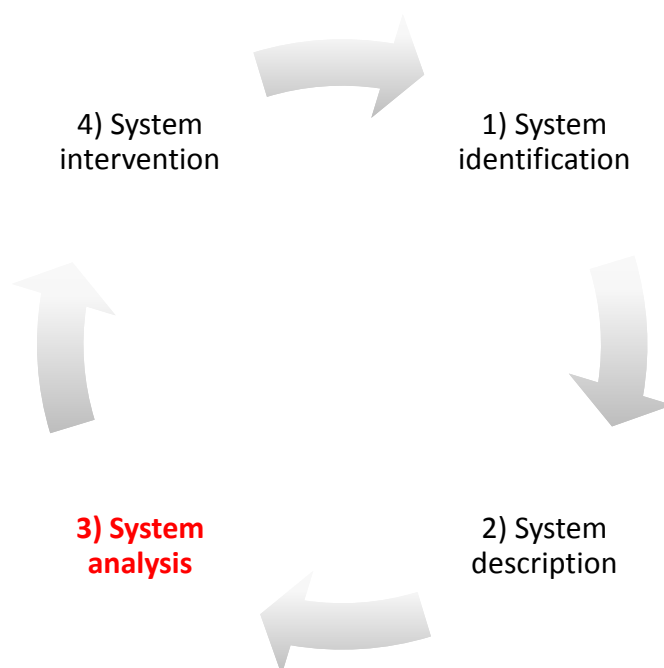
In order to derive a method to assess the functionality of each system function, we draw mainly on the studies by Bergek *et a*l. (2008), Wieczorek and Hekkert (2012), Jacobsson and Bergek (2004) and Klein Woolthuis *et al*. (2005). The functional assessment is the first stage of the functional-structural analysis. Here it is important to identify the functionality of each IIS function. Table 30 outlines a summarised approach of the developed indicators for each system function. The developed indicators allow an analysis to be specific about the aspects hindering the functionality of a specific system function. The guide of system indicators and diagnostic questions serves the purpose to reduce biased opinions from the researcher. The functional assessment further requires a thorough guided description of each system function and a description of the functional weakness in order to perform the preceding systemic problem identification step. This allowed the current study to be focussed towards those functions that are absent or weak.

Table 30: Assessing the I4ID functionality of each system function

Function	Indicators	Weakness indicator guide and description
Function 1: Entrepreneurial activities	1.1 Marginalised involvement	Information based on each indicator of each function, with the aim of explaining the 'type' of weakness of an indicator. This information is derived during the qualitative process of the study, after the system description step.
	1.2 Depth of involvement	
	1.3 Business involvement	
	1.4 Incentivised plans	
	1.5 Plan to scale	
Function 2: Knowledge development	2.1 Local knowledge	
	2.2 Research capacity	
	2.3 Research collaboration	
	2.4 Origin of knowledge	
	2.5 Focus of knowledge development	
	2.6 Training and development of capabilities/capacity	
	2.7 Institutional empowerment	
Function 3: Knowledge diffusion	3.1 Knowledge platforms and boundary spanning	
	3.2 Depth of knowledge	
	3.3 Knowledge influence trajectory	
	3.4 Marginalised-centred knowledge	
	3.5 Local language incorporation	
Function 4: Guidance of search	4.1 Clear shared vision and goal	
	4.2 Supportive legislation	
	4.3 I4ID expectation	
	4.4 Outcome indicators	
	4.5 Recognised constraints	
Function 5: Market formation	5.1 Define target market	
	5.2 Institutional barriers	
	5.3 Existing market interventions	
	5.4 Market structures supportive of I4ID	
	5.5 Institutional incentives	
Function 6: Resource mobilisation	6.1 Financial mechanisms	
	6.2 Access to resources	
	6.2 Investment security	
	6.3 Technological capabilities	
	6.4 Access to informal communities	
	6.5 Assessment of business plans	
	6.6 Public funding	
Function 7: Creation of legitimacy	7.1 Reputation of investments for I4ID	
	7.2 Resistance to change	
	7.3 Awareness of intention	
	7.4 Government involvement/commitment	
	7.5 Private sector commitment	

The coupled functional-structural analysis allows for the identification of the reason why system functions may be weak or absent and allow for the precise and systematic identification of the problems hindering the functionality of system functions. Table 31 outlines a condensed guide to identify systemic problems hindering the functionality of IIS functions.

Table 31: Identification of systemic problems

System functions	Structures	Type of systemic problems	Systemic problem guide
Functions [F1–F7]	Actor	Presence	Missing relevant formal actors. Missing marginalised actors. Missing intermediary actors.
		Capabilities	Actors may lack competence/capacity to articulate consumer requirements and lack competence to develop goals and strategies to I4ID.
	Institutions	Presence	Institutions supporting the IIS or I4ID are absent.
		Capacity	Hard institutional set-up is hindering the IIS or I4ID. Strict institutional set-up favour incumbent actors. Weak institutional set-up hinders I4ID, through insufficient support.
	Relationships	Presence	Relationships are absent due to 'distance' between actors.
		Quality	Quality/intensity of relationships. • strong network – strong networks among current actors hinder knowledge sharing and development, blocking the necessity to open up to external forces ('new constellation'). • weak network – hinders interactive learning and innovation; Conflicting objectives, assumptions, capacities between formal and informal actors. Lack of trust between formal and informal actors.
	Infrastructure	Presence	Infrastructure is absent (physical, financial, knowledge)
		Quality	Infrastructure is inadequate or malfunctioning – cannot support the IIS and I4ID.

Following the functional-structural analysis of the IIS, systemic goals may be derived (Wieczorek & Hekkert, 2012; Woolthuis *et al.*, 2005). The systemic goals here serve as a guide for the future state of an IIS. The systemic goals are specifically designed to serve as a guide to system structures in order to overcome systemic problems hindering the formation of IISs (Wieczorek & Hekkert, 2012; Woolthuis *et al.*, 2005). The goals of systemic instruments as described further guide the following process of identifying systemic instruments to achieve an integrated IIS and diffuse effective I4ID solutions as outlined in Table 32. To develop the systemic goals we again largely drew from the research by Wieczorek and Hekkert (2012), where we adapted and elaborated on systemic goals orientated to IISs.

Table 32: IIS systemic goals

Structures	Type of systemic problems	Systemic problem guide	Systemic policy goals
Actor	Presence	Missing relevant formal actors. Missing marginalised actors. Missing intermediary actors.	Encourage and organise involvement of a wide variety of actors • Establish new relationships and collaboration among the 'new' set of actors in the system.

			- Involve formal businesses and government in innovative ways. - Involvement of a multi-partner cross-sectoral team is required where the marginalised is actively involved. - Establish a set of intermediaries that act as knowledge brokers. - Gain and develop a deep understanding of the targeted individuals (the market). - Acknowledge the marginalised as valuable partners in business processes (users to partners).
	Capabilities	Actors may lack competence/capacity to articulate consumer requirements and may omit to develop goals and strategies	Establish spaces and methods for actor capability development - Development of research institutes and their capabilities to study the dynamics of I4ID and IIS. - Develop capabilities for the creation of sustainable I4ID business models and scaling initiatives through advanced technologies. - Documentation and learning from best practices (real-time data for evaluations) for I4ID and IIS. - Create spaces and environments for the integration of different actors' capability.
Institutions	Presence	Institutions supporting the IIS or I4ID are absent.	Presence of (hard and soft) institutions for the specific innovation in focus - Shared commitment: has a common goal and vision with benefit to all actors. - Hierarchy and silo approaches require intervention mechanisms to overcome too strong formal set-ups. - Establish institutions favouring I4ID.
	Capacity	Hard institutional set-up is hindering the IIS or I4ID. Strict institutional set-up favours incumbent actors. Weak institutional set-up hinders I4ID through insufficiently support.	Prevent too weak/stringent institutions - Establish institutional processes and participatory planning of marginalised actors. - Institutional structures support collaborative actions and orientation of formal actors towards inclusive solutions. - Inclusivity indicates readiness and localised implementation of inclusive solutions
Relationships	Presence	Relationships are absent due to 'distance' between actors. Conflicting objectives, assumptions, capacities between formal and informal actors. Lack of trust between formal and informal actors.	Motivate interaction opportunities between diverse actors. - Cooperative research programmes among the relevant knowledge-creation bodies. - Cooperative grants and programmes aligning interaction towards a shared interest for the marginalised. - Bridging instruments serve as enablers for interactions among diverse actors. - Debates facilitate decision-making towards inclusive system approaches. This should be evidence-based as far as possible.
	Quality	Quality/intensity of relationships.	Foster quality interactions among a diverse set of actors.

		• strong network – strong networks among current actors hinder knowledge sharing and development, blocking the necessity to open up to external forces ('new constellation'). • weak network – hinder interactive learning and innovation.	• Stimulate the development of innovation platforms and collaborative learning and interaction sessions. • Research programmes and workshops explore novel interaction networks.
Infrastructure	Presence	Infrastructure is absent (physical, financial, knowledge)	Motivate physical, financial and knowledge infrastructure. Financial: • Align funding of projects to the intended inclusive goals and appropriate time frames. • The development and creation of sustainable business models. • R&D grants for research institutes to develop inclusive interventions. • Taxes and loans that align and support inclusive interventions. Knowledge: • Acknowledge the consumer component of the technology. • Establish deep-rooted local knowledge (bottom-up knowledge), especially appropriate delivery mediums. • Measures and indicators of the effect of inclusive interventions. • Create traditional spaces and places enabling the involvement of a diverse set of actors. • Develop knowledge that guides decisions and implementations of I4ID. • Seek knowledge of sector and cluster studies. Physical: • Ensure adequate physical infrastructure is present.
	Quality	Infrastructure is inadequate or malfunctioning and cannot support the IIS and I4ID.	Ensure infrastructure quality is sufficient. Knowledge: • Create traditional spaces and places enabling the involvement of a diverse set of actors. • Develop knowledge that guides decisions and implementations of I4ID. • Seek knowledge of sector and cluster studies. • Create knowledge management techniques to ensure that data is relevant to the actors involved. Physical: • Infrastructure must be of adequate quality for its intended purpose.

5.3.4   SYSTEMIC INTERVENTION
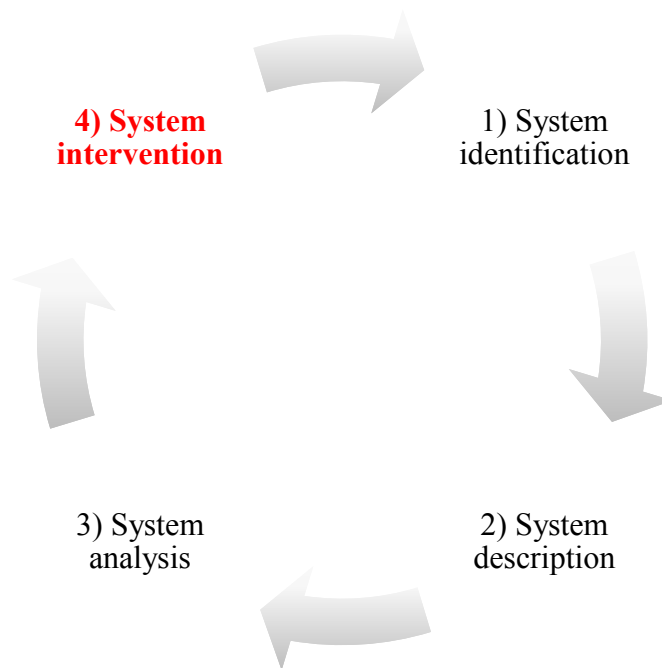
The development of systemic instruments follows after the identification of systemic problems, type of systemic problems and systemic instrument goals (Bergek *et al.*, 2008). The systemic instruments comprise an integrated clear set of tools tailored to the specific needs of an IIS or part thereof. These tools require selection with the goal of effective, strengthened and coordinated action to align an IIS to innovate for inclusive development. The systemic instruments outlined in this section aim to create opportunities and environments to form an inclusive system through the influence of structures and their relationships. The systemic instruments, through increased capacities and presence of structure, allow policymakers to influence the direction of a system to achieve inclusive goals (Bergek *et al.*, 2008). Systemic instruments may well serve as supporting tools to direct and influence the complex dynamics surrounding marginalised markets. It must be emphasised that this may be a too broad approach to apply to policy decisions, but it serves as a very useful guide to identify the type of interventions required, although further exploration is required.

Bergek *et al.*, 2008 proceeds by outlining systemic policy intervention objectives followed by tables dedicated to explore systemic policy interventions as follows:

- Actors: Systemic interventions relating to actors must have a focus of the active inclusion of a set of differing and diverse actors that is enabled through the creation of spaces and places that encourage active inclusion and participation (George, 2012).
- Interactions: 'Interaction' here refers to not only interaction with marginalised actors, but also interaction among research institute, organisations, government and NGOs (Kraemer-mbula and Wamae, 2010). A collective approach is required to be developed towards more inclusive solutions. There is also a requirement to overcome too strong networks (hierarchical presence)

and to innovate for inclusive development as well as to overcome weak ties between formal and informal markets.

- Institutions: An institutional set-up that favours innovations for inclusive development is still very limited. Institutions supporting I4ID should range from government level to incentives, tax benefits and discounts at product and service level (Foster and Heeks, 2015a). There is furthermore a requirement to adapt formal institutions to focus on I4ID as well as to consider soft institutional set-ups prevalent in informal settings.

- Infrastructure: Infrastructure consists of three dimensions, namely physical, financial and knowledge infrastructure. The I4ID often takes place where limited infrastructure exists to support the technology used (Foster and Heeks, 2014). There is a need to incorporate these aspects in business models. Financial infrastructure requires to venture into new financing models, where funding is for a fixed amount and time frame.

Table 33 outlines a summary of IIS systemic policy goals and instruments.

Table 33: Systemic policy goals and instruments for IIS structures

Systemic policy instrument goals	Specific systemic policy instrument goal	Systemic policy instruments
Actors		
Encourage and organise involvement of a wide variety of actors	Establish new relationships and collaboration among the 'new' set of actors in the system.	• Establish coordination among actors – mutual learning; governance and leadership (project champion). • Co-creation between formal and informal actors is required that align to a shared goal/vision for formal and informal actors;
	The involvement of a multi-partner cross-sectoral team is required where the marginalised is actively involved.	• Develop intermediary actors and institutions that serve as a bridge between formal/informal markets and products and service development and implementation. They may also serve as knowledge diffusion agents with technical expertise of I4ID. • Encourage and plan for the involvement of unconventional partners, such as inclusion of the marginalised and organisations that provide education or healthcare in marginalised communities. These organisations possess invaluable knowledge of these communities. • Integrate the marginalised in economic benefitting activities.
	Gain and develop a deep understanding of the targeted individuals (the market).	• There must be a deep awareness of interests (formal and informal). This is necessary to create capabilities and capacities for both formal and informal markets to foster mutual benefit. • 'On-the-ground' knowledge and engagement with the market – relationships must be established with influential players in informal communities. They possess invaluable

85

		information regarding 'on-the-ground' knowledge.
	Acknowledge the marginalised as valuable partners in business processes (users to partners).	• Include the marginalised as knowledge enablers; channels of knowledge diffusers; acknowledgment of local actors; partnerships based on trust with marginalised. • Build capacity of the marginalised communities through training programmes.
Establish spaces and methods for actor capability development	Development of research institutes and their capabilities to study the dynamics of I4ID and IIS.	• Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised-related). • Stimulate research institute programmes to foster inclusive innovation research. • Establish bursaries and educational incentives for institutions to conduct research for I4ID
	Develop capabilities for the creation of sustainable I4ID business models and scaling initiatives through advanced technologies.	• Focus on developing capabilities broader and beyond just the product and/or service. There must be supporting structures to develop capabilities and capacities of informal communities to obtain maximum benefit from I4ID. • Support the use of advanced technologies. It is important to consider technologies that may serve as platforms for added services to lower entry costs and promote activities for added I4ID solutions.
	Documentation and learning from best practices (real-time data for evaluations) for I4ID and IIS.	• Align research goals among the relevant stakeholders to search and develop a set of best practices for specific industries or projects. These set of good practices should be monitored in real time as the project is introduced. • Develop a set of benchmarks for best practices.
	Create spaces and environments for the integration of different actors' capability.	• Establish inclusive innovation platforms in communities as well as among inclusive knowledge leaders.
Interactions		
Motivate interaction opportunities between diverse actors	Cooperative research programmes among the relevant knowledge-creation bodies.	• There should exist links that encourage research programmes to align research activities of institutes, NGOs, government and donors. • Establish research and innovation hubs and resultant expertise that specifically focus on I4ID.
	Bridging instruments that serve as enablers for interactions among diverse actors.	• Provide a place for active engagement and learning from best practices and implement projects through the development of centres of excellence and competence centres. • Encourage information flow of the requirements of marginalised groups.

	Debates facilitate decision-making towards inclusive system approaches. This should be evidence-based as far as possible.	• Marginalised interaction goals: This does not include only listening, but also that there exists a deep debate on the topics under discussion – community – direct personal relationships with local communities and NGOs (intermediaries). • Collaborating effectively with agents on the ground. Having direct contact with relevant marginalised segments is vital. • Deep dialogue for local innovation must start with a deep immersion into consumers' lives to get unique insights. • Develop research strategies to identify barriers and opportunities for I4ID.
	Institutions	
Presence of (hard and soft) institutions for the specific innovation in focus	Shared commitment: has a common goal and vision with benefits to all actors.	• Have documented policies and institutions that specifically focus on a shared commitment from all parties involved and outline implementation practices.
	Hierarchy and silo approach intervention mechanisms to overcome too strong formal set-ups.	• Awareness programmes of the relevance of the marginalised actors. • Ensuring regulatory impediments do not prohibit or constrain innovations serving the poor (particularly regarding public services) while critical quality standards are being met.
	Institutions favour I4ID.	• Regulations must not prohibit innovations that seek to serve the marginalised without compromising on quality. Essential due to regulations hindering the implementation of successful I4IDs in Africa and South Africa, such as M-PESA (i.e. mobile phone-based money transfer) and the giving good model (see Author, date). • Insert inclusive innovation policies in innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. • Investigate and revise current policy that is aimed at marginalised groups, especially those policies that target better integration through enhancing access to services, novel Intellectual Property (IP) solutions and infrastructural constraints.
Prevent too weak/stringent institutions	Institutional processes and participatory planning of marginalised actors.	• Align participatory plans to improve productivity income and improve the well-being of the marginalised. • Encourage grassroots innovations – support knowledge and innovation flows, improve the capacity of low-income groups to absorb technologies for more effective use of innovations among low-income groups.
	Institutional structures support collaborative actions and orientation of formal actors towards inclusive solutions.	• Institutional structures, collaboration and orientation (national, regional and sectoral focus) to orientate formal ISs towards the marginalised.

