ICT-BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE: A DESIGN THINKING PERSPECTIVE

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Abstract

Health professionals in the developing world face the twin challenge of growing populations requiring services and dwindling resources in the face of reduced funding. Developments in information and communication technologies (ICT) present an opportunity to streamline service offering in a way that maximises the available meagre resources. Such innovations require the input and support of the public that these institutions serve. Design thinking has over the last 20 years developed into a "design paradigm" that can assist service providers to craft solutions to problems that take into account the views of the stakeholders involved.

This work explored how information technology can be used to improve service delivery. Adopting a pragmatic philosophical paradigm and a design science research approach, the researcher used concepts underlying the theory of service dominant logic, coupled with technology capability concepts, to develop a conceptual framework for use in design thinking projects. The development of the Technovation Framework continued over three design cycles, in which a number of design teams focused their efforts on how ICT could be used to improve post-natal care services. The empathy input for these workshops was derived from an eight-week-long in-depth study into the lives of new mothers, using journals and interviews. Interviews with midwives and doctors provided a healthcare perspective of the provision of post-natal care.

The first design workshop was made up of four teams, each consisting of two midwives, two mobile developers and two mothers in a design thinking workshop. The workshop resulted in the development of four prototypes of mobile applications aimed at assisting midwives in educating mothers as well as providing off-site monitoring. Two further workshops were conducted, providing two more iterations of the design process and resulting in further prototypes of potential solutions for use in healthcare. A final evaluation workshop was conducted to validate the fully developed Technovation Process.

This study contributes to knowledge in a number of ways. The first is a deep understanding of the lives of new mothers and challenges they face in a low-resource environment as they struggle with raising their babies in the first eight weeks after giving birth. The second contribution is a framework and an enhanced design thinking process that streamlines the process of consolidating empathy output while providing a mechanism to apply technology capabilities to proposed solutions. A third contribution is the set of lessons that arise from observing design teams at work. The final contribution is in the form of a number of prototypes that could be developed into solutions for use in a developing environment healthcare setting.

Keywords: ICT in healthcare, e-Health, innovation, co-creation, design thinking, developing country, post-natal care, design science research, Technovation, technology capabilities

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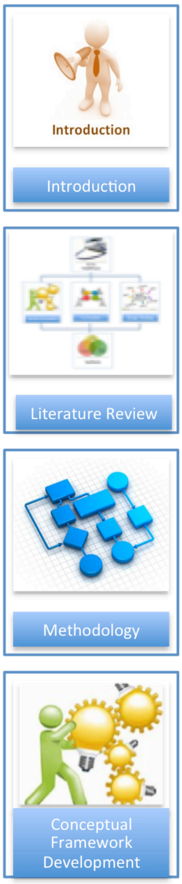
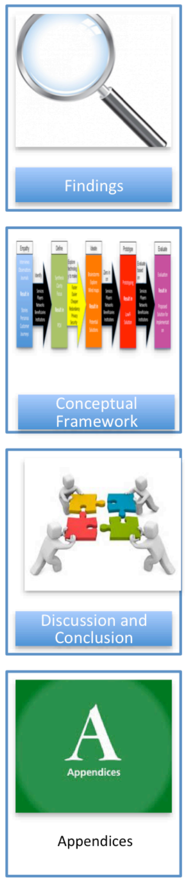
for