	Inclusivity readiness and localised implementation of inclusive solutions.	• Mitigate the structural barriers blocking effective inclusive innovations, remove market aspects not conducive to implementing I4ID solutions. • Develop agreements, standards, taxes and rights for I4ID.
	Infrastructure	
Motivate physical, financial and knowledge infrastructure	Align the funding of projects to the intended inclusive goals and appropriate time frames.	• Align funding goals with key performance indicators (KPIs) of government and organisations operating in the inclusive space. Develop programmes so that funding is for a fixed time frame and amount, which is essential to support I4ID interventions and provide legitimacy around the intervention.
	Financial infrastructure:	
	Development and creation of sustainable business models.	• Deep-rooted local knowledge (bottom-up knowledge)
	R&D grants for research institutes to develop inclusive interventions.	• There should exist cross-subsidising for consumption and novel ideas with the aim of lowered costs. • Financing mechanisms that are tailored to support I4ID initiatives.
	Taxes and loans that align and support inclusive interventions.	• Develop taxes that are favouring the emerging I4ID market through favourable loan schemes.
	Knowledge infrastructure:	
	The consumer component of the technology.	• Marketing of technology is required to take place through marginalised or intermediary actors. • Deep knowledge of the marginalised market must be stimulated through deep immersion into the lives of the marginalised.
	Deep-rooted local knowledge (bottom-up knowledge), especially appropriate delivery mediums.	• Give access to training programmes and capital that focus on capability and capacity to enable contributions of marginalised actors. • Capability and capacity education programmes and alternative financing schemes are required to build awareness.
	Measures and indicators.	• Learn from past experiences, and establish methods that ensure that project and system change is documented for further I4ID. • Develop instruments that will monitor the implementation, effect and reach of I4ID. • Develop specific monitoring and evaluation (M&E) for the sectors, projects and communities.
	Physical infrastructure	
	Ensure adequate physical infrastructure is present.	• Establish good practices of physical infrastructure requirements. • Make use of latest technological solutions (e.g. ICT).
Ensure sufficient infrastructure quality	Create traditional spaces and places enabling the	• Create traditional spaces and places to serve as a space where discussions are held around interventions. Make marginalised part of

	involvement of a diverse set of actors.	developing the community by their actions, and create mutual value for individuals and the community.
	Develop knowledge that guides decisions and implementations of I4ID.	• Create road maps (evaluation practices and toolkits) to guide the development of inclusive systems. • Surveys and databases to understand the requirements, constraints and opportunities faced by the marginalised. These should be used as knowledge enablers that are shared throughout the system to support mutual learning.
	Seek knowledge of sector and cluster studies.	• Set of indicators to compare trends for different interventions of competing sectors to innovate for inclusive development. • Establish supportive networks for I4ID and organisations.
	Create knowledge management techniques to ensure that data is relevant to the actors involved.	• Guiding principles for knowledge best practices to acquire knowledge to guide interventions appropriately.
	Identify and overcome the infrastructural barriers:	• Technology assessment and knowledge transfer mechanisms should be adequately explored before the study is commenced. Technologies used must be scalable and sustainable. • Technological capabilities must suit the needs of informal users, cross-pollination of marginalised knowledge and technologies is required. • The provision of I4ID must be developed in such a manner that existing infrastructure may support the I4ID, such as mobile phones, or the I4ID must be implemented in collaboration with the necessary infrastructure, joint delivery processes.

5.4   Conclusion

This chapter outlined the proposed IIS analytical framework. This was done by first deriving the basic structure from the TIS literature, largely based on the work of Wieczorek and Hekkert (2012). The analysis framework was developed to consist of four phases: system identification, system description, system analysis and system intervention. The four phases and their constituent steps were first identified in the context of traditional IS analysis. These phases and steps were then adapted to adhere to the requirement of I4ID, thus changing the IS framework to an IIS framework. This framework was developed with the aim of being able to explore the I4ID system dynamics within ISs, with the aim of identifying systemic problems and constructing systemic policy interventions to strengthen the system towards more inclusive solutions. The next chapter presents the illustrative case study to which the framework was applied.

CHAPTER 6 CASE INTRODUCTION: MATERNAL HEALTHCARE AND THE MOMCONNECT PROJECT

Chapter 5 presented the proposed IIS analytical framework. Chapter 6 presents the first phase of the analysis process, namely selecting an appropriate case study and boundaries to which the framework could be applied to illustrate its utility and usability.

As part of the case selection process, this chapter presents a discussion of the first step and phase of the analysis framework, namely defining system boundaries. This is done by providing an overview of the South African health system and outlining the health status of the population, as well as the health system approach followed by the South African government. It furthermore gives a broad overview of the mobile health sector as an appropriate system, firstly, to serve the health of the South African population, and secondly, an adequate system for analysis of I4ID.

4) System intervention

1) **System identification**

3) System analysis

2) System description
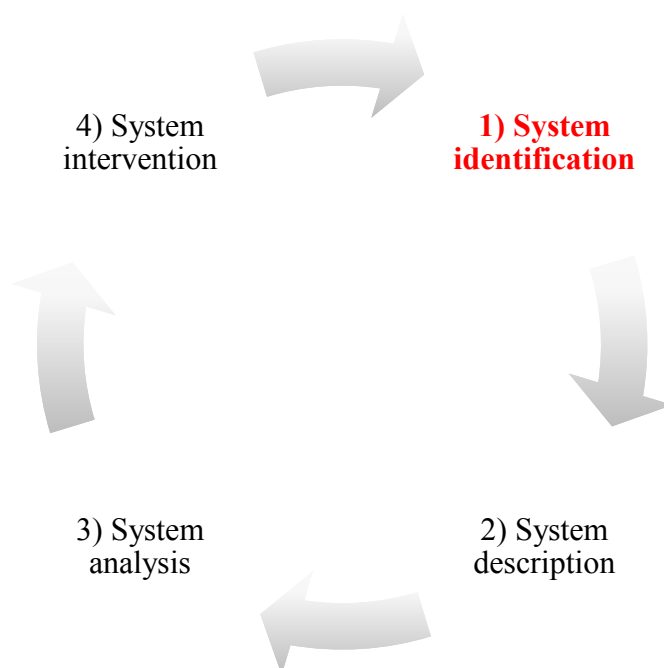
Figure 4 outlines the descriptive steps of defining system boundaries and serves as an illustration of the flow of this chapter.

Figure 4: Cyclical steps to derive system boundaries

6.1 Selection of appropriate marginalised project site(s) – why healthcare

An IIS or project focusses on 'vertical' or 'horizontal' linkages, or a combination of both. The healthcare industry in general serves 'horizontal' links with some aspects of 'verticality' as the sector is very specialised and regulated. There remain numerous obstacles to provide sufficient healthcare in Africa, and this was explored and is reported on in detail in this chapter.

6.1.1 THE SOUTH AFRICAN HEALTH LANDSCAPE

Healthcare systems are broadly classified as:

- free market: all healthcare is provided by private healthcare or health insurers through an agreement with private organisations or NGOs for the provision of services, while the state often subsidises the poor in these cases;
- national insurance: is classified as a legally enforced scheme of health insurance providing healthcare to all; and
- national health system: government has the monopoly regarding health provision and insurance (Kearney, 2011).

The South African health landscape is a combination of a free market and national health system (Kearney, 2011). The private health system is a free market, as health insurers contract health providers (Kearney, 2011). The national health system of South Africa provides free or at a small cost basic health services to all of the population. South Africa's National Health Insurance (NHI) is still very much in the development stage with some projects already launched throughout the country with positive consequences in the public healthcare system. This intends to bring reform through improved services and it is planned to be introduced over the following 14 years (National Department of Health [NDoH], 2012b).

6.1.1 HEALTH SITUATION OF THE SOUTH AFRICAN POPULATION

Although South Africa is one of the largest economies in Africa, the country faces major unemployment rates, with at least 36% of the country's population residing in rural areas (NDoH, 2015b). Rural areas lack infrastructure and are located in places that are hard to reach, which complicates the delivery of timely, efficient and quality healthcare solutions (NDoH, 2015b). The vast geographical region is not the main problem, but rather the inequality in the standard of living of the population residing in rural areas placing an immense burden on their health status due to a lack of appropriate, quality healthcare services (Botha, 2011).

South Africa's health system consists of a large private health sector serving the minority high-income consumers (Friderichs, 2011). Public healthcare serves 86% of the country's population (Friderichs, 2011), having access to only 47.9% of the health expenditure of the country (World Health Organization [WHO], 2016). South Africa has a good supply of doctors,), with 7.7 doctors per 1 000 individuals. Yet again the distribution is skewed, with provincial healthcare served by 0.6 doctors per 1 000 individuals and 0.9 specialists per 1 000 people (Trust, 2013). The population per public healthcare clinic is around 13 700, which is considerably higher than the WHO norm of 10 000. The public health sector faces aging infrastructure, mismanagement and a lack of adequate funding (Trust, 2013).

Healthcare financing is divided, where a major share of available finances is allocated through medical schemes, hospital care plans and out-of-pocket payments. This covers private clients who bought a benefit option of choice or have received such a plan through their employment at an organisation (Friderichs, 2011). The consequence is that only those with medical scheme cover have access to private healthcare. The National Treasury funds the majority of the population consisting of mainly public sector users (NDoH, 2012). *South African Health Review* (Health Systems Trust, 2016) said in a statement, "Many of the consequences of the HIV/AIDS epidemic, health worker shortages and inequities in resource distribution can be linked to shortcomings of political, public sector and medical / health leadership and a complex and protracted health transition."

6.2 Making sense of the community requirements and constraints – South Africa's quadruple burden of disease

The South African (SA) health system is under immense pressure as a result of unemployment, poverty and many rural settings, and is furthermore constrained by the burden of disease (Mars & Seebregts, 2008). The SA burden of disease differs in composition to that of many of the other developing countries, as HIV and AIDS have a disproportional influence on the disability-adjusted life years (DALYs) of the SA population. HIV and AIDS are opportunistic infections, which furthermore place an extra burden on the population's health through diseases, such as tuberculosis (TB), diarrhoea and meningitis (Tawfik & Kinoti, 2006).

Three broad categories classify the burden of disease. The first category comprises pre-transitional causes, i.e. communicable diseases, maternal and perinatal conditions, and nutritional deficiencies " (Ruxwana *et al.*, 2010). The second category, comprises all non-communicable diseases, and the third category relates to injuries. HIV and AIDS fall in the first category, as it is a communicable disease, but it is included as a separate group as it is seen as an epidemic (NDoH, 2010).

The most influential challenges faced by the SA health system are summarised as follows:
- over-utilised public health system;

- inequalities in health provision;
- quadruple burden of disease;
- a lack of health infrastructure;
- a lack of human resources; and
- the rural nature of the country, vast landscapes and economic inequalities (Leon and Schneider, 2012b).

The NDoH is aware of these circumstances, and made an active effort in the fight against these challenges, through their mission statement in the Annual Report of The Department of Health of South Africa, "To improve the health status through the prevention of illnesses and the promotion of a healthier lifestyle and to continuously improve the healthcare delivery system by focussing on the access, equity, efficiency, quality, and sustainability" (NDoH, 2010).

The challenges outlined and the focus of the NDoH on access, equity, efficiency, quality and sustainability clearly call for an innovative health system focussing on inclusive solutions. The following section reports on the opportunity for eHealth and how mHealth specifically adheres to these requirements.

6.3 Product/service/industry of choice – the mobile health system

Mobile health is seen as an efficient method to create awareness and knowledge among distant actors. It gives access to improved health services and is especially evident in resource-constraint settings. Firstly, ICT and eHealth are explained as mHealth is a sub-category of these areas.

6.4   Role of ICTs in healthcare

ICT is a combination of electronic communication and information technology with the goal of producing, transmitting, accumulating and salvaging digital data to use for clinical, educational and administrative purposes (Ruxwana, Herselman & Conradie, 2010). The following quotation sums up the usefulness of this approach to bridge the divide between rural and urban areas: "Information and Communication Technology solutions (e.g. e-health, telemedicine, e-education) are often viewed as vehicles to bridge the digital divide between rural and urban healthcare centres and to resolve shortcomings in the rural health sector" (Ruxwana *et al.*, 2010:23).

The potential and benefits of ICTs in rural communities is well known and hold the potential to improve the health status of these communities. Service delivery is enhanced through the use of ICTs in the following areas:

- providing improved access to basic services;
- optimising service delivery;
- increased efficiency through increased connectivity; and
- creating an enabling environment for the exchange of knowledge (Cargo, 2013; Gillwald, Moyo & Stork, 2012; Ruxwana *et al.*, 2010).

Policymakers need to strike a balance between adequate provision of e-government and basic needs of the marginalised people, and huge information technology (IT) expenditure for e-government will be difficult to justify from a social justice point of view (Ruxwana *et al.*, 2010). Furthermore, multiple ICT solutions exist, but fail to reach scale in rural South Africa, as limited technological solutions are available, tailored to the needs of rural communities (Cargo, 2013; Leon & Schneider, 2012; Mars & Seebregts, 2008; NDoH, 2015a).

ICT serves as an effective enabler to improved healthcare and development, but cannot be used in isolation and should be implemented in conjunction with rural development interventions to realise its fullest potential. These interventions include proper access to ICTs, knowledge diffusion of ICT usage and ICT-related skills and policies that support ICT implementation and use (Mars & Seebregts, 2008).

Important to consider when implementing ICT solutions is psychological variables, which have an influence on firstly, accepting the relevant technology and secondly, the ease of use, as rural communities are known to have limited literacy capabilities, and the use of new technologies might be daunting. Two variables exist that have an effect on individuals to use ICTs as mentioned by Ruxwana *et al.* (2010). Firstly, there is the perceived Usefulness (PU) of a technology and secondly the perceived ease of use (PEU). PU is the belief of an individual that the technology under consideration will have a positive effect on his/her requirements or make the job on hand easier and simpler and just be an overall improvement in job performance. The diffusion of knowledge of the applicability and use of technologies could enhance the PU of an individual, as could policy development around such a technology. PEU is the individual's belief that the technology will need the minimum effort to use. Multiple cases exist where the technology itself was seen as an added burden because the application was too complicated or where the user believed that the benefits of the technology did not overshadow the effort. There exist multiple barriers to PEU such as ICT access, access to supporting communication infrastructures and the Internet, as well as ICT-related skills (Ruxwana *et al.*, 2010).

6.4.1   eHEALTH

A study conducted on ICTs in LMICs outlined the significance of infrastructural and cultural circumstances and systems challenges as "The implementation of health ICTs in developing countries and sub-Saharan Africa, in particular, has been hampered by traditional obstacles: poor infrastructure; lack of resources; and insufficient political commitment and support" (Ruxwana *et al.*, 2010:27).

South Africa finds it challenging to obtain the benefits of eHealth, as it is slow to reach agreements on best practices and implementation of processes (Gardner & Ash, 2003). The country lacks a standardised healthcare approach, even less so at ICT system level (Ruxwana *et al.*, 2010). Standardisation of health systems across provinces is essential for the realisation of eHealth solutions and there are substantial barriers in the SA context, as provinces have vastly different interoperability among systems (NDoH, 2012a). To foster a lasting effect requires the 'four Cs" of ICT consideration, and should be viewed through an inclusive lens in the SA context. The four Cs of ICT development are summarised as follows (Gardner & Ash, 2003):

- **culture** – of information and technology use;
- **capacity** – in managing effective implementation, use and maintenance of the new ICTs;
- **connectivity'** – the interoperability of ICTs; and
- **costs** or financial implications

6.4.2   INTRODUCTION TO mHEALTH

Mobile phone technology, a subset of eHealth, has demonstrated the potential to improve health service delivery. However, little guidance and information exist to inform decisions to acquire and implement mHealth technologies at scale (Leon, Schneider & Daviaud, 2012) According to the NDoH (2015a), mHealth refers to mobile computing, medical sensor, and communications technologies used for the delivery of health-related services and the support of medical and public health practice.

mHealth has a vast array of application areas, including education and awareness, remote data collection and monitoring, communication and training for healthcare workers (HCWs) and community healthcare workers (CHWs), disease and epidemic outbreak tracking,; and diagnostic and treatment support (NDoH, 2015a). In the SA context, mHealth may be an enabler of knowledge richness through a collection of real-time data (Leon *et al.*, 2012). This aids the public health system, which is under pressure, as a tool for decision-making to increase effectiveness and efficiency of evidence-based decisions (Leon *et al.*, 2012). The WHO identified the following mHealth uses (World Health Organization (WHO), 2009):

- provision of emergency response systems;
- disease surveillance and control;
- enabling human resource coordination, management and supervision;

- diagnostic and decision support for point of care services;

- provision of remote patient monitoring and clinical care;

- provision of health promotion and community mobilisation;

- health services surveillance and reporting; and

- training for HCWs and CHWs.

6.4.3   THE OPPORTUNITY FOR MHEALTH IN SOUTH AFRICA

South Africa ranks among the countries with the largest number of mobile phone subscribers per population, as 142 of every 100 individuals connect to a mobile network (World Bank, 2017). Government furthermore has a strong concern with the broader application of mobile phone technology within government, as the health department launched an eHealth and mHealth strategic document in 2012 and 2015 respectively (World Health Organization and International Telecommunication Union, 2012; National Department of Health, 2015a).

The SA landscape has over 83 mHealth projects, but these are small-scale, donor-funded, sometimes short-term projects and not integrated into the mainstream health system (GSMA, 2013). What is not known is whether benefits witnessed in these local examples (and those in the broader literature) can be retained in terms of opportunities and challenges of implementation, for large-scale projects in the routine public healthcare sector (Leon *et al.*, 2012). Challenges to scale, however, are prevalent in all four health systems dimensions namely:

- stewardship;

- organisational;

- technological; and

- financial (Leon *et al.*, 2012).

6.4.4   CHALLENGES TO MHEALTH

Successful mHealth interventions is seen as follows: "mHealth implementation must support the daily workflows in healthcare settings through the accurate collection, transmission, storage, computation, and display of information" (NDoH, 2015a:72).

The lack of large-scale mHealth projects backed by the government of South Africa is the result of inadequate high-level strategic, policy and financial support from government. The health system is characterised by a weak organisational culture and a capacity to use health information for managerial purposes, as well as the lack of availability and use of mHealth for primary healthcare (Leon *et al.*, 2012). Furthermore, constrain technological challenges such as interoperability and integration of information systems and privacy of information as well as a lack of sustainable financing for large-scale mHealth technologies in resource-constraint settings the development of the mHealth sector (NDoH, 2015a).

mHealth interventions are further not integrated within the broader public health system and removed from government-level policy support (Leon *et al*., 2012). Interventions are mainly aligned to the goal of the funding organisations and delinked from the larger government objectives. Organisational weaknesses result in a gap between new policy formulation and effective implementation, limiting the introduction and use of new technologies (Leon *et al*., 2012). mHealth devices have considerable variability regarding capabilities, price and the reliability and proof of evidence of improved patient outcomes, work efficiency and access to healthcare. Challenges unique to SA mHealth projects are:

- a lack of alignment and integration of the interventions into health plans, strategies and systems;
- a lack of government leadership and coordination;
- existence of meagre documentation of and learning from best practices;
- the lack of practical approaches to privacy and security;
- a lack of interoperability; and
- the lack of a single framework to evaluate mHealth and eHealth as tools to strengthen the health system (NDoH, 2015a).

Barriers are not just the complexity of mHealth technologies itself but are rather related to broader health system challenges, such as practices of health personnel, integrating new technologies with current information systems, sustainable funding and suitable leadership to guide the shift to the usage of ICTs. mHealth implementation in LMICs faces multiple challenges as listed below:

- a lack of alignment with and integration into health sector plans, strategies and systems;
- a general absence of government leadership and coordination;
- poor documentation of and learning from best practices;
- the challenge of identifying and using affordable open-source options;
- a general absence of ensuring workable approaches to privacy and security; and
- the problem of finding workable approaches to interoperability (Leon *et al.*, 2012).

6.4.5   CALL FOR INDICATORS IN MHEALTH

The mHealth field is constrained by the lack of evidence on the effect of mHealth at scale, as well as small pilot projects (Levine *et al.*, 2015). A knowledge gap exists about the social, organisational and cultural elements of successful application of ICTs, extending to mHealth. Further challenges of mHealth evaluations (and eHealth) interventions focus on feasibility, rather than effect and cost-effectiveness, giving little space to evaluate benefits of the programmes (Leon *et al.*, 2012). The focus is on intermediary outcomes, rather than on the influence of quality and efficiency improvements in service delivery, strengthened health systems and improved clinical outcomes (Pillay, 2015). The following quotation summarises the call for indicators:

> In the light of the paucity of evidence about improvements in patient outcomes, as well as the lack
> of proof on their cost-effectiveness, it is vital that future eHealth and mHealth technologies be

evaluated against a comprehensive set of measures, ideally throughout all stages of the technology's life cycle (Leon *et al.*, 2012).

6.5 Individual and or group definition – maternal healthcare

Maternal, newborn and child health is a fundamental component on the SA healthcare agenda, as approximately 1.1 million births are registered per year (Deloitte, 2014). In South Africa, 45 out of every 1 000 children die before the age of five, and for every 100 000 births, approximately 140 women die during pregnancy and childbirth. Estimations indicate that at least 60% of maternal deaths are avoidable (Deloitte, 2014). These statistics are not close to the Millennium Development Goal (MDG) targets for South Africa (Levine *et al.*, 2015). Key elements to address maternal, newborn and child health and survival comprise:

- getting a higher number of women attending antenatal care in the first trimester;
- improved quality of antenatal care (e.g. early testing for HIV);
- access to improved maternal nutritional information;
- access to improved quality of intrapartum and emergency obstetric care;
- delivery in a health facility; and
- highly active antiretroviral therapy cover for HIV-positive breastfeeding mothers (Deloitte, 2014).

The three delays that lead to an increased mortality rate should be addressed, the three delays are:

- delay in deciding to seek care;
- delay in reaching care in time; and
- delay in receiving adequate treatment (Chris & Venter, 2015).

6.6   Introduction to the MomConnect project

The SA mHealth landscape has numerous pilot projects utilising digital technology in a quest to solve pressing health challenges (United Nations Foundation, 2015). Despite these projects, a national-scale digital health intervention remained out of reach for the NDoH (United Nations Foundation, 2015). In 2014, the SA Minister of Health was under increasing pressure due to missed sustainability development goals (SDGs) with regard to maternal healthcare, and requested a large-scale, nationwide response to minimise preventable maternal and infant deaths (Waldman & Stevens, 2015).

Subsequently, a task team was set up to review mHealth and to develop a national strategy to reach pregnant women, with the outcome the MomConnect project, the first nationwide mHealth project, implemented in an LMIC, managed by a NDoH (Waldman & Stevens, 2015). The MomConnect programme is a digital health programme that serves pregnant women and women with infants, through supplying directed stage-based health information and postpartum support via SMS. The service further

provides women with the ability to communicate pressing questions, rate their local clinic and enable an essential feedback loop to establish service of a better quality through data (United Nations Foundation, 2015). Table 34 presents a summary of the functioning of the MomConnect programme (Pillay, 2015; United Nations Foundation, 2015).

Table 34: The main functions of the MomConnect programme

MOMCONNECT: HOW IT WORKS			
National Pregnancy Register (NPR)	**Stage-based health information delivery**	**SMS helpline**	**Service ratings and feedback**
Pregnant women can self-register using Unstructured Supplementary Service Data (USSD), be registered by a CHW, or register directly at a clinic Data sent to backend database of registered pregnant women in South Africa	Stage-based SMS messages are sent to pregnant twice a week until newborn child's first birthday. Messages cover broad health topics related to women and child health. Messages available in six languages.	Pregnant women and health workers can file complaints and compliments. The NDoH reviews messages and send the messages to the district level to address challenges.	Pregnant women are sent a 5-question survey via SMS to rate their clinic experience on friendliness, cleanliness, privacy and waiting times. Data is used to develop clinic service ratings.

The overarching goal of MomConnect is to lower maternal and infant mortality rates and reach every pregnant woman in South Africa (Pillay, 2015; United Nations Foundation, 2015). The MomConnect project have the following goals (Pillay 2015; United Nations Foundation 2015):

- register every pregnant mother;
- reduce maternal and child mortality;
- improve access, coverage and quality of care for mothers and children;
- support mothers during their pregnancy, childbirth and child's first year;
- achieve the Millennium Development Goals (MDGs);
- the project must be scalable; and
- the outcomes of the project should be traceable (Pillay, 2015).

6.6.1   SELECTING SYSTEM/CASE – ROAD MAP TO MOMCONNECT

This section serves as a road map in describing the MomConnect programme and the mHealth system as an appropriate system for analysis of inclusive innovation performance.

Selection of appropriate marginalised project site(s)

The SA public health system is under severe pressure. Multiple challenges exist, requiring innovative solutions to overcome these difficulties. The following are the most pressing challenges in the public sector sphere:

- over-utilised public health system;

- inequalities in healthcare provision;

- quadruple burden of disease;

- lack of human resources and infrastructure;

- rural nature of the country and vast landscapes; and

- economic inequalities.

6.6.2   MAKING SENSE OF THE COMMUNITY NEEDS, REQUIREMENTS AND CONSTRAINTS

The NDoH is actively involved in the fight against the current health problems faced by the SA population. The main requirements of individuals using public healthcare are improved access to health solutions, equity in healthcare delivery across sectors, efficiency of solutions, quality of care, and sustainable interventions.

6.6.3   PRODUCT/SERVICE/INDUSTRY OF CHOICE

Literature points to ICT as an appropriate method to overcome current challenges faced by the SA public healthcare sector, in terms of five key perspectives, namely –

- improved access to healthcare;

- improved quality of care;

- illness avoidance;

- health promotion; and

- improved efficiency which can be viewed as improved healthcare by using fewer resources.

mHealth is an appropriate choice towards more inclusivity, as the multiple applications of mHealth may serve as a key enabler to a more inclusive health system. Some of the benefits are:

- research and disease surveillance;

- improved supervision;

- planning and development of service deliveries;

- tools for decision-making in clinical services,

- health promotion and disease prevention; and

- education of health professionals (Leon *et al*., 2012).

These applications have a direct influence on the health outcomes of the population and serve as an opportunity to include the marginalised in 'vertical' and 'horizontal' linkages, as large development is still required within South Africa to achieve the application and benefits of mHealth.

6.6.4   INDIVIDUAL AND OR GROUP DEFINITION (WHO IS TARGETED AND HOW)

The target of MomConnect is every pregnant mother. A large number of mothers are disconnected from formal value chains or systems, they do not have access to quality of products and services, and they do not have access to basic healthcare requirements (United Nations Foundation, 2015).

6.6.5   MOMCONNECT ADHERENCE TO THESE REQUIREMENTS

The MomConnect programme is a digital health programme that registers pregnant women, and distributes directed stage-based health information to pregnant women via an SMS service. It gives women the ability to communicate pressing questions, rate services of their local clinic and enable an essential feedback loop to establish better-quality services (United Nations Foundation, 2015). The project is significant as this is one of the few instances globally where a national health department implemented an mHealth scheme and launched out nationwide in an LMIC. Table 35 outlines a general list, derived from the system boundary selection process as summarised throughout this chapter, to evaluate whether the MomConnect programme is an appropriate project in the public healthcare sector, mHealth landscape, and maternal care.

Table 35: Selection of the MomConnect case

Requirements to be selected as eligible project	Yes/No	How?
The marginalised is defined through one of the numerous definitions that exist	Yes	Every pregnant woman in South Africa. Serve actors disconnected from formal value chains or systems and do not have access to quality of products and/or services as in formal markets and do not have access to basic healthcare needs.
Sector that represents the marginalised	Yes	Serve the public healthcare sector (maternal healthcare)
	Yes	Women in rural and informal communities
Serve the marginalised in terms of products, services or economic outputs with the aim of an improved outcome on the livelihood of the marginalised ,	Yes	Provide improved access to health solutions – SMS services.
Aim to reduce inequality in terms of products, services or economic outputs	Yes	Standardised service in formal and informal sector. Equity and quality of care in healthcare delivery across sectors.
Must be able to be studied within the system context.	Yes	Launched nation-wide.

6.6.6   CONCLUDING SYSTEM BOUNDARY

The road map to select the MomConnect project gives a thorough outline of selecting the project as an appropriate area of analysis for I4ID. Figure 5 gives a complete overview of the system under analysis. The MomConnect project forms the boundary of the system under analysis to break down the analysis into manageable parts. The direct and indirect influence of the systems surrounding MomConnect will

101

also be explored, but this was not the priority of the qualitative interviews. Data on these systems was derived mainly from secondary textual data.
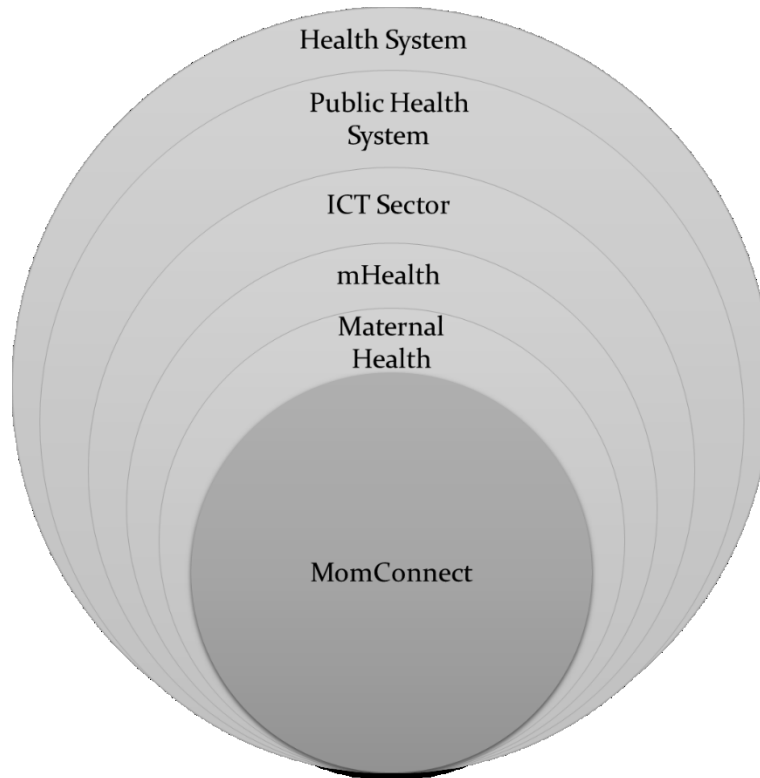
Figure 5: System under analysis

6.7   **Chapter conclusion**

This chapter introduced the IS in focus (system boundaries), the first step of the analytical framework. The SA public healthcare system is under immense pressure due to the quadruple burden of disease and a shortage of healthcare professionals. ICTs, eHealth and more specifically mHealth serves as appropriate means to address these burdens. Maternal healthcare was identified as one of the major constraints of the system, and was selected as the 'system' of analysis. To make the system measurable the MomConnect project was identified as a suitable case to analyse within the maternal and public healthcare systems.

CHAPTER 7 MOMCONNECT: CASE APPLICATION

Chapter 5 presented the proposed IIS analytical framework. Chapter 6 then presented the rationale for specific case selection and, as part of the case selection process, applied the first step of the developed framework to the case study. This chapter presents the results of applying the rest of the developed framework to the illustrative case study chosen in Chapter 6, namely the MomConnect project in South Africa.

Section 7.1 entails phase 2 of the framework development and provides a thorough description of the project in terms of the system structures and functions. Section 7.2 entails phase 3 and 4, providing a comprehensive overview of systemic problems, systemic policy goals and instruments for a project such as MomConnect to be more inclusively orientated.
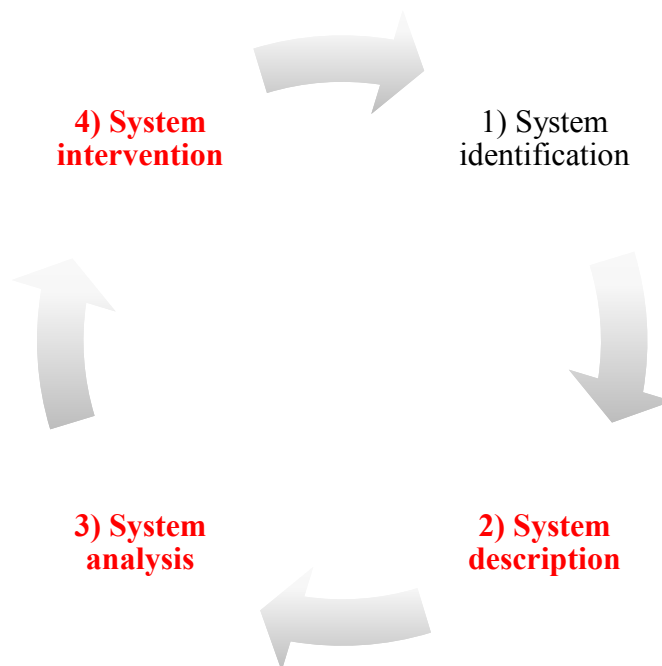
7.1   System description

This section provides an in-depth overview of the MomConnect project. Section 7.1.1 provides an overview of the structural description and section 7.1.2 outlines the functional description of MomConnect.

7.1.1   STRUCTURAL DESCRIPTION

This section outlines the system structure of the MomConnect programme. Section 7.1.1.1 provides an overview of the MomConnect system actors, section 7.1.2.2 provides an overview of the system

institutions, Section 7.1.1.3 provides an overview of the system interactions and section 7.1.1.4 provides an overview of the infrastructure of the system.

7.1.1.1 ACTORS

The notable actors involved in the MomConnect project are:

- government;
- private sector;
- donors;
- intermediaries (formal-orientated);
- embedded intermediaries; and
- informal consumer/user.

Government involvement

MomConnect is the first large-scale mHealth intervention that is supported by national and provincial health authorities in Africa. This is significant as most mHealth projects in South Africa are pilots and do not form part of government programmes. A critical success factor of the MomConnect project is the political will behind the project, driven by the highest levels of government, where the NDoH serves as a key actor and driver of the programme (United Nations Foundation, 2015). Strategic leadership was arguably the single most important factor in the vast and successful introduction and launch of MomConnect. Minister Motsoaledi (Minister of Health at the time) had a very clear goal and time frame: to connect every woman in South Africa to improved maternal healthcare through the use of mobile phones (United Nations Foundation, 2015). This clear goal set the stage for focussed leadership and direction as well as a coalition of partners, seen as the second success factor of MomConnect. This is in stark contrast with the general line of thought in other countries where organisations struggle to get backing and acceptance and support from government (Ismail *et al*., 2012).

Formal actors and intermediary organisations (formal)

The success of MomConnect is heavily dependent on the multiple partners from multiple backgrounds involved in the project. A multi-partner, cross-sectoral team of organisations supports the MomConnect project.

Table **36** outlines the partners of the project. Each partner plays a critical role in the success of the project (Pillay 2015; United Nations Foundation 2015). This is one of the success factors of the project, as a team from multidisciplinary backgrounds collaborated and shared invaluable knowledge and experience to reduce the learning curve and expenses for the programme.

Table 36: MomConnect partners

MomConnect Partners						
Driven by the NDoH						
Strategy	**Funding**	**Training**	**Mobile network operators**	**Monitoring & evaluation (M&E)**	**Content**	**Technology**
ICF[1] International, CSIR[2]	PEPFAR[3], Johnson & Johnson, Philanthropies, Discovery Foundation	PEPFAR District Support Partners	Vodacom, GSMA[4], MTN, Cell C, Telkom	University of Western Cape Stellenbosch University	Soul City, HealthEnabled, MAMA SA[5], Baby Center International	Jembi, Praekelt Foundation

[1] International Coach Federation

[2] Council for Scientific and Industrial Research

[3] President's Emergency Plan For AIDS Relief

[4] Group Special Mobile Association

[5] Mobile Alliance for Maternal Action

Source:(United Nations Foundation, 2015)

Intermediaries embedded in the local community

Intermediaries in local communities served as critical catalysts for the vast and effective launch of the MomConnect programme. The following actors are referred to as intermediaries situated in the informal market for this project:

- the local health clinics;
- healthcare workers; and
- community healthcare workers.

Informal actors

The stated programme target of MomConnect is to reach every pregnant woman and women with infants in South Africa (Health, 2015). The marginalised actors are thus seen by the programme as every pregnant woman in South Africa who had limited benefit from formal systems and who lacked knowledge of maternal healthcare. South Africa sees 230 deaths per 100 000 live births (Health, 2015). These deaths are mostly due to a lack of basic health information and access to services in South Africa (Health, 2015).

7.1.1.2   **INTERACTIONS/NETWORKS**

MomConnect was developed due to a collective endeavour involving government, donors, NGOs, academics and a range of additional organisations and individuals (Levine *et al.*, 2015). The NDoH took the lead over all the organisations, and specifically involved multiple partners to utilise the unique contribution and capacity of each (United Nations Foundation, 2015). Partners were specifically chosen

for their ability and experience to work with government on a national scale, having the capability to implement and offer the required resources, whether physical, financial or human resources (United Nations Foundation, 2015).

The NDoH created a platform where partners from different backgrounds came together to share knowledge and experiences of mHealth interventions. This enabled the MomConnect project to scale within six months nationally, as the learning curve was reduced due to the broad range of knowledge as well as knowledge sharing. If a lack of effort from numerous partners existed, it would have been difficult to see how the MomConnect project could have scaled as quickly (United Nations Foundation, 2015). From the interactions, several key lessons were learned (United Nations Foundation, 2015):

- how to build lasting partnerships with government,
- the value of knowledge sharing,
- the value of a multi-partner approach; and
- the value to create spaces for interactions.

7.1.1.3   INSTITUTIONS

South Africa has some legal frameworks guiding mHealth initiatives. Current frameworks protect patient confidentiality, as the National Health Act (61 of 2003) makes it clear that this information must be guaranteed. Notable legislative support is the Electronic Communications Act (36 of 2005), Independent Communications Authority of South Africa Act (13 of 2006), the Electronic Communications Act (3 of 2006) and The Protection of Personal Information Act (4 of 2013). Citizens have the right to privacy through the Bill of Rights in the Constitution (section 14). The control of information in the mHealth space is still an issue as it is unclear where the right to control information is lost by an individual and which legal frameworks address these privacy issues (Health Systems Trust, 2016). The country still lacks a concrete framework to guide decision-makers and policymakers in implementing mHealth interventions (Health Systems Trust, 2016). However, South Africa is placing increasing strategic awareness on the benefits and introduction of mHealth and eHealth, evident in the recently launched eHealth and mHealth strategic documents that serve as a guide for current and future mHealth initiatives (NDoH, 2015a).

7.1.1.4   INFRASTRUCTURE

This section gives a brief overview of physical and financial infrastructure that was supportive towards the introduction and launch of the MomConnect programme. This will be explained in more detail in section 7.1.2.

Physical

The following physical infrastructure was central to the introduction and success of the MomConnect programme:

- While the SA market sees an increase in the use of smartphones, an estimated 40% of adults still use basic phones (Health, 2015). The messages MomConnect sends out, are therefore available on basic devices (as well as smartphones).
- South Africa's telecommunications sector counts under the most advanced in Africa. The SA mobile penetration rates provide the largest network to connect with pregnant women and mothers with infants.

Physical infrastructure however remains one of the main constraints to mHealth interventions in LMICs (Deloitte, 2014; Leon *et al*., 2012; Powers, 2014; Mars & Seebregts, 2008). For the MomConnect programme this is no different, and the following infrastructural issues exist (Pillay 2015; United Nations Foundation 2015):

- ICT infrastructure in rural South Africa is still limited and expensive to implement;
- USSD (used for MomConnect sign-ups) time-outs. This happens very often due to poor network connectivity in more dispersed locations;
- interoperability of health systems across provinces differs vastly;
- the different maturity of the health system in provinces makes interactivity across systems a difficult task; and
- network coverage remains a critical aspect in dispersed regions.

Financial

The SA public healthcare sector is notoriously underfunded, and most of the public funds made available are used to either purchase stock or maintain primary healthcare facilities. Most of the public funds is used to keep services running. Donor funds are used for innovations and interventions, such as MomConnect. Initially donor funds were used to acquire information for decision-making in healthcare. This information enabled the NDoH to make result-orientated decisions and many positive knock-on effects were realised, such as the strong HIV programme in the country, funded by government.

The MomConnect programme was able to reach a national scale due to the financial assistance the project received (Pillay 2015; United Nations Foundation 2015). What is even more important is a fixed-term contract with PEPFAR, the largest donor of MomConnect. This is not the only donor. The project has multiple donors, minimising the risk of one of the donors pulling out. Another essential aspect is the substantial discount rates provided by the mobile operators for SMS services (United Nations Foundation, 2015).

7.1.2   FUNCTIONAL DESCRIPTION

This section will outline in detail the functional description of the seven system functions.

7.1.2.1   F1 – ENTREPRENEURIAL ACTIVITIES

The MomConnect programme follows similar trends as those followed by the general mHealth landscape in South Africa, which sees limited inclusive entrepreneurial activities in terms of active participation of the marginalised actors. However, a vast range of formal entrepreneurial activities exist in South Africa that bring innovative solutions serving the needs and interests of marginalised actors, and MomConnect is one such example. The SA landscape is still not conducive to seeking opportunities of co-creation between formal and marginalised actors. Entrepreneurs are mainly formal, driving solutions to marginalised actors that often do not include engagement with marginalised individuals, besides being beneficiaries of products and services.

Two very telling reasons emerged from the interview process of the lack of marginalised inclusion in the mHealth space. Firstly, the SA health market is regulated by very strict legislation and 'red tape', which makes it a difficult task indeed to utilise less formal actors. The second factor is the formal silos existing in the healthcare sector, due to the specialised nature of healthcare. This results in a time-consuming process to implement novel, inclusive solutions as a vast range of silos need to be broken down.