Matipa

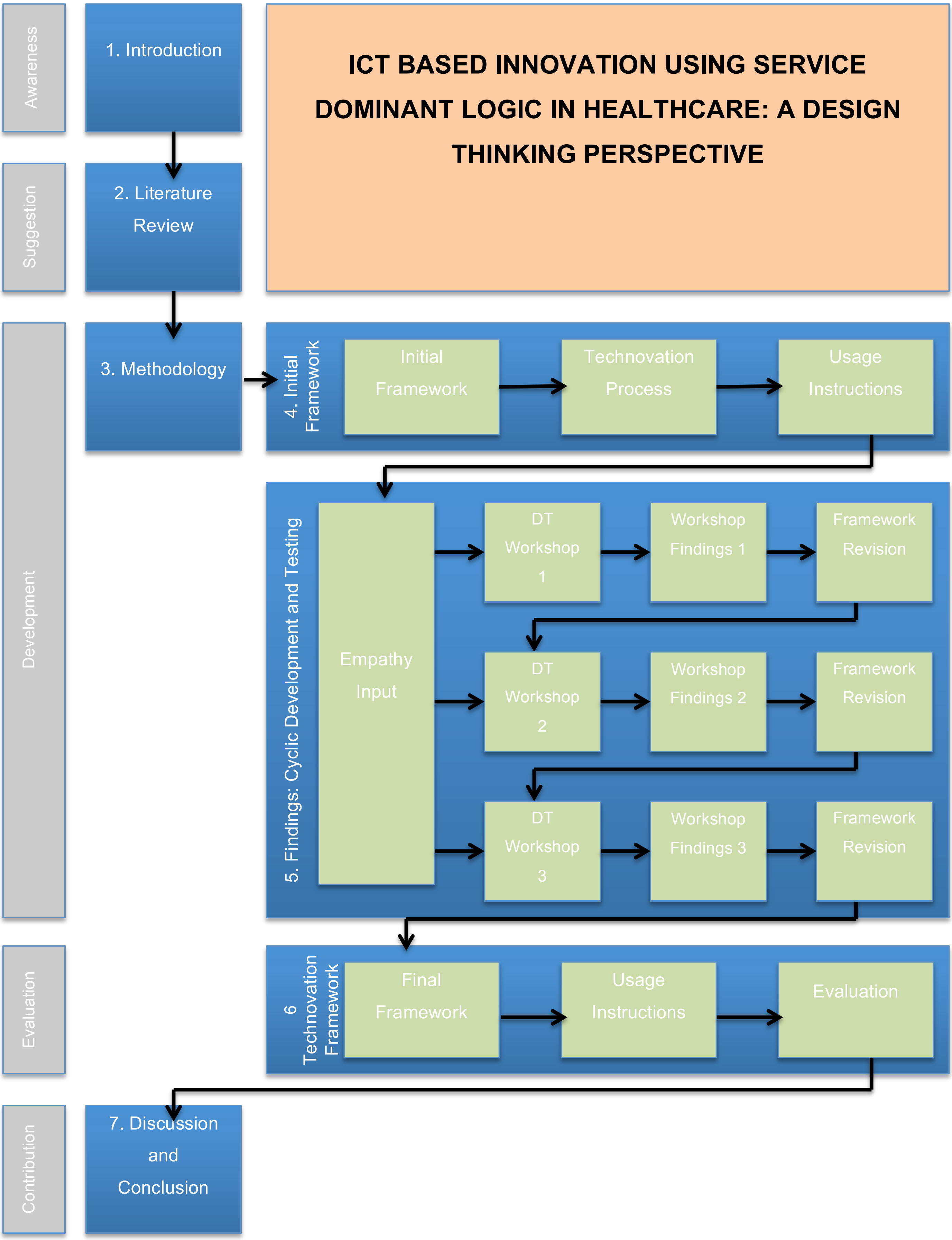
Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
CF	Conceptual Framework
DSR	Design Science Research
DT	Design Thinking
EMR	Electronic Medical Record
ERP	Enterprise Resource Planning
FP	Foundational Principles
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technologies
IDEO	A global design firm that takes a human-centred, design-based approach to helping organisations in the public and private sectors innovate and grow.
IS	Information Systems
ISO	International Standards Organisation
PALANTE	PAtients Leading and mANaging their healThcare through e-Health
POV	Point of View
SAP	Systems Application Products; German software used in many industries
SDL	Service Dominant Logic
USSD	Unstructured Supplementary Service Data
WHO	World Health Organisation
ZIMASSET	Zimbabwe Agenda for Sustainable Social-Economic Transformation





1. Introduction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Plan for what is difficult while it is easy, do what is great while it is small.