MomConnect: a notable inclusive link

Inclusive links for the MomConnect programme require further exploration. Notable actors that require attention are community healthcare workers (CHW). The MomConnect programme utilises the CHWs only as 'marketing agents' for the programme. The CHWs inform pregnant women or women with infants about the MomConnect programme. The job description of CHWs requires exploration, as many opportunities to utilise CHWs in the public healthcare domain exist. CHWs are "local inhabitants given a limited amount of training to provide specific basic health and nutrition services to the members of their surrounding communities" (Unite for Sight, 2016). They often remain in their home village or neighbourhood and work as health workers (Unite for Sight, 2016). These workers are immersed in the community and play a leading role through the provision of basic healthcare knowledge and services, mostly through home visits. A more focussed integration of mHealth and CHWs may open up a host of opportunities, from better healthcare to the advancement of data collection for the NDoH as well as improved income opportunities for these actors. There further exist opportunities to explore business models that may be semi-sustainable to fund CHWs.

A noteworthy opportunity exists to utilise mHealth in collaboration with CHWs to obtain 'ground-level' information in the following areas (Powers, 2014):

- patient identity (ID) and tracking;

- supply tracking;

- monitoring and evaluation (M&E);

- checklists and protocols;

- education and training;

- data collection;

- counselling messages;

- surveillance; and

- health records.

Lessons from Africa

Two prevalent examples came up during the interview process, as interviewees referred to examples in Malawi and Uganda as opportunities for marginalised integration in projects such as MomConnect and the greater mHealth community in South Africa. The Living Goods model in Uganda (Bjorkman-Nykvist *et al.*, 2013) supports health entrepreneurs (such as the CHWs in this case) who do house visits and educate families towards improved health and wealth. The CHWs further sell low-cost, life-saving and life-changing products for treatment such as malaria and diarrhoea, as well as food, water filters and cooking essentials. The result is the generation of income for thousands of micro-entrepreneurs and increased household incomes for families, as families are saving money on quality health products/services and transport costs for daily needs that are now delivered to them. The CHWs become semi-financially sustainable at country level.

The model in Uganda is 60% sustainable and sees a 25% reduction in childhood mortality (Living Goods, 2013). The programme provides numerous benefits to government as child mortality was reduced in the areas where the CHWs work and government found it inviting to come on board of the project, as the CHWs generate their own revenue and create a sustainable case for mHealth interventions. The second benefit of the programme was the use of mobile phones to track whether targets have been met and monitoring real-time data of daily activities of CHWs (Bjorkman-Nykvist, Svensson & Yanagizawa-Drott, 2013; Living Goods, 2013; Mobile Alliance for Maternal Action, 2013).

Reorientation towards more inclusivity

There exists a lack of supportive legislation as very few policies and little planning to benefit inclusive entrepreneurial solutions exist. There is a need to focus on building capacities to develop business models, incorporating unconventional actors as well as the development of knowledge of the environment of marginalised communities as such environments may be analysed to exploit inclusive solutions. There is a need for innovative ways of developing knowledge and using unconventional channels to distribute and capture knowledge.

110

There is further a need to build capabilities of a new range of 'extension workers'. Reference can again be made to other African countries where teachers are trained and licensed to sell basic medicine and to do basic tests. In Kenya, a whole new tier of healthcare workers undergoes training similar to that of doctors, but they do it over 3–4 years. This training enables them to do basic primary health services and to assist doctors. The new tier of healthcare workers might enable healthcare professionals to work to their fullest potential without wasting time on general issues. This may be very useful across all SA public health sectors where there is a large shortage of healthcare actors.

Research capabilities must be developed to identify opportunities where entry points exist within the system to create opportunities for the inclusion of marginalised actors. There is a need to engage research institutes and the private sector in developing an understanding of the environment to create opportunities and further identify the skill set required by those marginalised communities to be active participants in the system. Institutional and incentivised support by government is required to build an environment conducive to exploring more inclusively orientated business models.

7.1.2.2   F2 – KNOWLEDGE DEVELOPMENT

This section reports on the knowledge development function regarding the MomConnect programme as well as the influence of knowledge in the mHealth sector on the MomConnect programme. The key to the success and introduction of the MomConnect programme was the learning environment created by the NDoH.

Knowledge developed leading to MomConnect

Knowledge development served as one of the critical success factors of the MomConnect programme. Before the project, a survey including all mHealth services and projects was conducted. Following the survey, individuals and organisations leading these projects were invited to the first meeting, which led to the formation of the team who launched the MomConnect (Pillay, 2015). This was a critical success factor as the task team comprised organisations and individuals with varied backgrounds and experiences critical to the project. The programme made use of local experts to design MomConnect so that it would be compatible with the local SA context, through the assurance that the system was accessible and equitable to marginalised populations (Pillay, 2015). In this regard, knowledge from the SA Mobile Alliance for Maternal Action (MAMA) project, was analysed and used largely to get MomConnect under way (United Nations Foundation, 2015).

The technical infrastructure of MomConnect was largely utilised from, pre-developed eHealth and mHealth system components that had been implemented successfully in low-resource settings previously, and which had a proven track record of effectiveness and reliability (Peter, Barron & Pillay, 2015). This was essential, and a key differentiator for MomConnect from other mHealth interventions in South Africa, as it meant that most of the time and focus went into satisfying the end-user's

requirements (Peter *et al*., 2015). The infrastructure for MomConnect was integrated with the existing NDoH standard-based systems at the time of implementation and was adapted for the mobile maternal use case (United Nations Foundation, 2015). MomConnect makes use of messaging systems tested to be effective in other low-resource settings (Peter *et al*., 2015). The technical implementation of MomConnect was furthermore aligned with technological, legal and regulatory policies, both in South Africa and internationally.

Evaluation of mHealth and MomConnect

The mHealth system in general is constrained through a lack of real data of the outcome of interventions, both in terms of the effectiveness of interventions as well as the cost-effectiveness thereof. mHealth, however, provides a real opportunity to collect data about the implementation of and the critically evaluation for the effectiveness of programs, but remains largely elusive (Peter *et al*., 2015). There is consequently a serious need to move towards effective M&E processes.

For MomConnect, evaluation remains one of the major constraints. There is a lack of evaluation methods, measures and indicators to prove the reach and influence of the project at the level of the marginalised. There is a lack of data on the scale of the MomConnect programme at the level of the marginalised, where the need might be the biggest. The reality of the situation is that this type of information (such as income groups reach, impact and cost saving) is not always possible to acquire through routine monitoring, as it is not linked to information available in the health sector. The lack of evaluation creates problems in itself, and the project is playing catch-up, as there now is a need to go back to the field, otherwise real data of the outcomes on the ground will not be available.

Inclusive knowledge development

The MomConnect project follows similar trends in terms of inclusive knowledge and the inclusion of the marginalised in knowledge development activities. Knowledge development activities follow the conventional pattern of a top-down approach where government and donors enforce knowledge agendas.

There are isolated cases where communities are integrated in the process of designing and launching projects, but these are small projects. The MomConnect project and the mHealth landscape remain isolated from collaborative research activities with marginalised communities as key sources of knowledge. This calls for the fostering of relationships among research units and universities to understand interventions and evaluation mechanisms better in order to evaluate the outcomes and reach of marginalised interventions.

7.1.2.3 **F3 – KNOWLEDGE DIFFUSION**

The value of technologies is mitigated if not used to its full capacity, and knowledge is of little value if not diffused to all role players via appropriate channels. This section reports on the knowledge diffusion activities of the MomConnect programme and mHealth in general.

Knowledge diffusion among formal actors

Knowledge diffusion among formal actors was one of the critical success factors of MomConnect. The NDoH played a leading role in facilitating knowledge exchange among actors (Health, 2015). Before the start of the programme, the NDoH held focussed groups where leaders in the industry across all areas of expertise necessary for the programme were brought together to discuss and plan the implementation of the project. The NDoH further utilised knowledge from MAMA SA, another mHealth initiative, which achieved success in providing maternal SMSs to mothers in South Africa.

Knowledge diffusion among informal actors

The MomConnect programme almost exclusively made use of top-down knowledge diffusion channels, in collaboration with the two best-positioned sources within the community to diffuse knowledge in the communities itself, namely the CHWs and HCWs. It is estimated that the programme reached over 500 000 women in the first year and the use of the CHWs and HCWs is claimed to be one of the contributing success factors (United Nations Foundation, 2015).

The mobile technology presents a viable opportunity to diffuse knowledge to pregnant women across the country as mobile phone subscriptions increase in penetration compared to traditional communication mediums (United Nations Foundation, 2015). Mobile phones therefore provides the largest network to connect with pregnant women and new mothers (Peter *et al.*, 2015; United Nations Foundation, 2015). Text messaging platforms are the most common activity on a basic mobile phone and prove to be viable channels for a digital health programme, such as MomConnect, to engage successfully with the target population (United Nations Foundation, 2015). Another contributing factor making the mobile phone a viable channel is South Africa's relatively advanced telecommunications sector and mobile coverage (although some issues remain for dispersed locations), where SMS services provide an appropriate channel for knowledge diffusion. There is, however, a real issue with the sustainability of MomConnect as most of the running expenses relate to SMS costs. There is an opportunity to move to data-based communication mediums as the use of smartphones is increasing exponentially even among marginalised communities (Pillay, 2015), which may reduce the costs drastically.

Inclusivity towards knowledge diffusion

Knowledge diffusion remains largely top-down. It is evident from the research reported in Chapter 5 that a balanced combination of top-down and bottom-up knowledge may yield significant benefits, where the marginalised community may serve as active participant, as far as the specific project and system allow. There is a need for platforms and facilitators to bring together relevant role players and stakeholders, firstly, for formalised actors to share innovative ideas towards inclusivity, and secondly, for marginalised actors to form part of innovative knowledge diffusion. This could be as simple as providing a space to come together and have a discussion. There should be a real emphasis on indicating the value to all as the information is used especially to those individuals at 'ground level'. There is a real need to empower the marginalised and give them a voice. There is a requirement for actors to have long-term commitments to projects such as MomConnect and to provide more incentivised participation for all.

7.1.2.4   **F4 – GUIDANCE OF SEARCH**

The Guidance of the Search function explores the activities that shape the needs, requirements and expectations of actors for support of mHealth. The function explores actor choices related to mHealth as well as the hard institutions being supportive of the technology, such as policy targets. Further investigation refers to promises and expectations of various actors that contribute to mHealth and, more importantly, inclusive mHealth.

Belief in the potential of mHealth is growing through the demonstrated benefits of mobile technology, the widespread growing availability of mobile phones, as well as the relatively low levels of literacy required to operate a mobile phone. South Africa remains one of the countries having the highest proportion of mobile phone users per population (GSMA, 2014), making it an attractive utility for marginalised interventions. The SA market provides opportunities for successful implementation of mHealth due to the high prevalence of mobile phones, a growing supportive policy environment for mHealth, a growing number of mHealth initiatives, and a well-developed ICT industry (National Department of Health, 2015a). Government support is constantly increasing, notably through the launch of the national eHealth and mHealth strategies and the MomConnect programme.

mHealth has numerous policies supporting the emergence of novel mHealth systems in South Africa. In 2014, the NDoH published the Health Normative Standards Framework (HNSF), which augments previous SA government policies dealing with interoperability, enterprise architecture and standards. The framework addresses issues brought up by the National eHealth Strategy, launched in 2012, towards '*A long and healthy life for all South Africans*' as outlined in the eHealth strategy (National Department of Health, 2015a) . A further document supportive of mHealth was launched in 2015, namely the South African mHealth Strategy (National Department of Health, 2015a). This document is supportive of and complementary to the eHealth Strategy, and provides a road map for achieving a well-functioning, patient-centred electronic national health information system. Further, personal data is

acquired from mHealth and eHealth initiatives protected through the Protection of Personal Information Act (PoPI Act) No. 4 of 2013. This indicates a healthy guidance of search in terms of policies and institutions, as great emphasis is placed on the value of what may be achieved through mHealth initiatives, if appropriate supporting policies and legislation exist.

Although the SA market is clearly ready for and expanding on mobile devices for development, especially in the areas of healthcare, Cargo (2013) avers that vast challenges remain in the market, such as:

- fragmented industry: most mHealth initiatives are on a small scale and not sustainable;

- unsustainable business models: 75% of all services have received donor investment; few examples exist of revenue generation beyond donor investment;

- scale: limited services show promising adoption and active user rates;

- mixed findings on reaching at-risk populations;

- disproportional distribution of mHealth initiatives in the country; and

- regulators not sufficiently engaged: limited evidence base for the vast majority of services and inadequate incentives for mobile industry to provide socio-economic services.

Other notable weaknesses in the health systems, beyond mHealth, are limited organisational culture and capacity for using health information for management and technological challenges to ensure interoperability and integration of information systems as well as mixed findings on privacy of information.

Guidance of search for more inclusivity

Although big strides have been made for mHealth in South Africa through increased policies and legislation supporting the emergence of mHealth, the market mostly sceptical about the involvement of marginalised actors. Guidance of search is essential for more inclusivity as it points to activities within the system satisfying the needs, requirements and expectations of actors with respect to the (further) support of emerging innovations. There is a need for IIS guidance towards mHealth and MomConnect that may manifest in terms of hard institutions, such as policy targets for inclusivity. For an inclusive system, the function may move further to identify promises and expectations as expressed by marginalised actors in the community.

MomConnect: towards positive guidance and inclusivity

The mHealth sector lacks outcomes measurements that provide concrete data to move the sector forward. The sector is plagued by a lack of evidence-based interventions, which as a direct effect on the prospects for I4ID. This holds for the MomConnect programme. The programme is a perceived success, and strides are being made towards more readably available data. However, the real effect and reach of

the programme for those most at risk are still lacking. There is further limited data available of the effect of money spent and whether MomConnect may be a cost-effective way for increased health outcomes. There is a need to expand M&E methods to track an evaluate system change and outcomes, through interventions, such as MomConnect. There is a need to start building a database to store data that may serve as benchmarks for future studies. It is further necessary to develop evaluation methods and instruments and to provide the necessary skills for practitioners to conduct appropriate evaluations.

There is still much work to be done in terms of the combination of I4ID and mobile technologies on the one hand, and the environment on the other, to foster and enable inclusive technological innovation to take place. There is a general lack of interactive learning, sharing and application of technologies together with active marginalised participation; and there is not enough learning and sharing taking place as a result of successful endeavours.

The MomConnect project, however, is certainly a stepping stone for the guidance of search function, as it serves as a perfect example of what may be achieved through strong guidance (strong leadership and governance), and lessons must be learned and translated towards more inclusivity. This may result in guidance towards inclusive links that provide positive guidance for those inclusive links that may see the marginalised, firstly, as being beneficiaries of improved health outcomes and, secondly, as being beneficiaries of economical inclusion.

Towards inclusive guidance of search

To conclude, the guidance of the search function represents the selection process of technologies. This selection needs to move beyond the importance of the allocation of resources to translate broad visions into concrete manifestations (Suurs, 2009). It is known that, without a concrete sense of direction, other functions such as knowledge development, knowledge diffusion and entrepreneurial activities are bound to end up not achieving their desired potential –especially for emerging systems, such as the IIS, this is essential. To fulfil an inclusive guidance of the search function for more inclusive mHealth systems and projects such as MomConnect, an interactive process is required, which involves governments, technology producers, technology users and NGOs, all collaborating towards the potential of mHealth, as institutional structures must be enforced to influence the guidance of the system positively.

7.1.2.5   **F5 – MARKET FORMATION**

The mobile phone is the most widely owned communication device in the developing world. South Africa sees a similar trend (Cargo, 2013). Although the SA market sees wide ownership of mobile phones, one of the pressing issues remains the difference in penetration rates in urban and rural South Africa (Cargo, 2013). This is largely due to the cost of setting up networks and the return on investment for mobile operators (Cargo, 2013). Interesting to note is that shared access to mobile phones largely

decreases the effect of the divide in rural and urban areas (Cargo, 2013). It is further argued that the mobile phone is seen as a utility rather than a luxury, even for groups with income as low as R30 per day, which makes the mobile phone a very viable technology for the advancement of healthcare in general in South Africa (Cargo, 2013).

The lead-up to MomConnect

The success of MomConnect lies in the ability of the programme to demonstrate its reach and scale at national level. This is largely due to lessons learned from the organisations piloting mHealth initiatives in years leading up to the launch of MomConnect and the commitment by government and donors to fund the programme as well as leadership at the highest government levels.

Over the last years, South Africa developed numerous small-scale mHealth initiatives. This led to healthcare providers and operators investing in technical platforms and building content banks that may be repurposed. The result is that knowledge is increasing in terms of insights into mHealth and operational expertise. The products, skills and know-how accumulating over the years of testing mHealth solutions in South Africa, were utilised to design and implement MomConnect. MomConnect came to existence in 2012, led by the NDoH, the Praekelt Foundation, Jembi Health Systems and UNICEF. The MomConnect programme relied on the success of Mobile Alliance for Maternal Action in South Africa (MAMA SA), which has provided education to women to have a healthy pregnancy and healthy infants (United Nations Foundation, 2015).

Market formation plays an important role in piloting, scaling and sustainability of a system or project. The SA landscape has numerous mobile health pilot projects, creating a vast base of general knowledge. Most pilot projects in South Africa do not reach scale, as not all projects are sustainable. Some notable aspects hindering the sustainability of projects are:

- projects aim to achieve donor objectives (often alienated from objective required);
- the constraint of time and resources;
- pilot projects are alienated from the NDoH health system and objectives; and
- there are isolated projects integrated with the requirements of the NDoH (MomConnect) and limited knowledge is adequately shared with the NDoH.

The following section reports on the lessons learned during piloting and, scaling and the issue of sustainability.

MomConnect: piloting, scaling and sustainability

The numerous efforts of partners were essential for MomConnect to be able to scale in a short space of time. There are significant lessons to be learnt in building lasting partnerships with government as well as in scaling-up and engaging with stakeholders, including donors and other NGOs.

It is important to acknowledge the significant set-up and start-up costs for financial investment and time devoted to learning, pilot programming, testing and refining a product or service for mHealth. The MomConnect programme was able to utilise years of lessons from previous mHealth pilots in South Africa. If this expertise was not applied, up-front investment for setting up and deploying the programme would have been much higher. Some of the most notable factors that differentiated MomConnect from other non-scalable initiatives are (United Nations Foundation, 2015):

- multi-partner, cross-sectoral team;
- knowledge gained from multiple partners of previously piloted programmes;
- funding commitments from government and donors;
- exceptional leadership from highest government levels, steered by strong government stewardship;
- MomConnect managing to reach a large national audience, as the goal was always to scale beyond the start-up phase;
- selecting scalable technology;
- MomConnect reaching its target audience at an early stage; and
- developing relevant (engaging) content for the target audience.

The MomConnect programme had to overcome several challenges on the road to successful scaling, such as (United Nations Foundation, 2015):

- **Raising awareness:** using television and radio advertisements to launch and drive the uptake of MomConnect. Using mass media for advertising on a national scale to generate awareness requires significant financial resources (United Nations Foundation, 2015)
- **Increasing adaption rates**: the NDoH relies on clinics to register users. There are monitoring and solutions in place for low adaption rates at clinics. Some regions take longer than others (United Nations Foundation, 2015).
- **Funding high costs of mobile phone data fees:** SMS costs are some of the highest costs for the project, and the NDoH is pursuing multiple strategies to reduce SMS costs and identify sustainable funding sources (United Nations Foundation, 2015)
- **Adapting to technology changes:** there are alternatives to SMS services, such as data solutions through mobile app platforms, and MomConnect is required to explore alternatives. In 3–5 years there is going to be a dramatic shift in the types of phones people are using. If you can get people to use data, then national mobile operators will be willing to offer zero-rated URLs, because it will sell data as a whole.

The benefits of using data include (United Nations Foundation, 2015):
- significantly reduced costs;

- improved speed and efficiency;

- unrestricted content constraints in comparison to SMSs;

- the ability to experiment with platforms such as WhatsApp and Facebook Messenger; and

- the issue around expanding the language options and content provision.

Although MomConnect reached scale in a very short time, some issues remain in terms of sustainability. MomConnect is mainly funded by external donor funds, NGOs and the NDoH, and does not generate revenue. The ability to scale is the result of the service being free of charge for pregnant women and mothers. The addition of any fee per message or registration costs for the end-users or hospitals would probably have had major consequences on the scalability of the project. This would have been fatal for the project to reach its target of reaching and providing vital health information to the most vulnerable (United Nations Foundation, 2015). The project further makes use of the latest technological platforms and specifically designed the platform to scale. This aspect is explained in more detail under the resource mobilisation function (see Section 7.1.2.6). Notable sustainability challenges for MomConnect are:

- donor funding ended in 2016, while the project is not creating any revenue of its own;

- concrete data regarding the reach and outcomes of the project remains limited;

- SMS costs are high – every time there is a sign-up, the cost to government increases; and

- it is necessary to view sustainability from new perspectives, as sustainability is normally measured in revenue.

Inclusive market formation

Although the market sees improved institutional support for mHealth, which cumulated to the formation of MomConnect, there are still vast challenges that remain, such as to establish strong market formation for mHealth and even more so for inclusive mHealth. To establish more inclusive market formation, it is important to investigate and implement institutional strategies and institutional incentives that support and align a positive view of the market. There is a need for more sustainable funding towards inclusive projects, as well as for research centres that will establish a base of knowledge from which future activities may be launched, that will contribute to actively including the marginalised, and to base decisions on M&E data.

7.1.2.6   F6 – RESOURCE MOBILISATION

Resource mobilisation for this project focuses its attention on three aspects, namely technological (physical) infrastructure, financial infrastructure, and human infrastructure. The SA market relies on several mHealth initiatives and the infrastructure of these projects served as an important enabler for MomConnect to build on. This section provides a brief overview of the technological infrastructure of the MomConnect programme, without going into any technical details.

The technological system

The technological infrastructure development approach made use of a system approach that ensured that MomConnect aligned to the wider NDoH architecture. As the NDoH took full ownership of the project, the already available building blocks were used rather than re-invented. The system was designed with scale in mind, as the system is used in thousands of facilities (Pillay, 2015). The system was designed with the goal of being data-orientated. The data accumulated is data for registering and subscribing clients, messages sent to clients to promote antenatal care, and data for monitoring and evaluating the programme (on a technical level, not in terms of outcome and reach).

MomConnect was specifically designed for data security and privacy through a unique patient identifier, as privacy and security are of primary concern. This was obtained through a security policy that has been developed and implemented by the NDoH

Some technological infrastructure limitations

MomConnect was able to scale through the use of some exceptional innovative technological deigns as mentioned. The programme further utilised infrastructure already available from other mHealth initiatives. The MomConnect programme made notable advances, but there remain limitations of South Africa's ICT infrastructure as follows :

- connectivity remains expensive;
- some (especially rural) areas are still without mobile coverage;
- patient and data confidentiality remains an issue, although notable strides are made in this regard; and
- health systems vary across provinces.

Financial infrastructure

Sustainability is a big burden on IISs, and it is necessary to utilise resources, especially regarding funding, in the most effective way. This section reports on the utilisation of resources, especially donor funding.

The SA public healthcare sector is notoriously underfunded as outlined in Chapter 6, and most of the public funds made available are used either to purchase supplies or maintain primary healthcare facilities. Most of the money is used to keep the services running. Donor funds are used for innovations and interventions. Donor funding is a substantial contributor of novel projects and pilot interventions for mHealth in South Africa. There is a need to coordinate donors to align to a shared goal and, more importantly, to local requirements. South Africa is dependent on donors, but some donors have certain agendas, and when government accepts the money they have to comply with the donor's objectives.

Financially, MomConnect was able to scale and maximise its influence as the service is free of charge for pregnant women and mothers. A fee or registration costs for the end-users or the hospitals would very likely have severe reactions in terms of adoption rates. This would prevent MomConnect from reaching its goal of providing vital health information to those most in need. The MomConnect project was further able to reach a national scale due to the financial assistance the project received from donors, NGO partners, and the NDoH. Even more important is that some of the money was committed through a fixed-term contract with PEPFAR, the largest donor of MomConnect. The MomConnect programme further has a considerable number of donors, minimising the risk resulting from a donor abandoning the programme. Another essential financial aspect of the programme was the substantial discount rate provided by the telecom operators for SMS services (United Nations Foundation, 2015). Even with discounted rates from the telecom operators, nearly 70% of the PEPFAR (the largest donor) budget is used for SMS and USSD costs.

Fixed funding and a multi-partner approach were essential to the national launch of MomConnect. Without these, it is difficult to see how the project would have moved beyond the piloting phase. The funding model has three elements to lower the failure risk and to contribute to the sustainability of MomConnect (United Nations Foundation, 2015):

- the donor funding was committed for a fixed period (September 2016), making it possible to prove its value proposition;
- the funding is very diverse, creating a buffer. If one partner pulls out, the project is still carried by the other funders; however, if a major funder pulls out, or when SMS rates are not provided at discount rates, the programme would be in danger; and

- the strong political will from the NDoH generated a common shared mission of lowering maternal and infant mortality rates and brought all the partners together to work towards that goal.

Despite these strengths, there are some risks attached to the model (United Nations Foundation, 2015):

- political risk: if the NDoH pulls out, there will be major burdens on organisations to carry the programme, and the overall goal might not be achieved as organisations may focus on their smaller targets;

- funding risk: the aim is to reach more or less one million women per year. The loss of a major donor will decrease the capacity to reach enough women;

- costs risk: SMS and data usage may well increase, changing the financial model and leading to much higher costs to run the programme as this is the largest running expense;

- the programme's business model does not generate revenue; and

- services are free of charge for pregnant women and mothers. Any registration or service fee for the end-users or hospitals/clinics would significantly diminish adaption rates. A low adaption rate would be fatal to the goal of providing critical health information to the most vulnerable.

There are calls to explore alternative funding or revenue streams to mitigate these risks (United Nations Foundation, 2015). There is a need to add recurring revenue streams, and this is critical for the development of a truly sustainable business model. There is also emphasis on exploring alternative funding options as the SMS service will remain free of charge for end-users (United Nations Foundation, 2015).

Human infrastructure

As outlined in this chapter, human infrastructure serves as one of the success factors of the programme. The following notable aspects were of importance for MomConnect:

- strategic leadership: strong government stewardship led the project;

- a multi-partner cross-sectoral team;

- a learning environment was established; and

- collaboration was at the forefront to establish the project.

7.1.2.7 **F7 – CREATION OF LEGITIMACY**

As described in Chapter 5, the creation of legitimacy in emerging and especially inclusive markets is essential. This is not only required in formal markets but it is just as essential in creating legitimacy for marginalised users and consumers of technology.

The SA market sees widespread enthusiasm for and use of mHealth; however, many reviews outline the gaps in evidence of the results of mHealth at scale, especially as most programmes are small-scale

(Leon *et al.*, 2012). MomConnect will provide valuable information, but research on evidence is still ongoing, as no concrete data exists on the effect of the programme. Another limitation to legitimacy is that evaluations of mHealth mostly focus on feasibility, and on neglect in evaluating outcome and cost-effectiveness, resulting in difficulties to identify the real outcome of the project (Leon *et al.*, 2012). There is further a need to move to impact studies on the quality and efficiency of improving service delivery processes, strengthening health systems and improving health outcomes where mHealth initiatives are implemented (Leon *et al.*, 2012).

The mHealth landscape of South Africa sees a good number of mHealth projects. However, uncertainties prevail around these projects as measurement of the effectiveness and sustainability of the interventions is lacking. Some of the most notable issues in the SA landscape hindering legitimacy around mHealth are (Cargo, 2013):

- unsustainable business models (high risk for discontinuation of services);
- lack of scaled programmes;
- mixed findings on reaching risk populations (marginalised);
- lack of data backing the effectiveness of interventions;
- still questions surrounding the effectiveness of solutions;
- disproportional distribution of mHealth projects throughout the country regions; and
- regulators not sufficiently engaged.

The MomConnect programme contributes to the legitimacy regarding mHealth interventions as well as consumer confidence. This is a stepping stone for future interventions, and creates the opportunity to add other services to the programme. Some of the most influential contributions to legitimacy are:

- government involvement and backing;
- the scale at a national level;
- reach of more than 95% of the countries healthcare clinics;
- free services;
- an example of a multi-partner approach; and
- the value of shared commitment.

Factors from the MomConnect that negatively influence mHealth legitimacy in the marginalised space:

- a lack of data of reach at living standards measure (LSM) 1 level;
- funding remains donor-dependent; and
- a lack of a well-organised evaluation framework and evidence-based outcomes.

The MomConnect project demonstrates the need agree to and accept a technological idea from the most important role players and users. There is a need to create legitimacy for marginalised actors as well, and this can be achieved by involvement in programmes from the onset. This is a very important aspect,

which is lacking due to time and resource constraints, and the perception from high-level actors that the marginalised cannot be involved in debates regarding solutions in local settings. This again indicates the perceptions of formal organisations and even government, where legitimacy in terms of the value of including the marginalised is limited and there is a real need to start building this into the system through new policies and institutions. Removing existing institutions to favour I4ID is a major challenge, and adapting current regulations to suit an inclusive market is required.

7.2   System analysis and intervention

This section reports on the MomConnect project within the greater mHealth system to analyse barriers and systemic problems towards inclusivity and to propose systemic policy interventions towards more inclusivity. The structure of this section is as follows: Each system function is firstly explained, bearing in mind three guiding thoughts current drivers of the function, the limitations towards inclusivity as proposed in Chapter 5, and a brief overview of the requirements to overcome barriers and systemic problems towards inclusivity. Secondly, an in-depth structural-functional analysis is outlined for each system function.

The discussion of each system function is based on the qualitative interviews, where the systemic problem analysis and systemic policy instruments follow the approach as outlined in Chapter 5.

Entrepreneurial activities

Entrepreneurial activities in South Africa have seen a very steady increase in the mHealth sector since 2009, and have resulted in the MomConnect programme. These entrepreneurial activities are largely driven by NGOs, the NDoH, donor funders as well as a very small, but increasing number of private sector actors. Functions such as an increase in knowledge development for mHealth, guidance of search through the eHealth and mHealth strategies, as well as other institutions supporting mHealth have been essential enablers towards increased formal entrepreneurial activities that target healthcare solutions for marginalised communities in a quest towards 'better health for all'. The system, in general, is seeing steadily increasing support for the formal entrepreneurial activities that focus on the marginalised through products and services, MomConnect is a clear example.

However, the system remains very limited towards the involvement of marginalised actors and is still immature for the creation of opportunities to move inclusive interventions beyond services and products, largely due to a lack of formal actor capabilities and capacities and a lack of supportive institutions. The hierarchy and silos within MomConnect and the greater mHealth system create strong network problems, hindering relationships among marginalised actors. Further, there is a lack of institutions that support and guide incentivised plans towards an inclusive mHealth system favourable for marginalised entrepreneurial activities.

There is a need for a project, such as MomConnect, to gain and develop a deep understanding of the targeted individuals (the market) to make it possible to identify rents and barriers to entry of marginalised involvement. It is further necessary to identify and establish bridging instruments that serve as enablers of interactions among diverse actors. There is a need to bridge the barriers of the hierarchical structure and silos through institutional structures supporting collaborative actions and the orientation of formal actors towards inclusive solutions. A shared commitment, having a common goal and vision with benefit for all actors, will go a long way towards an active search for mutual benefit and inclusion among formal and informal actors. Table 37 outlines the systemic problem analysis and systemic policy interventions for entrepreneurial activities.

Table 37: Entrepreneurial activities and systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 1: Entrepreneurial activities	1.1 Marginalised involvement and depth of involvement	• Marginalised limited to recipients of products and services. • There is a strong hierarchical presence, silos within the sector as well as a lack of institutional guidance that supports active marginalised inclusion. • A lack of understanding the health system at 'ground level', to be able to identify entry points.	Actor – presence Actor – quality and capability	***Encourage and organise involvement of a wide variety of actors*** • Gain and develop a deep understanding of the targeted individuals (the market). • Acknowledge the marginalised as valuable partners in business processes (users as partners).	• There must be a deep awareness of interests (formal and informal). This is necessary to create capabilities and capacities for both formal and informal markets to foster mutual benefit. • Include the marginalised as knowledge enablers; channels of knowledge diffusers; acknowledgment of local actors; partnerships based on trust with marginalised. • Build capacity of the marginalised communities through training programmes.
			Relationships – strong network and quality (too strong formal network).	***Motivate interaction opportunities between diverse actors*** • Establish new relationships and collaboration among the 'new' set of actors in the system. • Bridging instruments that serve as enablers for interactions among diverse actors.	• Establish coordination among actors; mutual learning; governance and leadership (project champion). • Encourage information flow of the requirements of marginalised groups.
	1.2 Business involvement	• Sustainable business models remain elusive for mHealth and MomConnect. • Hierarchy not open to innovative ways of developing knowledge and using unconventional channels to distribute and capture knowledge.	Actor – capability, formal actor	***Establish spaces and methods for actor capability development*** • Create spaces and environments for different actors' capability integration. • Development of research institutes and their capabilities to study the dynamics of I4ID and IIS. • Develop capabilities for the creation of sustainable I4ID business models	• Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised related). • Stimulate research institute programmes to foster inclusive innovation research. • Establish bursaries and educational incentives for institutions to conduct research for I4ID. • Focus on developing capabilities broader and beyond just the product and/or service. There must be supporting structures to develop capabilities and capacities of informal

		• There is a lack of business models actively involving the marginalised. • Business models largely top-down. • In general, there are fragile PPPs. • Formal and informal actors remain delinked from one another, especially in terms of those individuals at 'ground level'.		and scaling initiatives through advanced technologies.	communities to obtain maximum benefit from I4ID.
			Relationships – lack of formal/informal interaction.	***Motivate interaction opportunities between diverse actors*** • Bridging instruments that serve as enablers for interactions among diverse actors. • Debates facilitating decision-making towards inclusive system approaches. This should be evidence-based as far as possible.	• Provide a place for active engagement and learning from best practices and implement projects through the development of centres of excellence and competence centres. • Marginalised interaction goals: This does not include only listening, but there also exists a deep debate on the topics under discussion – community – direct personal relationships with local communities and NGOs (intermediaries). • Develop research strategies to identify barriers and opportunities for I4ID
			Institutional – weak institutional set-up hinders I4ID through insufficient support.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Institutions favour I4ID. ***Prevent too weak/stringent institutions*** • Inclusivity readiness and localised implementation of inclusive solutions	• Regulations must not prohibit innovations that seek to serve the marginalised without compromising on quality. Essential due to regulations hindering the implementation of successful I4IDs in Africa and South Africa, such as M-PESA and the Giving Goods model. • Insert inclusive innovation policies in innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. • Investigate and revise current policies that are aimed at marginalised, especially those that target better integration through enhancing access to services, novel IP solutions and infrastructural constraints. • Mitigate the structural barriers blocking effective inclusive innovations; remove market aspect not favourable to I4ID solutions.

					• Develop agreements, standards, taxes and rights for I4ID.
	1.3 Incentivised plans	Discounted SMS and data rates - mobile service providers gave substantial discounts for service provision (most donor funds are still allocated to remaining service provision costs). Limited in terms of marginalised involvement. The project does not see any incentivised benefits of exploring the marginalised to be beneficiaries beyond service and products.	Institutions – hard and soft institutional set-up.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Shared commitment: have a common goal and vision with benefit to all actors. ***Prevent too weak/stringent institutions*** • Institutional structures supporting collaborative actions and orientation of formal actors towards inclusive solutions.	• Have documented policies and institutions that specifically focus on a shared commitment by all parties involved and outline implementation practices. • Institutional structures, collaboration and orientation (national, regional and sectoral focus), to orientate formal ISs towards the marginalised.

Knowledge development

The SA landscape and MomConnect see a steady increase in knowledge being created, in terms of mHealth interventions, especially interventions that focus on increased service provision for marginalised communities. This knowledge accumulated in the MomConnect programme, where one of the main reasons for success of the programme was the ability to bring together a multi-partner cross-sectoral team, bringing with them years of experience and expertise.

However, there remains fragmented knowledge development in terms of the inclusion of the marginalised and knowledge of 'on-the-ground' settings. Knowledge development is mostly top-down as government and donors enforce knowledge agendas. There exists some bottom-up knowledge in isolated cases, as a knowledge gap exists in terms of adhering to the real requirement of the marginalised. There is very limited knowledge in terms of areas of involving the marginalised. The marginalised remains largely delinked from any collaborative research activities. There are limited relationships with research units and universities to understand interventions and evaluation mechanisms better to evaluate the outcomes and reach of marginalised interventions. It is important to develop research institutes and their capabilities to study the dynamics of I4ID and IIS. There is also a real need to broaden the research agenda at universities, which actively seeks to understand the marginalised market and how this knowledge may be merged with mHealth knowledge to drive a knowledge base that guides in serving the needs and interests of the marginalised. Research institutes must foster learning and innovations with the aim of collective sharing and co-creation (marginalised-related). Government may further paly a leading role in the provision of educational incentives for institutions to conduct I4ID research. Table 38 outlines the systemic problem analysis and systemic policy interventions for entrepreneurial activities.

Table 38: Knowledge development systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 2: Knowledge development	2.1 Local knowledge	Extensive in terms of a lack of quality and access to healthcare. Very much limited to 'on-the-ground' knowledge. Very much limited in terms of areas of involving the marginalised. Knowledge development mostly top-down – government and donors enforcing agendas. There exists some bottom-up knowledge in isolated cases, where a knowledge gap exists to adhere to the real requirement of the marginalised.	Actor – presence, lack of marginalised involvement	***Encourage and organise involvement of a wide variety of actors*** • The involvement of a multi-partner cross-sectoral team is required where the marginalised is actively involved. • Gain and develop a deep understanding of the targeted individuals (the market). ***Establish spaces and methods for actor capability development*** • Development of research institutes and their capabilities to study the dynamics of I4ID and IIS.	• Encourage and plan for the involvement of unconventional partners, such as inclusion of the marginalised and organisations that provide education or healthcare in marginalised communities. These organisations possess invaluable knowledge of these communities. • 'On-the-ground' knowledge and engagement with the market – relationships must be established with influential players in informal communities. They possess invaluable information regarding 'on-the-ground' knowledge. • Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised-related). • Stimulate research institute programmes to foster inclusive innovation research. • Establish bursaries and educational incentives for institutions to conduct research for I4ID.
			Infrastructure – physical and financial absent and not supporting creation of local knowledge.	***Knowledge infrastructure*** • Deep-rooted local knowledge (bottom-up knowledge), especially appropriate delivery mediums.	• Give access to training programmes and capital that focus on capability and capacity to enable contributions of marginalised actors. • Capability and capacity education programmes and alternative financing schemes are required to build awareness.

	2.2 Research capacity	There are limited activities to learn from past experiences in terms of what is required for I4ID. Formal organisations lack capacity to research the marginalised market sufficiently. Limited capacity for marginalised requirements, involvement and delivery mediums and real-time data for evaluations.	Actor – capability to explore novel research methods.	***Establish spaces and methods for actor capability development*** • Development of research institutes and their capabilities to study the dynamics of I4ID and IIS.	• Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised related). • Stimulate research institute programmes to foster inclusive innovation research. • Establish bursaries and educational incentives for institutions to conduct research for I4ID.
			Infrastructure – physical and financial absent and not supporting creation of local knowledge.	***Knowledge infrastructure*** • Measures and indicators.	• Learn from past experiences, establish methods that ensure that project and system change is documented for further I4ID. • Develop instruments that will monitor the implementation, outcomes and reach of I4ID. • Develop specific M&E for the sectors, projects and communities.
	2.3 Research collaboration	The MomConnect project serves as a real-life example of what can be achieved if shared goals exist and multiple partners work together and utilise different sets of knowledge. The marginalised remains largely delinked from any research collaborative activities. In general, there is limited research collaboration among research institutes and NGOs, due to tenders for the same donor funding.	Relationships – presence, lack of informal link. Relationships – quality, too strong, formal relationships hinder collaborative learning.	• Inclusivity readiness and localised implementation of inclusive solutions.	• There should exist links that encourage research programmes to align research activities of institutes, NGOs, government and donors. • Establish research and innovation hubs and resultant expertise that specifically focus on I4ID. • Institutional structures, collaboration and orientation (national, regional and sectoral focus), to orientate formal ISs towards the marginalised. • Mitigate the structural barriers blocking effective inclusive innovations, remove market aspect not favourable for I4ID solutions. • Develop agreements, standards, taxes and rights for I4ID.