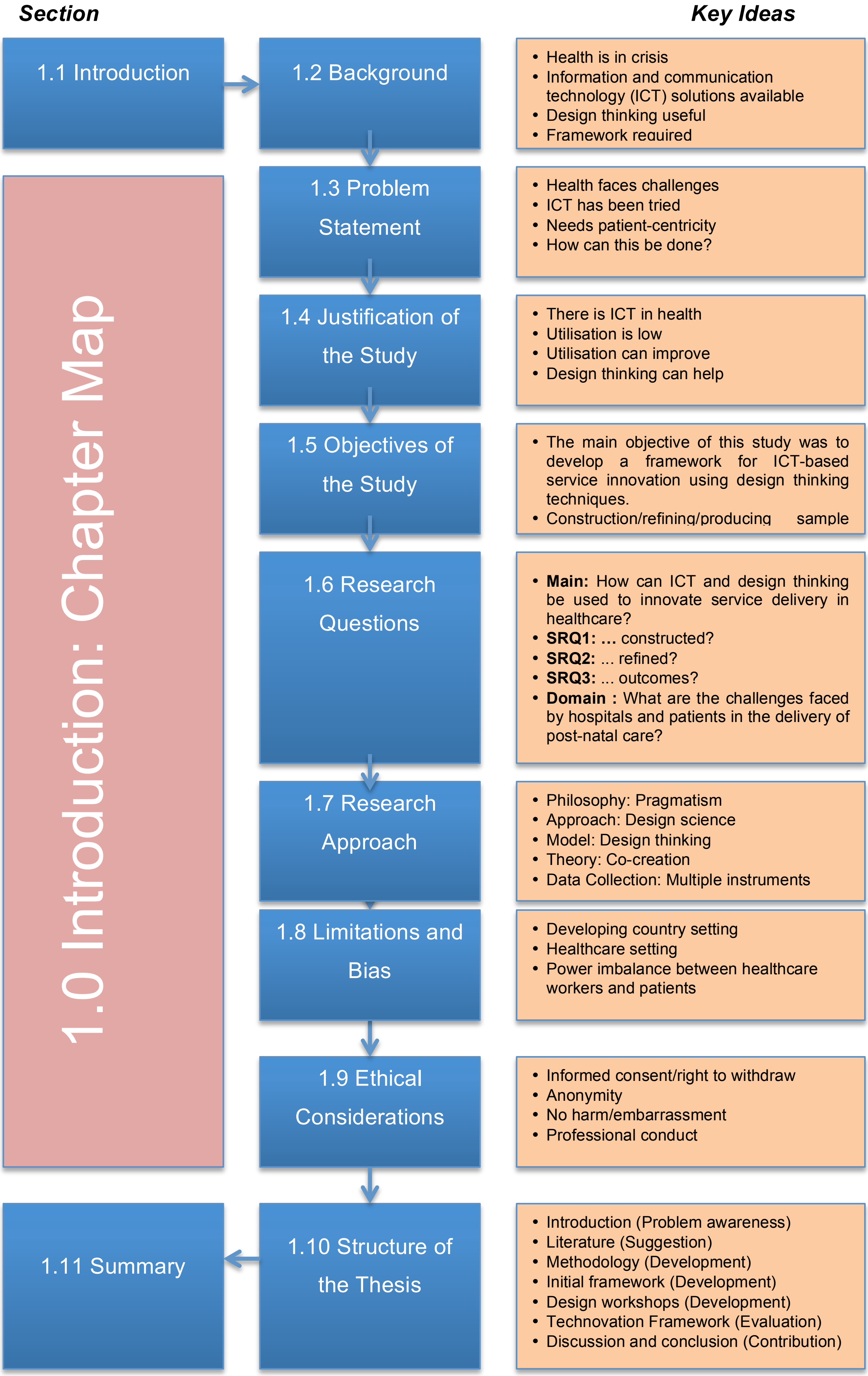
The Art of War

Sun Tzu

Innovation in health care is not a complicated issue. It is a complex issue.

Simple: Baking a cake
Complicated: Sending a rocket to the moon
Complex: Raising a child
Chaos: Politics

(Plesk, 2003)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1 INTRODUCTION

1.1 Introduction

Health professionals in the developing world face the challenge of growing populations requiring services and dwindling resources in the face of reduced or stagnant funding (Dixon et al., 2002). Developments in information and communication technologies (ICT) present an opportunity to innovate and streamline service delivery in a way that maximises the meagre resources available to health institutions. Such innovations require the support of the public that the health institutions serve. Design thinking has over the last 20 years developed into a “design paradigm” (Plattner et al., 2012) that can assist service providers to craft solutions to problems that take into account the circumstances of stakeholders involved.

The purpose of this study was to provide a framework through which the power of ICT can be harnessed in the crafting of solutions that are relevant to those who wish to use the services of the healthcare sector. Such a framework may be of relevance to policy makers in the healthcare sector, healthcare practitioners and designers of ICT solutions for the healthcare sector, as well as researchers who continue to look for solutions to challenges faced by the sector. A framework that is based on the ideas of design thinking and co-creation could lead to the development of solutions that take into account the views of those for whom the solutions are being developed in a timely and cost-effective manner. The involvement of the target population in solution development ensures the buy-in of the population.

Through this study, the Technovation Framework was developed for use in driving innovation through the use of ICT. Healthcare professionals and ICT professionals, working with beneficiaries of their services, assisted in the continued development of the framework, through design thinking workshops that followed the guidelines provided by the conceptual framework. The workshops resulted in the development of seven prototypes of potential solutions for use in the community. Pragmatism was adopted as a philosophical stance, while design science research (DSR) was adopted as the research strategy, in which the framework was the main artefact produced.

This work is presented in seven chapters, starting with this introductory chapter, which outlines the problem area and sets out a roadmap for finding a solution. Chapter 2 covers the literature, offering potential solutions through how ICT is currently used in healthcare, how innovation is conducted, the co-creation of value between organisations and those whom they serve, as well as ideas behind design thinking. Chapter 2 is concluded with a proposal for a framework whose development becomes the subject of the remainder of this work. Chapter 3 discusses the methodological considerations taken into account and reinforces the appropriateness of a pragmatic philosophical paradigm and the use of design science as the research strategy. The theoretical basis provided in

Chapter 3 concludes with a roadmap for the research journey and discusses the various instruments employed in answering the research questions. Chapter 4 discusses the initial development of the Technovation Framework from a conceptual basis and lays outestablishes the basis for its use. Chapter 5 begins with a presentation of the results of a research project in the work and lives of those involved in post-natal care, positioning this as test data for use in the further development of the Technovation Framework. The rest of Chapter 5 describes several design cycles that are used to refine the development of the framework. Chapter 6 describes the final version of the tested Technovation Framework, leading into Chapter 7, which discusses the findings of the study and presents concluding ideas.

1.2 Background

Chandrasekhar and Ghosh (2001) point to three ways in which ICTs can drive service innovation in the healthcare sector, a field that has come to be known as e-health. Firstly, ICTs can be used to inform and train healthcare workers on the latest advances in the field, providing them with access to techniques and information on drugs, as well as diseases and their cures. Secondly, dissemination of information on disaster management services to places that are difficult to access is made easier through the use of ICT. Thirdly, the use of ICT has the capacity to improve transparency and accountability, leading to greater availability and quality of service. Wickramasinghe et al. (2005) describe a range of goals of e-health, cautioning that e-health is more than just the use of the internet in medicine, a position that is in line with the approach adopted in this paper. e-Health drives efficiency through improved communication, while increasing quality of service. e-Health has the capacity to empower consumers and patients, while providing a platform to educate healthcare providers. e-Health redefines the geographical scope of service delivery, while also redefining the relationship between patients and service providers.

The PALANTE ('PAtients Leading and mANaging their healThcare through e-Health') project, run across several European countries, focussed on researching the effects of giving patients access to their own data. The goal of the project was to make ICT tools available to patients to encourage them to remain in contact with healthcare providers and take ownership of the process of delivering health services to them. The project was aimed not only at lowering the cost of service delivery, but also at improving its quality and efficiency (Competitiveness and Innovation Framework Programme, 2014). In a paper advocating faster and more effective research in e-health, Baker et al. (2014) advocate the conduct of small, discrete studies that use efficient designs, but with a universal and timeless focus. Researchers are urged to look outside the traditional boundaries of health and attempt to anticipate the next 'big thing' and look for models that push against the boundaries of current practice.

Service innovation focuses on finding new ways of delivering services that are already being delivered or delivering totally new services that add value for end users (Wylant, 2008). Despite services contributing to a large percentage of the United States of America's (USA) economy, innovation activities have traditionally been focused on products instead of services (Bitner et al., 2008), a situation that is changing. Researchers argue that technology, knowledge and networks are the key drivers of service innovation (Kandampully, 2002).

Design thinking is a human-centred approach to problem-solving that moves beyond the rational and analytic but looks to utilise intuitive and pattern-recognition abilities to suggest functional products and services that appeal to their users emotionally (Brown & Wyatt, 2010). Products and services built on assumptions about user preferences fail to fulfil the needs of those for whom the products and services are designed. Proponents of design thinking argue that the perspective of end users of products and services are brought to the fore and when used together with rapid prototyping, more effective solutions are quickly found (Brown & Wyatt, 2010). While arguing that users' ideas are often difficult to convert into commercial services, Magnusson et al. (2003) concede that users do make a positive contribution if their role is properly managed.

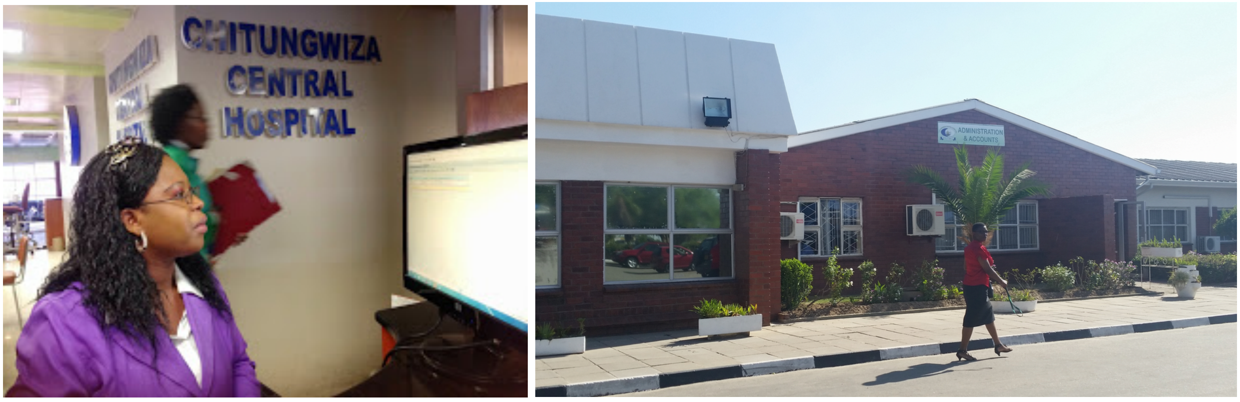
Brown and Wyatt (2010, p.32) describe design thinking as "optimistic, constructive and experiential", offering a pragmatic approach to building solutions that the end users value. Brown (2008) describes a design thinking exercise as consisting of three phases: inspiration, ideation and implementation. During inspiration, designers are involved in processes to identify problems or opportunities and understand constraints while looking for hidden assets, ideas and expertise within the business, while synthesising possibilities for solving problems. In the ideation phase, brainstorming is used to create scenarios, which in turn are used to build frameworks and prototypes, all the while engaging customers and other stakeholders. Finally, during implementation, the vision is executed and the message spread to the community.