	2.4 Origin of knowledge	There remains very little social engagement with local communities. Very little research and training to exploit research in and around marginalised communities.	Infrastructure – physical and financial absent and not supporting creation of local knowledge.	**Financial infrastructure:** • R&D grants for research institutes to develop inclusive interventions. ***Ensure infrastructure quality to be sufficient*** • Create traditional spaces and places enabling the involvement of a diverse set of actors.	• There should exist cross-subsidising for consumption and other novel ideas with the aim of lowered costs. • Financing mechanisms that are tailored to support I4ID initiatives • Create traditional spaces and places to serve as a space where discussions are held around interventions. Make marginalised part of developing the community by their actions and create mutual value for the individuals and the community.
	2.5 Focus of knowledge development	There remain limited relationships with research units and universities to understand interventions and evaluation mechanisms better to evaluate the outcomes and reach of marginalised interventions.	Relationships – presence, relationships across stakeholders limited.	Cooperative research programmes among the relevant knowledge-creation bodies.	• There should exist links that encourage research programmes to align research activities of institutes, NGOs, government and donors. Establish research and innovation hubs and resultant expertise that specifically focus on I4ID.
	2.6 Training and development of capabilities/capacity	Limited novel thinking to support inclusive development and local capacity building.	Actor – capability lacking from formal side.	***Establish spaces and methods for actor capability development*** • Development of research institutes and their capabilities to study the dynamics of I4ID and IIS.	• Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised related). • Stimulate research institute programmes to foster inclusive innovation research. • Establish bursaries and educational incentives for institutions to conduct research for I4ID.

Knowledge diffusion

For knowledge diffusion, distinct contrasts are visible in the general mHealth sector, MomConnect and the involvement of the marginalised community.

The general mHealth sector sees very limited knowledge diffusion among organisations and endeavours, as outlined by the majority of the interviewees. The interviewees further agreed that this is one of the factors of large start-up costs and that a national collaborative space is required to bring together 'pockets of knowledge'.

The complete opposite was evident in the MomConnect programme, where one of the success factors of MomConnect was the fact that the NDoH brought together a team with the necessary expertise. The NDoH provided platforms for these actors to interact and share knowledge that led to the successful and vast launch of the MomConnect programme.

Again, a contrast exists where there is a need to include the marginalised in terms of knowledge diffusion activities. There are limited spaces to encourage knowledge exchange among formalised and marginalised actors. There is however a lack of interaction with marginalised communities to create an environment of learning by interaction. Knowledge diffusion is mostly top-down, with limited influence by marginalised communities and it is limited to products and services. The marginalised are not active participants to generate knowledge of their livelihood that may lead to insights to identify a host of opportunities, firstly, to improve healthcare services, and, secondly, to foster active inclusion and participation of the marginalised with mutual benefit for formal and informal actors. Table 39 outlines the systemic problem analysis and systemic policy interventions for knowledge diffusion.

Table 39: Knowledge diffusion systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 3: Knowledge diffusion	3.1 Knowledge platforms and boundary spanning	• There are no spaces to encourage knowledge exchange among formalised and marginalised actors.	Infrastructure – presence, a lack of spaces and places	***Encourage and organise involvement of a wide variety of actors*** • The involvement of a multi-partner cross-sectoral team is required where the marginalised is actively involved.	• Develop intermediary actors and institutions that serve as a bridge between formal and informal markets and products and service development and implementation. They may also serve as knowledge diffusion agents with technical expertise of I4ID.
	3.2 Depth of knowledge	• There is a lack of interaction with marginalised communities to create an environment of learning by interaction.	Relationships, presence-related, formal/informal	***Motivate interaction opportunities between diverse actors*** • Bridging instruments that serve as enablers for interactions among diverse actors.	• Provide a place for active engagement and learning from best practices and implement projects through the development of centres of excellence and competence centres. • Encourage information flow of the requirements of marginalised groups.
	3.3 Knowledge influence trajectory	• Knowledge diffusion is mostly top-down, with limited influence by marginalised communities.	Actor – presence and capability	***Motivate interaction opportunities between diverse actors*** • Bridging instruments that serve as enablers for interactions among diverse actors.	• Provide a place for active engagement and learning from best practices and implement projects through the development of centres of excellence and competence centres. • Encourage information flow of the requirements of marginalised groups
	3.4 Marginalised-centred knowledge	• This remains limited to products and services.	Actor – presence, marginalised largely de-linked	***Encourage and organise involvement of a wide variety of actors***	• There must be a deep awareness of interests (formal and informal). This is necessary to create capabilities and capacities for both formal and informal markets to foster mutual benefit. 'On-the-ground' knowledge and engagement with the market – relationships must be established with influential players in

134

		The marginalised are not active participants to generate this knowledge.		• Gain and develop a deep understanding of the targeted individuals (the market).	informal communities. They possess invaluable information regarding 'on-the ground' knowledge.
			Institutional – lack of supportive institutional set-up	***Prevent too weak/stringent institutions*** • Institutional processes and participatory planning of marginalised actors.	• Align participatory plans to improve productivity income and improve the well-being of the marginalised. • Encourage grassroots innovations – support knowledge and innovation flows; improve the capacity of low-income groups to absorb technologies for more effective use of innovations among low-income groups.

Guidance of search

The guidance of the search function is essential as it refers to the activities that shape the needs, requirements and expectations of actors with respect to their (further) support of the mHealth sector and inclusive mHealth. Although big strides are made for mHealth in South Africa through increased policies and legislation, supporting the emergence of mHealth and the birth of MomConnect, is the market mostly sceptical about the involvement of marginalised actors.

MomConnect still lacks the necessary outcomes measurements to foster positive guidance of search as there is still a lack of data of the real influence and reach of the programme for those most at risk. The MomConnect programme further provides limited data on the result of money spent and on whether MomConnect might be a more cost-effective manner for increased health outcomes. There exist very few proved examples in the SA context to have a positive outlook on the combination of mHealth and the active inclusion of I4ID. There is still much work to be done around the combination of I4ID and mobile technologies on the one hand, and the environment on the other in order to enable inclusive technological innovation to take place. There is a general lack of interactive learning, sharing and application of technologies with active marginalised participation; and there is not enough learning and sharing taking place from those successful endeavours.

Before a project such as MomConnect may seek deeper inclusion of marginalised actors is positive guidance of essence for the current system and MomConnect 'as is', as this will form the base for future endeavours. There is a need to identify broad visions for inclusive mHealth solutions that are required to be translated into concrete manifestations. Without a clear sense of direction the other functions such as knowledge development, knowledge diffusion and entrepreneurial activities will remain isolated to effect change in the system. To move a project such as MomConnect towards more inclusive patterns and to guide the sector require the involvement of governments, technology producers, technology users and NGOs to collaborate and influence the guidance of an inclusive system, assisting the preceding functions. Table 40 outlines the systemic problem analysis and systemic policy interventions for guidance of search.

Table 40: Guidance of search systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness Indicator Guide and description	Type of systemic problem	Systemic policy goal	• Systemic policy intervention
Function 4: Guidance of search	4.1 Clear shared vision and goal	• For MomConnect, a clear goal is a critical success factor. • For an inclusive health system goals are still fragmented and very little evidence-based data supports inclusive views.	Institutions – presence, lack of institutional guidance.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Shared commitment: have a common goal and vision with benefit to all actors.	• Have documented policies and institutions that specifically focus on a shared commitment from all parties involved and outlines implementation practices.
	4.2 Supportive legislation	• General mHealth is gaining ever-increasing support. • The inclusive market lacks legislation promoting the active guidance towards an IIS.	Institutions – presence, lack of institutional guidance.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Institutions favour I4ID.	• Regulations must not prohibit innovations that seek to serve the marginalised without compromising on quality. Essential due to regulations hindering the implementation of successful I4IDs in Africa and South Africa, such as M-PESA and the Giving Goods model. • Insert inclusive innovation policies in innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. • Investigate and revise current policy that is aimed at the marginalised, especially those that target better integration through enhancing access to services, novel IP solutions and infrastructural constraints.
	4.3 I4ID expectation	• The market is sceptical about the involvement of marginalised actors. • The mHealth system characterised by multiple pilots serving the	Institutions – capacity, weak institutional set-up hinders I4ID, through	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Shared commitment: have a common goal and vision with benefit to all actors.	• Have documented policies and institutions that specifically focus on a shared commitment from all parties involved and outlines implementation practices. • Institutional structures, collaboration and orientation (national, regional and sectoral focus), to orientate formal ISs towards the marginalised. • Develop agreements, standards, taxes and rights for I4ID.

137

		marginalised that do not scale. • MomConnect scaled, but lacks impact indicators, and sustainability remains a pressing issue.	insufficient support.		
	4.4 Outcome indicators	• There is a lack of M&E that indicate the outcome of projects. • There is still negative guidance as the project is not sustainable or generating revenue. • There is also a lack of evidence-based data on the project.	Actor – capacity, formal actors.	***Establish spaces and methods for actor capability development*** • Development of research institutes and their capabilities to study the dynamics of I4ID and IIS**.**	• Research institutes must foster learning and innovations with the aim of collective sharing, co-creation (marginalised related). • Stimulate research institute programmes to foster inclusive innovation research.

Market formation

The lead-up to MomConnect saw an ever-increasing knowledge base of mHealth within the borders of South Africa, where several mHealth initiatives exist, mostly unable to scale and to move beyond the piloting stages. Infrastructure, although still fragmented, was increased to be utilised for a national launch of an mHealth initiative. There was an increase in role players, as the NDoH was able to obtain the knowledge of a multi-partner cross-sectoral team who had a vast knowledge base. Further, the mHealth sector saw an increase in activities contributing to an increased demand for mHealth to aid public healthcare and the provision of improved services for marginalised actors, such as the eHealth and mHealth documents.

The MomConnect project led to a rapid increase in market formation for mHealth as the project was able to persuade a large number of organisations to form part of and invest in the mHealth sector, serving the needs and interests of improved healthcare for marginalised actors. This may well serve as a catalyst and enabler in the future to support the formation of a truly inclusive IS around mHealth. However, this is still a far-off goal as there is very little market formation that supports a truly inclusive innovation mHealth system supported by the necessary legislations.

There remains a real need to reinvent and rethink current policies and legislation that support inclusive mHealth activities to guide the emergence of inclusive mHealth by means of market-supporting policies and institutions. There is a need to add inclusive innovation policies to innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. Table 41 outlines the systemic problem analysis and systemic policy interventions for market formation.

Table 41: Market formation systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 5: Market formation	5.1 Define target market	• Limited analysis and understanding of opportunities for inclusive solutions. • MomConnect is clear to reach every woman.	Actors – capacity, formal actors. Presence, lack of marginalised involvement.	***Encourage and organise involvement of a wide variety of actors*** • Gain and develop a deep understanding of the targeted individuals (the market).	• There must be a deep awareness of interests (formal and informal). This is necessary to create capabilities and capacities for both formal and informal markets to foster mutual benefit. • 'On-the-ground' knowledge and engagement with the market – relationships must be established with influential players in informal communities. They possess invaluable information regarding 'on-the-ground' knowledge.
	5.2 Institutional barriers	• Very limited institutional support for inclusivity.	Institutions – capacity and presence, weak institutional set-up hinders I4ID through insufficient support.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Hierarchy and silo approach intervention mechanisms to overcome too strong formal set-ups. • Institutions favour I4ID.	• Awareness programmes of the relevance of the marginalised actors. • Ensuring regulatory impediments do not prohibit or constrain innovations serving the poor (particularly regarding public services) while critical quality standards are being met. • Insert inclusive innovation policies in innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. • Investigate and revise current policy that are aimed at marginalised, especially those that target better integration through enhancing access to services, novel IP solutions and infrastructural constraints.
	5.4 Market structures	• Limited business plans. • The level of utilisation and	Institutional – presence, lack of supportive legislation.		

140

supportive of I4ID	support from research bodies to gain insight into the market and to start building a knowledge base of the market remain weak. • Sustainable funding remains a major issue.	Infrastructure – presence and quality of funding.		
5.5 Institutional incentives	• Very limited institutional incentives for I4ID.	Institutions – capacity and presence, weak institutional set-up hinders I4ID through insufficient support.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Hierarchy and silo approach intervention mechanisms to overcome too strong formal set-ups. • Institutions favour I4ID.	• Awareness programmes on the relevance of the marginalised actors. • Ensuring regulatory impediments do not prohibit or constrain innovations serving the poor (particularly regarding public services) while critical quality standards are being met. • Insert inclusive innovation policies in innovation policy agendas. This will ensure that aspects of both economic growth and inclusiveness are achieved and that policy coherence exists. • Investigate and revise current policies that are aimed at marginalised, especially those that target better integration through enhancing access to services, novel IP solutions and infrastructural constraints.

Resource mobilisation

MomConnect was able to scale nationally by using some exceptional innovative technological designs. The programme further utilised infrastructure already available from other mHealth initiatives. The MomConnect programme made notable advances in technological provision, but there remain limitations of South Africa's ICT infrastructure as follows:

- connectivity remains expensive;

- many (especially rural) areas are still without mobile coverage;

- patient and data confidentiality remains an issue, although notable strides are made in this regard; and

- health systems vary across provinces.

The mHealth sector and MomConnect remain mostly donor-dependent. In general, investments are made for only a very limited time and very often not beyond the pilot phase. This is one of the main reasons why more than 95% of projects in South Africa do not move beyond the pilot phase (Cargo, 2013). MomConnect had fixed funding for a fixed period of time, which was crucial for the expansion of the project on a national scale. The funding, however, was limited until the end of 2016.

There is further a need for R&D grants for research institutes to develop inclusive interventions and funding that align with and support inclusive interventions. Incentives are required for organisations that participate in I4ID solutions in the sector, as well as funding for business development and support to innovate successfully for inclusive development through financing mechanisms.

There exists limited human capital to conduct research on marginalised communities and the requirement to align and develop a more inclusive innovation mHealth system. Furthermore, there is a need to establish coordination among actors, mutual learning as well as the establishment of governance and leadership (project champion) to drive the development of capabilities and capacities of formal actors to include the marginalised in the process towards more inclusivity. This may be achieved through the co-creation between formal and informal actors who are aligned to a shared goal or vision for formal and informal actors. Table 42 outlines the systemic problem analysis and systemic policy interventions for mobilisation of resources.

Table 42: Resource mobilisation systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 6: Resource Mobilisation	6.1 Financial mechanisms	• Sector is mostly donor-dependent.	Infrastructure – presence and quality of funding.	***Motivate physical, financial and knowledge infrastructure*** • The development and creation of sustainable business models. • R&D grants for research institutes to develop inclusive interventions. • Taxes and loans that align and support inclusive interventions.	• There is a requirement for business models that cater specifically for the active inclusion of marginalised actors. These models must have practical guidelines for the benefit of marginalised actors, the importance of partnerships as well as scaling strategies. • There should exist cross-subsidising for consumption and other novel ideas with the aim of lowering costs. • Financing mechanisms that are tailored to support I4ID initiatives. • Develop taxes that are favouring the emerging I4ID market through favourable loan schemes.
	6.2 Access to resources	• There is still limited access to networks in remote and widely dispersed areas.	Infrastructure – presence and quality of funding.	***Ensure infrastructure quality to be sufficient*** • Ensure adequate physical infrastructure is present.	• Establish good practices of physical infrastructure requirements. • Make use of latest technological solutions (e.g. ICT).
	6.3 Investment security	• In general, investments are for only a very limited time frame and very often not beyond the pilot phase. This is one of the main reasons why more than 95% of projects in South Africa do not move beyond the pilot phase (Cargo, 2013). • One of the successes of the MomConnect project is the fixed funding it received from	Infrastructure – presence and quality of funding.	***Motivate Physical, financial and knowledge infrastructure*** • Align the funding of projects to the intended inclusive goals and appropriate time frames.	• Align funding goals with KPIs of government and organisations operating in the inclusive space. Develop programmes so that funding is for a fixed time frame and an amount which is essential to support I4ID interventions and provide legitimacy around the intervention.

143

		multiple donors, but this ended in 2016.			
	6.4 Access to informal communities	• Human capital is not utilised from a marginalised perspective. • Solutions remain largely top-down.	Actors – presence, lack of marginalised involvement. Capability, lack of formal orientation.	Establish new relationships and collaboration among the 'new' set of actors in the system.	• Establish coordination among actors, mutual learning, governance and leadership (project champion). • Co-creation between formal and informal actors is required that aligns to a shared goal/vision for formal and informal actors;
			Infrastructure – presence, lack of spaces and places of involvement.	***Establish spaces and methods for actor capability development*** • Create spaces and environments for the integration of the capabilities of different actors.	• Establish inclusive innovation platforms in communities as well as among inclusive knowledge leaders.
	6.5 Assessment of business plans	• The MomConnect programme lacks any 'escape' plan. After committed donor funding, there is a lack of business plan for sustainable projects. A lack of scaling initiatives from the planning phase does not generate revenue.	Actor – capability, lack of formal capabilities.	***Establish spaces and methods for actor capability development*** • Develop capabilities for the creation of sustainable I4ID business models and scaling initiatives through advanced technologies.	• Focus on developing capabilities broader and beyond just the product and/or service. There must be supporting structures to develop capabilities and capacities of informal communities to obtain maximum benefit from I4ID. • Support the use of advanced technologies. It is important to consider technologies that may serve as platforms for added services to lower entry costs and promote activities for added I4ID solutions.

Creation of legitimacy

In general, there is a lack of projects that scale. There is also minimum M&E to measure the real reach of projects. The sector is further hampered by ICT infrastructure that is not the same across the country, with high rates for mobile services and data, and major issues in terms of connectivity in areas where a project, such as MomConnect, is needed. It is important to sketch this information, as this comprises the background and reality that surrounded the lead-up to MomConnect.

Although the MomConnect project shared some of the constraints in terms of legitimacy, such as mixed findings on reaching risk populations (marginalised), a lack of data backing the effectiveness of interventions, questions surrounding the effectiveness of solutions, and funding which remains donor-dependent, the project contributes to increased legitimacy. The contributions towards increased legitimacy are:

- the belief in mHealth in LMICs as well as solutions presented to the marginalised;
- the role of government involvement and backing;
- the fact that the project scaled at national level;
- reaching more than 95% of the healthcare clinics in the country; and
- providing an example of a multi-partner approach as well as showing the value of shared commitment.

To move further into the legitimacy around inclusion, a lack of legitimacy, even for product and service interventions, remains. There is a need to develop and create sustainable business models and for the formation of R&D grants for research institutes to develop inclusive interventions. Further, taxes and loans that align and support inclusive interventions are elusive. It is necessary to have debates, facilitating decision-making towards inclusive system approaches, where these approaches are evidence-based as far as possible. Table 43 outlines the systemic problem analysis and systemic policy interventions for creation on legitimacy.