Design thinking is consistent with the ideas of co-creation of Prahalad and Ramaswamy (2004), in which customers co-construct the products or services to be enjoyed, allowing them to participate in defining the problems as well as the solutions to these problems. Co-creation is concerned with engaging customers in creating value, as opposed to organisations going out of their way to please customers. Co-creation aims to create experiences that suit the customers' context through joint problem definition and problem-solving. Co-creation promotes active dialogue with customers so that their experience of a product or service is personalised. The European Union (EU) (2014) describes co-creation as providing multiple sources of innovation for an organisation through the involvement of its customers, encouraging cross-fertilisation and idea generation through sharing of ideas and experiences. Co-creation is seen as leading to ways of bringing innovations to the market more quickly and at lower cost. In addition to the direct benefits of innovation, co-creation is seen as resulting in greater customer loyalty, greater perceived value of the organisation's products and services, as well increased chances of eliciting positive sentiments towards the organisation.

Voorberg et al. (2013), in reviewing literature on co-creation and co-production, note no significant differences in the use of the words co-creation and co-production. According to their study, co-creation/co-production is credited with resulting in more effective and more efficient processes that lead to greater customer involvement and satisfaction. In a majority of studies cited in the review, co-creation/co-production is seen in itself as a source of value for customers. Co-creation/co-production is viewed as being consistent with organisational cultures that are open to customer participation, risk-averse, shaped to accept customer input and in a position to benefit from win/win situations. On the customer end, general awareness, a desire to belong, ownership of basic skills required to play a part and an aversion to risk contribute to a successful partnership in a co-creation/co-production engagement. Similar arguments are presented by Lusch and Vargo (2006, p.281) in discussing the "reactions, reflections and refinements" to their earlier article on evolving to a new dominant logic, the service dominant logic (SDL), for marketing (Vargo & Lusch, 2004). Lusch and Vargo (2006) further adopt the view that co-creation is superordinate to co-production.

This study is based on work done at Chitungwiza Hospital, located in a township outside Harare, Zimbabwe. Seen from outside, Chitungwiza Hospital is a typical third-world hospital, located in a township with a population of 1,2 million, 30 kilometres from Harare. A series of single-storey buildings house the administration, outpatients departments, clinical departments and mortuary. Inside, wards have recently been refurbished with the help of private companies as part of corporate social responsibility initiatives. Government funding is limited and many of the patients who come from the neighbourhood cannot afford the services. Driven by a practising physician who doubles up as the hospital's chief executive officer (CEO), the hospital has continually defied the odds by remaining viable despite the precarious financial situation in which it finds itself. Rallying the staff to focus on improving processes through the implementation of the International Standards Organisation (ISO) quality standard 9001, the hospital is seen as a trailblazer in improving service delivery, despite its humble environs.

Figure 1: A receptionist captures details of a new patient (left) Administration block (right)



Chitungwiza hospital is part of the public healthcare system in Zimbabwe. The health system is structured around five nationally administered central hospitals that deliver quaternary level care, serving as the ultimate referral centres for complex problems and specialist care (Ikeogu, 2018). These are supported by several provincial healthcare institutions such as Chitungwiza Hospital, offering tertiary level care and basic specialist care such a obstetrics and gynaecology, oncology and general medicine. Secondary level healthcare is provided through district hospitals, typically manned by a district medical officer (doctor) and several nurses. These district hospitals in turn support up to a dozen downstream clinics, as well as primary level healthcare workers located in villages and wards. In towns the district level hospitals are typically owned by local authorities such as the municipality, while in the rural areas mission-owned hospitals play a significant role at the district level. In the years since independence in 1980, a private healthcare system has mushroomed in the face of a decaying public healthcare system. Privately owned clinics, typically owned by the same doctors that man the public hospitals, work hand in hand with the public healthcare system to provide a slightly more reliable, albeit more expensive service. In the capital city, several medical aid insurers have set up their own hospitals that operate at similar levels as the provincial hospitals, along with supporting clinics in the case of the largest of the medical insurers. Patients who need highly specialised care and can afford the expense are typically refered to facilities in South Africa.

Chitungwiza Hospital has a complement of 400 beds for inpatient treatment, 350 nurses and 40 doctors. The hospital, which is owned by the government of Zimbabwe, was built in 1984 and has grown steadily to its current size (Ndhlovu-Dumbeni, 2012). In 2011, the government of Zimbabwe embarked on an initiative to modernise government operations through the use of technology. As part of a broader e-government initiative code-named ZimConnect, the government chose Chitungwiza Hospital as the pilot implementation of the e-Health initiative, based on the System Application Products' (SAP) HealthCare solution. This project, which has operated in a live environment since June 2013, covers not only the supporting functions such as finances, human resources and plant maintenance, but also the core of the business concerning patient management and clinical and ambulatory services. This system has been complemented by a platform based on the short message service (SMS), which allows the hospital to communicate with its patients as well as the public at large.

The researcher's involvement with the government of Zimbabwe in the implementation of this project, as well as the relationships built over the last 20 years during which the researcher has been involved in implementing various SAP initiatives in government, allowed unprecedented access to the people who became part of this study. The CEO of the hospital gave written approval for this study to proceed, focusing the researcher's efforts on the provision of post-natal care to new mothers and their babies. The importance of this area is highlighted by the World Health Organisation (WHO) (2015), which notes that while considerable progress has been made in improving post-natal care, in 2013 alone, 2.8 million babies worldwide died within a month of birth. One million babies died within 24 hours of being born. While the WHO issues strict guidelines on the provision of post-natal services, the healthcare sector in Sub-Saharan Africa fails to meet many of the guidelines owing to chronic shortages of resources and inefficient service delivery.

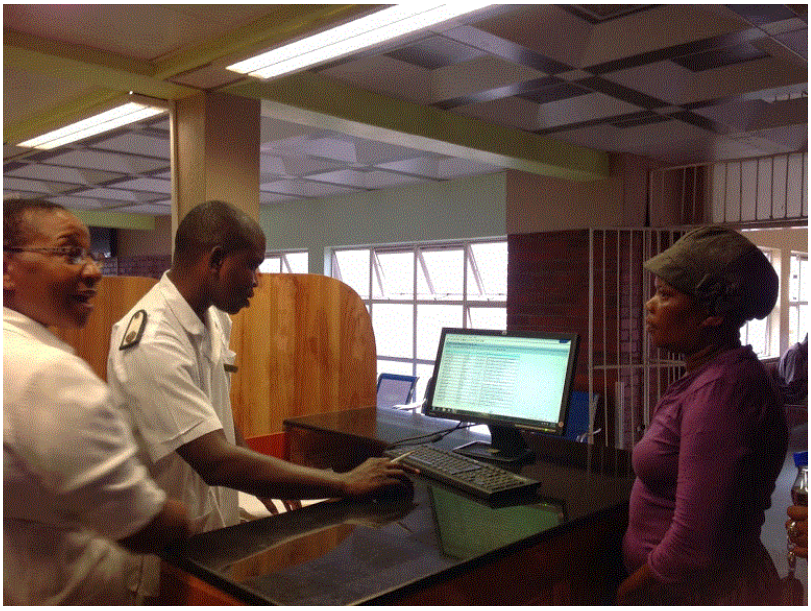


Figure 2: An admissions nurse captures a patient's vital statistics while an SAP consultant observes the process

(Out of the picture: The patient was standing on a scale and was having her height and weight checked)

1.3 Problem Statement

The healthcare industry is faced with the challenge of having to do more with fewer resources (Dixon et al., 2002). In Europe, a decrease in fertility, coupled with a post-world war baby boom, increased longevity and a net migration pattern, has placed additional pressure on health delivery systems (Di Pasquale et al., 2013). Developing countries feel the additional pressure of having to offer services to marginalised communities (Jahan & Chowdhury, 2014). Increasingly available ICT resources present an opportunity to introduce service improvements that take advantage of technology. Patel et al. (2014) argue that cost concerns have led to the incorporation of technology into service delivery in the healthcare sector. Out-of-hospital monitoring and treatment follow-up have been made possible by the use of ICT (Gund et al., 2012). A desire to place the patient at the centre of service delivery has also brought ICT to the forefront of healthcare (Klecun, 2014). Using ICT to get a better view of the patient has brought about efficiency by combining social care and medical care (Müller et al., 2012). ICT is seen as a way of bridging the gap in medical service offering between the urban and rural citizens of South Africa (Ruxwana et al., 2010).

While specialists working closely with the users of these systems have traditionally deployed ICT systems, an opportunity exists to extend this to include the people who benefit from the systems. In the healthcare sector, these beneficiaries include not only the patients who need attention from hospitals and other healthcare institutions, but also their families and the ecosystem around the institutions that work together to deliver a service to them. In setting the agenda for research in medical informatics in the next 10 years, Ückert et al. (2014) advocate research that puts the patient in a position of influence.