Table 43: Creation of legitimacy systemic problem analysis and systemic policy interventions

Function	Indicators	Weakness indicator guide and description	Type of systemic problem	Systemic policy goal	Systemic policy intervention
Function 7: Creation of legitimacy	7.1 Reputation of investments for I4ID	• Vicious – the mHealth sector and specifically mHealth for development are characterised by a lack of scale and unsustainable projects. • There is a lack of M&E. • MomConnect – the programme made a big impact towards a more virtuous cycle due to the ability of the project to scale; however, the programme is still unsustainable.	Infrastructure – presence	***Motivate physical, financial and knowledge infrastructure*** • The development and creation of sustainable business models. • R&D grants for research institutes to develop inclusive interventions. • Taxes and loans that align and support inclusive interventions.	• There is a requirement for business models that specifically cater for the active inclusion of marginalised actors. These models must have practical guidelines of the benefit for marginalised actors, the importance of partnerships as well as scaling strategies. • There should exist cross-subsidising for consumption and other novel ideas with the aim of lowering costs. • Financing mechanisms that are tailored to support I4ID initiatives. • Develop taxes that are favouring the emerging I4ID market through favourable loan schemes.
	7.2 Resistance to change	• This is one of the biggest obstacles to I4ID in the mHealth and healthcare space. The hierarchy system and silos within organisations make it very difficult to innovate in this space.	Relationships – presence of strong formal relationships	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Hierarchy and silo approach intervention mechanisms to overcome too strong formal set-ups.	• Awareness programmes on the relevance of the marginalised actors. • Ensuring regulatory impediments do not prohibit or constrain innovations serving the poor (particularly regarding public services) while critical quality standards are being met.
	7.3 Awareness of intention	• Lack of awareness amongst marginalised communities.	Actor – presence, lack of	***Encourage and organise involvement of a wide variety of actors***	• Develop intermediary actors and institutions that serve as a bridge between formal and informal markets and products and service development and implementation, they may also

		marginalised involvement	• The involvement of a multi-partner cross-sectoral team is required where the marginalised is actively involved.	serve as knowledge diffusion agents with technical expertise of I4ID.
7.4 Government involvement/commitment	• Most successful interventions are NGO-driven and not part of mainstream public health services (Leon & Schneider, 2012b). • MomConnect – donors provided fixed funding and time frames and government was the project champion. • Government still lacks institutions supportive of I4ID.	Actor – presence	***Encourage and organise involvement of a wide variety of actors*** • Establish new relationships and collaboration among the 'new' set of actors in the system.	• Establish coordination among actors, mutual learning; governance and leadership (project champion). • Co-creation between formal and informal actors is required that align to a shared goal/vision for formal and informal actors.
7.5 Private sector commitment	• The private sector remains at arm's length, where most interventions are NGO- and government-driven.	Institutions – lack of supportive institutions	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Institutions favour I4ID.	• Encourage the establishment of incentivised programmes for partaking in I4ID projects and solutions.
7.6 View of marginalised involvement	• The mobile and health sector lack understanding of the value of each role player and different impact indicators (Cargo, 2013). • There is a need to create awareness of the benefit to all and to make it clear what those benefits are,	Actor – presence, lack of marginalised involvement	***Encourage and organise involvement of a wide variety of actors*** • Establish new relationships and collaboration among the 'new' set of actors in the system. • The involvement of a multi-partner cross-	• Co-creation between formal and informal actors is required that align to a shared goal/vision for formal and informal actors. • Encourage and plan for the involvement of unconventional partners, such as inclusion of the marginalised, and organisations that provide education or healthcare in marginalised communities. These organisations possess invaluable knowledge of these communities.

		and how it will be achieved.		sectoral team is required where the marginalised is actively involved.	
			Institutions – presence, soft institutional set-up hinders marginalised involvement.	***Presence of (hard and soft) institutions for the specific innovation in focus*** • Shared commitment: have a common goal and vision with benefit to all actors. ***Prevent too weak/stringent institutions*** • Institutional structures supporting collaborative actions and orientation of formal actors towards inclusive solutions.	• Have documented policies and institutions that specifically focus on a shared commitment from all parties involved and which outline implementation practices. • Institutional structures, collaboration and orientation (national, regional and sectoral focus), to orientate formal ISs towards the marginalised.
			Relationships – presence, lack of trust between formal and informal actors.	***Motivate interaction opportunities between diverse actors*** • Bridging instruments that serve as enablers for interactions among diverse actors. • Debates facilitating decision-making towards inclusive system approaches should be evidence-based as far as possible.	• Provide a place for active engagement and learning from best practices and implement projects through the development of centres of excellence and competence centres. • Marginalised interaction goals: this does not include only listening, but that there exists a deep debate on the topics under discussion: community and direct personal relationships with local communities and NGOs (intermediaries). • Collaborating effectively with agents 'on the ground' having direct contact with relevant marginalised segments is vital. • Deep dialogue for local innovation must start with a deep immersion into consumers' lives to get unique insights. • Develop research strategies to identify barriers and opportunities for I4ID.

148

7.3   Chapter conclusion

This chapter focussed on steps 2, 3 and 4 of the analysis framework, namely system description, system analysis and system intervention. The system description focussed on the structural element of the MomConnect programme, the functional description focussed on the MomConnect programme as well as on the greater mHealth system, and the system analysis and intervention focussed on the identification of systemic problems and aligned these systemic problems with systemic policy goals and interventions.

CHAPTER 8   CONCLUSION

The final chapter of this thesis provides a brief overview of the objectives achieved in this study and concludes with the thesis findings, in line with the stated objectives. Section 8.1 outlines the research objectives, section 8.2 briefly concludes on the developed framework, and section 8.3 provides a brief summary of the attainment of each research objective. Section 8.4 outlines the limitations of the study, and Section 8.5 concludes the thesis by providing suggestions for future research opportunities.

1	• Overview of research objectives
2	•Framework – discussion and conclusion
3	• Attainment of objectives
4	• Limitations of the study
5	• Future research opportunities

8.1   Overview of research objectives

The aim of this study was to develop an IIS framework that will enable the identification of barriers towards I4ID by guiding the process of exploring the dynamics of the IIS; and the identification of interventions that could strengthen IISs that foster I4IDs.

The objectives that supported the attainment of the aim were:

1. to derive a state-of-the-art IS analytical framework based on the work of Wieczorek and Hekkert (2012) and the most renowned TISs literature.

2. to adapt the IS analysis framework to determine and describe an inclusive IS successfully by:
   * outlining factors constraining structures of the IS that hinder I4ID as well as outlining the new orientation required towards enhanced inclusivity;
   * developing indicators to guide the process of analysing and assessing the functional dynamics of I4ID; and
   * developing a framework that supports the identification of systemic policy instruments to strengthen inclusive innovation in the system;

3. to validate the developed IS framework by applying it to a case study to:
   * identify and describe structures that form part of the inclusive IS successfully;

- identify and describe the inclusive functional dynamics of each system function by means of the above-mentioned set of functional indicators;
- identify and describe barriers to I4ID as well as systemic policy instruments by:
  - identifying the structural barriers that hinder the formation of adequate inclusive IS functions; and
  - developing systemic policy interventions to support the development of more inclusivity in inclusive ISs.

Section 8.2 concludes the framework that was developed.

8.2   **Framework – discussion and conclusion**

The current study focussed on developing a framework to adapt the analysis structure of the state-of-the-art TIS frameworks to include a more nuanced analysis perspective on the dynamics of marginalised communities (thus developing an IIS analysis framework). The framework that was developed takes into account that structures and functions of IISs have a different focus from that of conventional ISs. An IIS differs from other ISs in its purpose, which is to induce I4ID. By definition, a well-functioning IIS contributes to the well-being of the marginalised. By contrast, other conventional 'well-functioning' ISs could contribute to growth that cause deeper poverty and greater inequality.

The study adapted the structures of a leading IS analysis framework in order for it to account for the factors of each structure hindering the formation of I4ID, as well as the new orientation required to induce I4ID. The functions of the IS framework were reorientated to allow for the identification and inclusion of I4ID system dynamics towards the identification of systemic weaknesses and systemic problems hindering the formation of I4ID, as well as aligning systemic policy goals and interventions with systemic weaknesses and problems.

The study found that both the structural and functional analyses are promising analytical methods to assess the inclusive dynamics of a system. The study further found that the two analyses (structural and functional), could be complementary for the analysis of IISs. The functional analysis complements the structural analysis, as the function of the IIS is the manifestation of structures that make up the IIS. The link between functions and structures of the IIS is important. Beyond the clear analytical purposes, it serves as an important guide for practical reasons as well. The functions of the IIS may only be influenced by policies through modifications of structural components (Bergek *et al.*, 2008) (see Chapter 7). A clear example of this is the market formation function of MomConnect, where there is a need for the participation of actors to I4ID, incentives for I4ID and legislation and policies supporting not only mHealth, but also inclusive mHealth. However, this may only be realised when structural components are stimulated through systemic interventions.

The study further indicated how outlining the systemic problems of functions guide the design of systemic policy instruments, which address systemic problems in a cohesive manner. Systemic problems are defined by their structural characteristic and is directly connected and influences the functional pattern of the IIS. Systemic problems that are identified through the application of the coupled structural–functional analysis, mutually

express structural problems and the effect of structural problems on the I4ID processes. For example, in the MomConnect case, some knowledge development systemic problems were:

- M&E activities that are insufficient to determine reach and outcomes;
- limited knowledge based on past I4ID activities;
- formal organisation lacking capacity to research the marginalised market sufficiently;
- the marginalised remaining largely delinked from any research collaborative activities; and
- limited research collaboration among research institutes and NGOs due to tenders for the same donor funding.

These systemic problems are due to a lack of the presence of actors, such as a lack of marginalised involvement to foster in-depth I4ID knowledge as well as actor capability, where formal research institutes are required to develop additional capabilities and capacities to collaborate with one another, while the marginalised are required to establish deep-rooted I4ID knowledge. Another structural problem related to knowledge development is a weak network among the formal and informal market, clear in the MomConnect programme. The results of these systemic problems are manifested negatively in the functional patterns of the MomConnect programme and the larger mHealth sector.

This indicates that the mechanisms hindering IIS functions may easily be stated in terms of categories of the structural components as well as the types (presence, capacity) of systemic problems. The advantage of defining a 'checklist' that guides the identification of systemic problems of an IIS is that it provides a guide for the researcher to align specific policy aims and specific systemic policy instruments to strengthen I4ID system dynamics. To conclude with our illustrative example of knowledge development, the following systemic policy aims were appropriate:

- develop indicators for I4ID M&E;
- establish spaces and methods for actor capability development;
- prevent too weak/stringent institutions; and
- motivate interaction opportunities between diverse actors.

Specific systemic policy instruments, supportive to reach the systemic policy aims were as follows:

- measurements and indicators;
- gaining and developing a deep understanding of the targeted individuals (the market);
- creating traditional spaces and places enabling the involvement of a diverse set of actors;
- development of research institutes and their capabilities to study the dynamics of I4ID and IIS;
- R&D grants for research institutes to develop inclusive interventions;
- deep-rooted local knowledge (bottom-up knowledge), especially appropriate delivery mediums; and
- inclusivity readiness and localised implementation of inclusive solutions.

By discouraging undesirable circumstances for I4ID (systemic policy instruments) and replacing it with positive ones as well as increasing the capacities thereof, may not only improve the environment for I4ID, but

may also influence the direction of an IS to transform into an IIS, achieving more I4ID objectives. The proposed IIS framework may therefore be used as an analytical tool towards enhanced inclusiveness due to the open and data-rich character of the framework, where the systemic approach is sufficiently comprehensive to incorporate a wide and diverse set of identified barriers (systemic problems and weaknesses), and the functional indicators are satisfactorily targeted to identify systemic weaknesses that are context-specific and tangible. Showing how different issues interrelate and share similar causes is valuable as it allows for the formulation of recommendations that deal not with individual problems but with their shared underlying causes. The interventions that follow from these recommendations therefore do not aim to solve individual problems, but aim to strengthen the problem-solving or innovation capacities of the system analysts.

Section 8.3 concludes the thesis in the context of the research objectives.

8.3 Research conclusion in context of research objectives

This section outlines each research objective in terms of the manner in which the objective was obtained as well as the outcome and lessons learned for each objective. Section 8.3.1 outlines objective 1, section 8.3.2 outlines objective 2 and section 8.3.3 outlines objective 3.

8.3.1 OBJECTIVE 1

Outcome 1: Derive a state-of-the-art IS analytical framework based of the work by Wieczorek and Hekkert (2012) and the most renowned TISs literature

Objective 1 was obtained by firstly outlining the role of innovations, in creating exclusionary societies, as well as the contrary role thereof, where innovation is a major source of novel innovative solutions in the fight against exclusion and poverty. Secondly, the research outlined the shortcomings of current ISs to serve the needs and interests of marginalised actors through an in-depth literature review, where a conclusion was constructed between the differences of conventional and inclusive ISs. An in-depth literature review outlined the IIS and the TIS research as an appropriate framework to exploit inclusionary systems. Thirdly, an analysis framework was constructed through an in-depth literature review, consisting of four main phases, mainly based on the work of Wieczorek and Hekkert (2012) and supplemented by the most renowned TISs literature. An in-depth overview of the framework was provided in Chapter 5, which reflected the following four phases:

- system identification;
- system description ;
- system analysis and
- system intervention.

8.3.2 OBJECTIVE 2

The general features of ISs as well as the analysis approach are appropriate to use as an analysis framework. However, it cannot be used as is as the content of the framework requires adaption to conceptualise the

dynamics of I4ID. The contents and dynamics of system structures and functions require adaption to adhere to the dynamics of the marginalised market.

Outcome 2.1: Outlining constraining aspects of the structures of the IS that hinder I4ID as well as outlining the new orientation required towards enhanced inclusivity.

Firstly, system structures must be able to identify constraints and, secondly, they must incorporate a new orientation/capability to be able to innovate for inclusive development. Chapter 5 firstly described a new orientation for system structures towards the IIS. Secondly, Chapter 5 outlined notable constraints for each system structure to innovate for I4ID. It also identified a new orientation for each system structure to foster more I4ID. These constraints and new orientation were derived from previous studies that were based on empirical findings.

Outcome 2.2: Develop indicators to guide the process of analysing and assessing the functional dynamics of I4ID.

System functions are described through the use of seven system functions identified in the literature analysis in Chapter 4. These functions were adapted to be able to incorporate the dynamics of the marginalised market through a set of indicators for each system function. The system functions were aligned with conventional IS literature, where the studies of Wieczorek and Hekkert (2012), Bergek *et al*. (2008) and Suurs (2009) were used to ensure that the indicators remained aligned to innovation studies. The indicators were derived from an in-depth study of empirical and theoretical studies of inclusive innovation. The indicators were not sector-specific and served as a general list, as these indicators were derived from a diverse set of countries and the empirical studies focussed on vastly 'different' marginalised markets. These indicators were used as the 'coding' structure for the qualitative analysis process.

Outcome 2.3: Develop a framework that supports the identification of systemic policy instruments to strengthen I4ID in the system.

The attainment of this sub-object was achieved through the description of systemic policy instrument goals and systemic policy instruments. Wieczorek and Hekkert (2012) provide eight systemic policy goals that were adapted for the requirements of this study. Each systemic policy goal was aligned with a set of systemic policy instruments, serving as a guide to overcome IIS systemic policy problems, preventing an IS towards to more inclusively orientated. These systemic policy goals and instruments were derived through an in-depth literature review of I4ID studies, both theoretical and empirical.

8.3.3   OBJECTIVE 3

Outcome 3.1: Identify and describe structures that form part of the inclusive IS.

The system structures allowed the study to take into account a multi-stakeholder, actor-orientated approach. This allowed the qualitative analysis process to orientate systemic problem identification to both formal and marginalised actors. The revised orientation to focus on I4ID, allowed the research to identify the shortcomings of system actors towards a more inclusive IIS.

Outcome 3.2: Identify and describe the inclusive functional dynamics of each system function by means of the above-named set of functional indicators.

The list of functional indicators was very useful to orientate the analysis to focus on the dynamics of I4ID. The functional indicators allowed the alignment of the interview process towards the inclusive links of MomConnect. Further, the indicators were general enough to take into account the dynamics of the system surrounding a project, and enough data was obtained to give meaningful feedback on the influence of the wider mHealth systems on the MomConnect project. The functional indicators allowed the successful identification of systemic problems preventing the formation of a truly inclusive system. The functional indicators further, provided a base from where these systemic problems could be identified, from where systemic policy instruments may be developed to strengthen the IS, towards a strengthened IIS.

Outcome 3.3: Identify and describe barriers to I4ID as well as systemic policy instruments.

The systemic problem analysis served as a very useful approach to link system functional performance to system structures for an IIS. The approach identified the structural properties that were hindering an IS to I4ID. The identified barriers served as a very useful guide to determine the areas where systemic policy interventions are required.

The systemic policy instruments served as an integrated set of tools tailored to the specific needs of I4ID. The development and selection of the instrument were outlined with the goal of effective, strengthened and coordinated action to align the MomConnect project and the mHealth system to more inclusive development. This guide may be used as a general list to derive systemic policy interventions. It should be noted that further investigation is required as this list is broadly defined and did not investigate implementation strategies.

Another useful outcome of the tool is its ability to indicate the interrelationships of systemic problems sharing similar causes. This is a valuable outcome as it allows systemic policy instruments to address not only individual problems but rather a shared underlying cause on the IS level. This in turn stimulates interventions aimed at strengthening the capacity of the entire system towards more inclusivity.

8.4   Limitations

Key limitations

It must be noted that the developed functional indicator list for each function is not exhaustive and serves only as a useful guide for analysis purposes. This also holds for the developed policy aims and systemic policy instruments. The systemic policy instruments, although directed towards specific systemic problems would

require more in-depth alignment to the specific system under study as the case was used primarily to illustrate the basic premise of the framework and its potential usefulness, and therefore requires to be tested empirically to evaluate the value thereof.

Despite every effort being made to improve the rigour of the study, various furthered limitations of the methodology could be identified.

Firstly, the interviews were mostly conducted with the individuals who were instrumental in leading the MomConnect project as well as with the main developer and implementers of the project. The framework was applied by means of qualitative research, where only influential decision-makers of the MomConnect project were utilised to gather information. Although it proved sufficient for the purposes of the illustrative case study. it would be beneficial in practice to apply the framework through the lens of the marginalised market and other key role players. It is envisioned that these alternative perspectives would produce rich complementary sets of data. This is especially true for IISs, where the aim is specifically to empower the marginalised beyond only products and services to include active involvement in productive activities.

Secondly, the interventions derived for this study were based primarily on generic interventions which were meant to serve as a base from where further studies are required for implementation purposes. Furthermore, the recommended interventions were not implemented due to time constraints.

Thirdly, there is a need to broaden the proposed functional indicators to align with a specific sector, or towards a specific marginalised target group. The generic indicators developed will likely not be sufficient in a practical application in their current form and future research in this area is encouraged.

8.5 Recommendations for future work

This section provides an overview of some recommendations to build on the work completed in this thesis.

Systemic interventions

The systemic interventions identified in this study could serve as a meaningful starting point to plan interventions. However, the interventions were broadly defined and require concrete application methodologies. It is recommended that future work, firstly, refine the identified interventions, and secondly, develop a road map of interventions for systemic problems. To conclude there is a need for empirical validation and evaluation of the implementation of systemic policy interventions.

Policy implementations

The systemic interventions should serve as an appropriate starting point for system reform. However, future research is required to explore policy measures to influence inclusive ISs positively. The current systemic interventions are too broad to derive policy implementations.

The value chain approach

The value chain analysis approach may be incorporated in the IS analytical framework. The approach may well complement the ISs analysis approach as the value chain approach is useful in:

- identifying opportunities to involve the marginalised in the value chain (system applicable) – points of entry;
- providing a market-based focus to determine the competitiveness, economic viability and sustainability of products;
- providing a diagnostic tool for blockages – core rents and barriers to entry; and
- analysing the role of institutions in structuring business relationships and industry locations.

Cumulative causation

This study did not include the effect of system functions on one another. The study only focussed on improvement of the individual system function through systemic instruments. Future studies should explore the effect of strengthening one function on other system functions.

Qualitative measures

The performance of system functions was derived via the corresponding system indicators. This was a simplistic exercise to derive a score between 1 and 3 to identify areas where system functions are inadequately orientated to I4ID. Further exploration is required towards measurable indicators. A refined approach may facilitate the comparison of systems as well the measurement of progress of an inclusive IS over time.

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APPENDIX A: SYSTEM STRUCTURES: INNOVATION FOR INCLUSIVE DEVELOPMENT

This section outlines the adapted system structures after the application of the analytical framework to the MomConnect project.

Government

Table 1:Major constraints, a new orientation and key factors to consider for governments

Major constraints of governmental bodies	New orientation and key factors to consider
• Governments are politically driven to own agendas • lacks sustainable business models • silos existing within government and provincial departments, diminishing knowledge developed and duplicating efforts	• Multi-partner cross-sectoral team • exceptional leadership from highest government levels • strong government stewardship • provides credibility to project • have clear strategies

Formal actors/organisations

Table 2: Major constraints, a new orientation and key factors to consider for formal actors

Major constraints for formal actors	New orientation and key factors to consider
• Lack of knowledge and internal capabilities – lack of marginalised knowledge (empowering knowledge marginalised), deep understanding of people (the market), lack of 'on-the-ground' knowledge and engagement with the market to adhere to the requirements of the marginalised, cross-pollination of knowledge and technologies, marginalised requirements, involvement and delivery mediums. • Assumptions – assumptions prevail, underutilising the effectiveness of interventions. • Traditional thinking – assumption that technology could bypass steps to involve the community. • Partnership and coordination among actors. • Scaling and sustainable business models – scaling initiatives, co-creation (marginalised-related) are lacking, formal actors lack value offerings to include marginalised sustainably.	• Identify the new set of actors and establish new relationships among these actors; • new knowledge – through immersion into the lives of the marginalised; • new channels for knowledge diffusion and co-creation; • risk creation – burden of uncertainties, develop for and by the marginalised; and • demand-side innovations.