> *An initiative involving all stakeholders is needed, where the patients could be the driving force. Informed patients with their own medical data at hand might even change society as a whole.*
>
> (Ückert et al., 2014, p.3)

Watkins et al. (2015), in discussing the challenges of undertaking a user-centric approach in the developing world, based on a study on deploying medical solutions in Zambia, point to culture and language as inhibitors of successful innovation. Despite these examples, no framework exists to help practitioners conduct the work that Ückert et al. (2014) argue for.

1.4 Justification of the Study

The literature is replete with studies of implementation and adoption of ICT in the healthcare sector. Frameworks have been developed before for readiness (Chattopadhyay et al., 2008), review (Tsiknakis & Kouroubali, 2009), evaluation (Ammenwerth et al., 2004; Noir & Walsham, 2007), and decision-making (Cardno, 2000). Lopez and Bernd (2009) provide a framework for the development of projects in healthcare informatics, while van Reijswoud (2009) provides a framework for deploying systems in a developing world setting. The difference in this study is that it develops a framework that can be used not only for developing or deploying new ICT systems, but also to give guidance on how innovation can be driven using new and existing technology capabilities.

Many institutions, including those in the developing world, have deployed some levels of systems, or find themselves in environments where systems are available to them either as part of broader government initiatives, as low-cost cloud-based offerings or other public offerings. Nevertheless, utilisation of these platforms is low because ICT-based innovation is only associated with large-scale implementations of ICT platforms. This study takes a pragmatic view that encourages healthcare professionals to look around in their environments, understand the challenges they face and come up with relevant solutions that exploit the technological capability at their disposal.

Having worked with a number of governments in the developing world in implementing various initiatives over a 20-year period, the researcher has become disillusioned with systems that are deployed, but are not utilised to their full potential and whose usefulness rapidly diminishes with the passage of time. The reason for the debility of many of these systems is not lack of skills in the systems per se, but having organisations delimiting the use of the systems they purchase to that which was defined at the time of implementation. Many of these systems are deployed as 'best practice' implementations, limiting customers to that which the vendor believes they need in the interest of quickly completing the project. Highly flexible mobile-based applications have been easily available and their implementation is within reach of many institutions in the developing world. This research, from a personal perspective, will fulfil a desire to see institutions do more with what they invested in, or could easily access, while at the same time offering more value to their customers.

Commercially, this study builds a framework that provides an opportunity for customers of systems such as SAP HealthCare to re-examine their service provision and try to maximise the use of the technology in which they have invested. Alternatively, these customers could look at low-cost systems, such as mobile applications or cloud-based applications that are readily available for possible implementation. While this may not result in as much commercial business as would emanate from complete re-implementation of systems, customer satisfaction levels are likely to result in further business for the providers and implementers and to generate more goodwill for products and services offered.

Lindberg et al. (2012) argue that empirical evidence needs to be found on how design thinking can be conceptualised and applied in the ICT industry, especially focusing on how it can be imparted and implemented in organisations. This study adds to the body of knowledge on the use of design thinking in innovation in the ICT sector. The study would also interest policy makers and healthcare practitioners, ICT practitioners, as well as academics who have an interest in health informatics. Co-creation in innovation is an area that continues to attract attention in various sectors and this work is also likely to be of relevance to practitioners in this area.

1.5 Research Questions

The purpose of this work was to develop a framework for service innovation using ICT in healthcare. The work exploits the ideas of SDL, technology capabilities and design thinking. The resulting framework was tested in a healthcare setting, focusing on the provision of post-natal care service. The following research questions were posed to guide the research process:

Main Research Question (MRQ)
How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

Sub Research Question 1 (SRQ1)
How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?

Sub Research Question 2 (SRQ2)
How can the Technovation Framework be refined in an e-health environment?

Sub Research Question 3 (SRQ3)
What are the outcomes of using the Technovation Framework in an e-health environment?

In order to help answer these research questions, it was essential to understand the domain in which the research would be conducted. To gain this understanding, one domain-level research question was addressed.

Domain Research Question (DRQ)
What are the challenges faced by hospitals and patients in the delivery of post-natal care?

The penultimate chapter of this work, Chapter 6, is presented as an answer to the MRQ, but also presents in summary the answers to the other research questions. In response to SRQ1, Chapter 4 provides an overview of the construction of the Technovation Framework, whose key constructs are first proposed at the end of the literature review in Chapter 2. Chapter 5 describes the process followed in refining the Technovation Framework and provides an answer to SRQ2. The outcomes of using the framework are presented in Chapter 5 in the form of prototypes developed by the design teams that use the Technovation Framework. A final prototype is described in Chapter 6, along with a presentation of the final versions of the Technovation Framework and process. The DRQ is answered in Chapter 5 in preparation for the design workshops that use the Technovation Framework.

Figure 3 presents the core elements of this study and they way in which they relate to these research questions.