Major constraints for formal actors	New orientation and key factors to consider
• Mutual learning is absent – evidence on inclusive endeavours on which to base interventions is absent, poor documentation and learning from best practices, lack of continuous evaluation of implemented projects.	

Intermediary organisations (formal)

Table 3: Major constraints, a new orientation and key factors to consider for formal intermediary organisations

Major constraints for intermediary organisations (formal)	New orientation and key factors to consider
• Misalignment of formal actor goals - competing for the same resources (NGOs); • Lack of trust in low-income communities – focus broader than just the product and/or service (this is a systems approach). • Adaptive capacities limited due to push–pull strategies from formal and informal actors – lack of collaboration, knowledge sharing, mutual learning, technological knowledge is very fragmented leading to a lack of capabilities to utilise technologies, sustainable business models.	• Shared goal (formal and informal); • awareness of interests (formal and informal); • actively involved in the local community (trust); and • focus broader than just the product and/or service (systems approach).

Intermediaries embedded in the local community

Table 4: Major constraints, new orientation and key factors to consider for informal intermediary organisations

Major constraints of intermediaries embedded in the local community	New orientation and key factors to consider
• Low-income; • a lack of education and skills (illiteracy and lack of education); • proximity (isolated, dispersed and distant locations); • cultural, lifestyle and language barriers; and • poor infrastructure.	• Acknowledgement of local actors; • must understand the use of the new products and services and how it will improve their livelihood; and • have credibility in community.

Informal actors

171

Table 5: Major constraints, a new orientation and key factors to consider for informal actors

Major constraints for informal actors	New orientation and key factors to consider
- Delinked from formal value chain; - a lack of basic skills, knowledge and capital; - a lack of broader market place – little diffusion and development channels; - illiteracy, low income; - proximity (isolated, dispersed and distant locations); and - cultural, lifestyle and language barriers.	- Demand-side actors – behaviour of recipient of consumers; - require active participation in development and evolution of the business offering; and - act as knowledge enablers as local actors will provide information blindingly obvious.

Institutions

Table 6: Major constraints, a new orientation and key factors to consider for systemic institutions

Major institutional constraints	New orientation and key factors to consider
Hard institutional problems Priority areas for hard institutional support, strategy and leadership, stakeholder engagement, standards, governance and regulation, investment, affordability and sustainability, realisation of benefits, capacity and workforce, applications to support delivery of institutional set-ups, and monitoring and evaluation of inclusive projects. **Soft institutional problems** Acknowledgment of the value of marginalised interaction, a lack of 'on-the-ground' interactions, collaboration, co-creation, a lack of inclusion in innovation process, and sharing and mutual learning culture. - too strong institutional set-up hindering innovations to take place; - hierarchy not favourable for inclusive solutions; - silos within companies make it hard to break down structures to innovate in the marginalised space;	- Institutional processes and participatory planning; - institutional structure and collaborative and orientation to a national, regional and sectoral focus; - inclusivity readiness; - localised implementation; and - participatory planning.

Major institutional constraints	New orientation and key factors to consider
• a lack of institutions to building a system and, more importantly, an IIS around technologies; and • a lack of interactive learning and the market is not favourable for knowledge sharing; and • a lack of evidence-based knowledge for institutional interventions.	

Interactions

Table 7: Major constraints, a new orientation and key factors to consider for interactions

Major constraints	New orientation and key factors to consider
• Acknowledgment of the value of marginalised interaction; • a lack of 'on-the-ground' interactions – actors are delinked from individuals at 'ground level'; few endeavours to understand the marginalised landscape; • collaboration, co-creation; • a lack of inclusion in the entire innovation process; • a lack of sharing and mutual learning culture; • hierarchical approach by formal actors, silos within organisations; • limited research collaboration among research institutes and NGOs, difficult to collaborate as research institutes pool from the same funding (conflicting interests); and • a lack of government involvement in early stages of projects results in slow progress or even abandonment of projects.	• Necessity (but also limitations) of informal, loose but socialised relations; • contextualised (supply, demand, other) learning by interacting and using and doing; • learning about diffusion (sales and support) and use; • learning about wider social processes, including non-instrumental procedures; and • survival and utility maximisation as guides; • research programme: cooperative research programmes, bridging instruments (centres of excellence, competence centres) serve as places for active engagement and learning from best practices and implemented projects; • collaboration and co-creation along the entire innovation system and value chain, with an active focus on collective mutual value creation to all; and • innovation must start with a deep immersion into consumers' lives to get unique insights.

Infrastructure

173

Table 8: Major constraints, a new orientation and key factors to consider for infrastructure

Major constraints	New orientation and key factors to consider
• Physical – spaces and places to interact, research institutes focussing on marginalised knowledge creation, the marginalised setting has fragmented infrastructure to work with. • Financial – a lack of financial schemes, business models, taxes and subsidies to support innovation for inclusive development. • Knowledge – does not include the marginalised in value offering, lacks capabilities and capacities to understand the needs of the market, lacks opportunities to include the marginalised to benefit economically. • Functional literacy – practical knowledge of low marginalised settings and health technologies, cross-pollination between those two areas requires research.	• Physical – create spaces, and places to interact, tailor technologies to suit the needs of the marginalised, research institutes must orientate themselves to applied research for marginalised settings. Technologies used had to be scalable and sustainable. • Financial – business models that scale and which are sustainable to include the marginalised. Funding alignment to support research institute to research applicable areas of interest. Sustainability of business models, evidence-based results of financing, cost-saving models and evidence, industry incentives. Funding should be for a fixed period and amount. R&D grants (public research labs) aimed at research institutes supporting the cross-pollinations of knowledge and technologies to serve the requirements for innovation for inclusive development. Taxes favouring the emerging innovation for inclusive development market. • Knowledge – bottom-up knowledge creation with the active participation of local actors. Functional literacy – practical knowledge of low marginalised settings and technologies, cross-pollination between those two areas requires research. Deep-rooted local knowledge (bottom-up knowledge); opportunities for marginalised to benefit economically. What should sustainable and scalable projects contain? Deep-rooted local knowledge (bottom-up knowledge). Opportunity for marginalised to benefit economically. Sustainable and scalable projects: • Foresights, trend studies (intelligent benchmarking), foresight and growth potential for lasting outcomes for innovation for inclusive development.

	- Road maps (evaluation practices and toolkits) guide decision and implementations tailored to the marginalised. - Knowledge management techniques, guiding principles for knowledge best practices to acquire knowledge to guide interventions appropriately.

APPENDIX B: SURVEY QUESTIONNAIRE

Discussion Guideline: Understanding Innovation for Inclusive Development Dynamics from an Innovation Systems Perspective

Why this discussion

Innovation is today regarded as a key driver for the creation of new income and employment opportunities. Including the marginalised in the process of innovations (the active involvement of the marginalised group in design and development), and secondly, inclusivity of output (end products and services specifically meeting the needs of the marginalised group with appropriate quality) are two ways of creating mutual benefit for the marginalised and formal organisations.

Definition of key terms

- An '**Innovation System'** is defined as the network of institutions in the public and private sectors, whose activities and interactions initiate, import, modify and diffuse new technologies.

- '**Inclusive innovation'** refers to innovation that benefits the marginalised, it is the means by which new goods and services are developed for and/or by marginalised groups or individuals.

- '**System components'** are the makeup of the system and by their interaction generate innovations through its set of functions.

- **'System functions'** can be understood as types or sets of activities that contribute to the overall innovation process of a system. The performance, or functioning of the system, can then be expressed in how well the individual functions have been fulfilled.

Aim of the Inclusive Innovation System framework

- Systematically identify the description of the Inclusive Innovation System regarding its Inclusive Performance, through indicators and descriptive questions regarding the systems functions as showed in the table below. (Descriptive step)

- Conduct a cause analysis of "why" the system is performing as it is, regarding its inclusiveness. (Analysis step)

Example of points for discussion

- Engage and support a new constellation of actors where a wider range of diversity is required.

- The new range of institutions is required and a 'reinvention of the commons' such as new forms of dealing with IP, having implications for the process of knowledge execution and circulation.

- Real requirement for social innovation exists where goals may be stated for social and economic systems.

176

- Actors to engage in new ways – spaces and places need to be created where this may happen, taking on new roles and approaches to engage.
- New capabilities which have implications for the type and form of learning that needs to take place to drive an improved understanding of issues, perspectives, and transformations toward constructive and productive interactions.

The system functions and components (the make-up of the system) require understanding regarding the concept of 'Inclusive Innovation.' The points mentioned earlier will serve as a lens to view:

Table 8: System functions and structures

System Functions	System Components
F1 – Knowledge Development	Actors
F2 – Knowledge Diffusion	Institutions
F3 – Entrepreneurial Activities	Infrastructure (physical, financial, knowledge)
F4 – Guidance of Search	Networks
F5 – Market Formation	
F6 – Resource Mobilization	
F7 – Creation of Legitimacy	

Interview Questionnaire

Measure performance of innovation for inclusive development:

- Systemic Weaknesses/Failures/Problems
- Reason for being absent or weak (Blocking Mechanisms)
- Engage and support a **new constellation of actors** where a **wider range of diversity** is required not only in the **presence of actors** but also the **options that are generated** through these interactions between these actors.
- **New range of institutions** is required and a **"reinvention of the commons"** such as new forms of dealing with **Intellectual Property** which will have far reaching implications for the process of **knowledge execution and circulation**.
- **Real requirement for social innovation** exists where goals may be stated for social and economic systems – which has implications for how this constellation of actors choose to **approach society's greatest challenges**.
- **Actors to engage in new ways** – spaces and places need to be created where this may happen often through **intermediaries, innovation platforms or through some traditional actors** taking on **new roles and approaches to engage**.

- **New capabilities** which has implications for the **type and form of learning that needs to take place** – the form and focus of these learning activities will drive an improved understanding of issues also various perspectives and transformations toward constructive and productive interactions.

Table 9: Entrepreneurial Activities

Indicators	Questions
Marginalised individuals/groups involvement	Are the marginalised individuals/groups involved as producer, employee, entrepreneur, consumer? Details of involvement (e.g. size of producer?)
Marginalised individuals/groups entry	Extent to which marginalised individuals/groups can be involved, which barriers to entry exist e.g. high initial investment, bureaucratic burden etc.?

Table 10: Knowledge Development

Indicators	Guiding Questions
Sources of knowledge	Main producers of knowledge, is this knowledge locally produced or international? Top-down/push vs bottom up/pull?
Focus of knowledge development	Does it cater for the needs of marginalised individuals/groups, i.e. does the marginalised individuals/groups profit from it in any way?
Research capacity	Is the knowledge that is created of sufficient quantity and quality to provide adequate solutions that are scalable and sustainable?
Research collaboration	Is there collaboration between different producers of knowledge, between producers and users? Marginalised individuals/groups involvement?

Table 11: Knowledge Diffusion

Indicators	Guiding Questions
Focus of dissemination	Top-down/push vs bottom up/pull? Is it aimed at poverty alleviation?

178

Channels of dissemination	What methods are used, are these successful to educate and empower individuals?

Table 12: Guidance of Search

Indicators	Guiding Questions
Strategy	Are there clear strategies for the initiative? Are there targets set to implement strategy?
Nation-wide or local	Is the strategy on national scale or only in a certain are?
Private sector and government focus	What is the focus of government/private sector policy in terms of this project? Does it include poverty alleviation strategies?

Table 13: Market Formation

Indicators	Guiding Questions
Institutional incentives	What institutional incentives exist to market formation? E.g. Tax benefits, subsidies etc. Are there specific incentives for poverty reducing initiatives?
Instruments for market formation	What instruments for market formation exist? (e.g. challenge funds, public-private partnerships, incubators), any of these specifically pro-poor?

Table 14: Resource Mobilisation

Indicators	Guiding Questions
System formation capital/ Access to capital	Are there sufficient financial resources for system development? Do they correspond with the system's needs? To what extent do (BoP) businesses have access to capital?
Human and Physical Resources	Are adequate infrastructure in place so that the innovation can realise it's benefit fully?

Table 15: Creation of Legitimacy

179

Indicators	Guiding Questions
Consumer confidence	Do sector outputs have good reputation? Is the consumer willing to use the product service?
Commitment of government	Does the government show commitment to the advancement of the sector?
Commitment of private sector	Does the private sector show commitment to the advancement of the sector?
Resistance to the market	Is there much resistance to change?
	Where is resistance coming from?

APPENDIX C: ETHICAL CLEARANCE

Written Consent Form

STELLENBOSCH UNIVERSITY

WRITTEN CONSENT TO PARTICIPATE IN RESEARCH

TITLE OF RESEARCH PROJECT:	Evaluation of inclusive innovation system performance
REFERENCE NUMBER:	SU-HSD-003490
PRINCIPAL INVESTIGATOR:	Edward van der Merwe
ADDRESS:	Industrial Engineering, Banghoek Rd, Stellenbosch, 7600
CONTACT NUMBER:	0765691774
E-MAIL:	evdmer@gmail.com

Dear Prospective Participant

Kindly note that I am a *MEng* student at the Department of Industrial Engineering at Stellenbosch University, and I would like to invite you to participate in a research project entitled Evaluation of inclusive innovation system performance.

Please take some time to read the information presented here, which will explain the details of this project and contact me if you require further explanation or clarification of any aspect of the study. This study has been approved by the Research Ethics Committee (REC) at Stellenbosch University and will be conducted according to accepted and applicable national and international ethical guidelines and principles.

1. **INTRODUCTION:**

A review of the literature reveals innovation system literature as an appropriate method of analysis for inclusive innovation systems, but requires adaption. There exist a gap in literature for a comprehensive analytical framework of inclusive innovation systems performance, addressing system weakness, barriers,

indicators and performance measurements. There furthermore is also a lack of empirical data on how the innovation systems literature should be adjusted towards inclusive practices. This master's thesis presents a generic theoretical and empirical mHealth framework for determining the inclusive innovative performance of a mHealth innovation project within South Africa. The type of research undertaken in this project is a theory/model building study. Mouton (2001:176) describes such a study as "Studies aimed at developing new models and theories to explain particular phenomena." The study is empirical in nature. In some instances, databases may be analysed and extracted. The structure of the model is derived from secondary textual data. The method followed in deriving the model for this study is therefore chosen to be deductive reasoning, one of the most powerful methods of deriving models and new theories.

2. **PURPOSE:** Strengthen the inclusive innovation and inclusive innovation system literature through:

- Identifying inclusive innovation performance indicators and performance measurements;
- Identifying inclusive innovation system performance indicators and performance measurements;
- A generic analysis framework towards analysing an inclusive innovation system;
- A mHealth inclusive innovation specific analysis framework.

3. **PROCEDURES:** The study is qualitative of nature. The participants will engage in a discussion on conceptualising Inclusive Innovation within a South African context. The discussions will be held in person or via Skype, depends on the preference of the participant.

4. **TIME:** The discussion will be between 20min and 30min.

5. **RISKS:** N/A

6. **BENEFITS:** Improved methods of analysis that may be utilised in a real-world setting. All relevant analysis within the thesis document as well as published articles will be shared to participants.

7. **CONFIDENTIALITY:** Any documentation will not contain any reference to the participant interviewed. Within the thesis document will participants be referred to as "numbers", thus no personal information of any participant will be available in any documentation. Quotes from the interviewees will not be included in the documentation, as this may cause a risk to maintain anonymity. Furthermore, will transcribed data not be made available to any other party than the interviewer himself, and his study leader(s).

8. **RECORDINGS:** Voice recording will be made use off.

9. **DATA STORAGE:** All of the information obtained from participants in the study will be thoroughly protected via the following measures:

1. The computer where the data will be stored is located in my office only accessible via my student card, and the computer never leaves the office
2. The computer has password protection.
3. All the information is stored on Dropbox. It is password protected with only me having access to it.

If you have any questions or concerns about this research project, please feel free to contact Edward van der Merwe.

Edward van der Merwe

0765691774

evdmer@gmail.com

RIGHTS OF RESEARCH PARTICPANTS: You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché (mfouche@sun.ac.za / 021 808 4622) at the Division for Research Development. You have the right to receive a copy of this Consent form.

If you are willing to participate in this research project, please sign the Declaration of Consent below and hand it to the investigator.

DECLARATION BY THE PARTICIPANT

As the **participant** I hereby declare that:

- I have read the above information and it is written in a language with which I am fluent and comfortable.

- I have had a chance to ask questions and all my questions have been adequately answered.

- I understand that taking part in this study is voluntary and I have not been pressurised to take part.

- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

- If the principal investigator feels that it is in my best interest, or if I do not follow the study plan as agreed to, then I may be asked to leave the study before it has finished.

- All issues related to privacy, and the confidentiality and use of the information I provide, have been explained to my satisfaction.

By signing below, I _____ agree to take part in this research study, as conducted by Edward van der Merwe.

Signed at *(place)*   **Date**

_____

Signature of Participant

DECLARATION BY THE PRINCIPAL INVESTIGATOR

As the **principal investigator** I hereby declare that the information contained in this document has been thoroughly explained to the participant. I also declare that the participant has been encouraged (and has been given ample time) to ask any questions. In addition I would like to select the following option:

	The conversation with the participant was conducted in a language in which the participant is fluent.
	The conversation with the participant was conducted with the assistance of a translator, and this "Consent Form" is available to the participant in a language in which the participant is fluent.

_____   _____

Signed at *(place)*   **Date**

_____

Signature of Principal Investigator

Humanities REC Letter

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Van Der Merwe, Edward E

Proposal #: SU-HSD-003490

Title: Understanding Innovation for Inclusive Development Dynamics from an Innovation Systems Perspective

Dear Mr. Edward Van Der Merwe,

Your **New Application** received on **12-Oct-2016**, was reviewed

Please note the following information about your approved research proposal:

Proposal Approval Period: **10-Nov-2016 -09-Nov-2019**

The following stipulations are relevant to the approval of your project and must be adhered to:

184

The researcher is reminded to submit copies of permission letters obtained from participating companies to the REC: Humanities for recordkeeping.

Please provide a letter of response to all the points raised IN ADDITION to HIGHLIGHTING or using the TRACK CHANGES function to indicate ALL the corrections/amendments of ALL DOCUMENTS clearly in order to allow rapid scrutiny and appraisal.

Please take note of the general Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

Please remember to use your **proposal number** (**SU-HSD-003490**) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process. Also note that a progress report should be submitted to the Committee before the approval period has expired if a continuation is required. The Committee will then consider the continuation of the project for a further year (if necessary).

This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki and the Guidelines for Ethical

Research: Principles Structures and Processes 2004 (Department of Health). Annually a number of projects may be selected randomly for an external audit.

Institutional Permission Letter

health

Department:
Health
REPUBLIC OF SOUTH AFRICA

Private Bag X828, PRETORIA, 0001. 27th Floor, Room 2710, Civitas, Cnr Thabo Sehume & Struben Street, PRETORIA, 0001
Tel: +27 (0) 12 395 8000, Fax: +27 (0) 12 395 8422

INSTITUTIONAL PERMISSION LETTER

INSTITUTION NAME & ADDRESS: MomConnect

CONTACT PERSON: Peter Barron

CONTACT NUMBER:

EMAIL ADDRESS: pbarron@iafrica.com

TITLE OF RESEARCH PROJECT: Evaluating Inclusive Innovation System Performance

ETHICS APPLICATION REFERENCE NUMBER: SU-HSD-003490

RESEARCHER: Edward van der Merwe

DEPT NAME & ADDRESS: Industrial Engineering, Banghoek Rd, Stellenbosch, 7600

CONTACT NUMBER: 0765691774

EMAIL ADDRESS: evdmer@gmail.com

Dear Edward van der Merwe

We have reviewed your request to conduct a research project involving data related to MomConnect. You have permission to utilize the data for this project as define in your "Project Proposal".

The following stipulations should be observed:

* [Insert any stipulations]   Nil

Sincerely,

Name: ▓▓▓ (name and surname of the contact person at the institution) Mrs Magda Fourié

Who warrants that he/she is duly authorised to sign on behalf of ▓▓▓ (name of institution) Department of Health.

Position: ▓▓▓ Deputy Director

Date: ▓▓▓ 16 November 2016

Signature: ▓▓▓ Fourié.