Figure 3: Core elements of the study

Problem

Advances in ICT offer an opportunity for the healthcare sector to streamline service in a manner that takes into account the needs of those who use these services. While many health institutions, even those in the developing world, have implemented or have reasonably easy access to systems that can enhance their service, few institutions actively consider ways to incorporate these systems in innovations to improver service delivery.

Purpose

The purpose of this study is to develop a framework that can be used to employ information and communication technology in improving service delivery.

Research Questions

How can information and communication technology and design thinking be used to innovate service delivery in healthcare? In order to answer the main research question, the thesis focuses on a healthcare setting and post-natal care services in particular. The following SRQs are posed and addressed in tackling the objectives of this study:

- SRQ 1: How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?
- SRQ 2: How can the Technovation Framework be refined in an e-health environment?
- SRQ 3: What are the outcomes of using the Technovation Framework in an e-health environment?
- DRQ: What are the challenges faced by hospitals and patients in the delivery of post-natal care?

1.6 Objectives of the Study

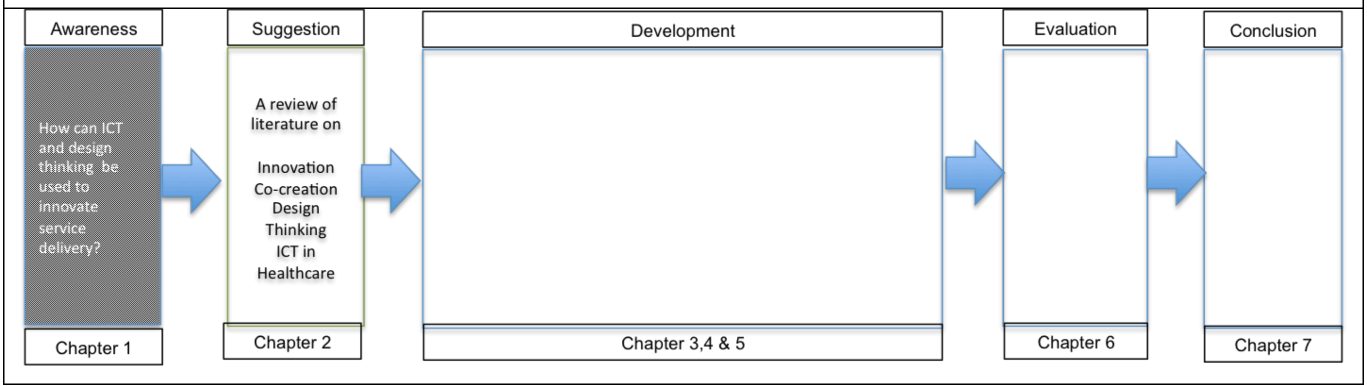
The main objective of this study was to develop a framework for ICT-based service innovation by adopting a design thinking perspective. This framework was refined in a healthcare setting. Figure 4 summarises the objectives of this study and indicates where they are addressed in the study.

Figure 4: Addressing the study objectives and questions				
	Research Objective	Research Question	Addressed in	Evidence
MRQ	To develop a framework for ICT-based service innovation using design thinking techniques. This framework is tested and enhanced in a healthcare setting.	How can ICT be used to innovate service delivery in healthcare?	Chapter 6	Technovation Framework and process
SRQ1	To construct a framework that guides technology-based service innovation	How can a Technovation Framework that guides technology-based service innovation be constructed?	Chapter 4	Technovation Framework and process
SRQ2	To refine the Technovation Framework in an e-health environment	How can the Technovation Framework be refined in an e-health environment?	Chapter 5	Technovation Framework and process
SRQ3	To produce sample prototype solutions through the use of the Technovation Framework and process.	What are the outcomes of using the Technovation Framework in an e-health environment?	Chapter 5	Prototypes
DRQ	To obtain domain knowledge and identify a problem to be solved using the Technovation Framework	What are the challenges faced by hospitals and patients in the delivery of post-natal care?	Chapter 5	Health workers' and mothers' perspectives

1.7 Research Approach

This study was initiated on the understanding that more could be done with ICT in innovation to improve service delivery. The research approach adopted was to undertake a DSR project that could deliver a 'tool' that could be used, in a service setting, to drive the innovation process. Adopting pragmatism as a philosophical stance, the researcher undertook a review of the literature on ICT in healthcare/e-health, innovation, co-creation and design thinking. This led to a suggestion of a solution in the form of the Technovation Framework. In order to test the Technovation Framework and develop it further, the researcher, in consultation with a potential user institution, chose the area of post-natal care as the area of application and set out to understand the challenges faced in delivering and using services.

Figure 5: The research journey: Awareness



The researcher interviewed doctors and nurses to understand the challenges faced in delivering post-natal care to mothers and their new-born children. This was followed by an in-depth study into the lives of the mothers in the eight weeks after giving birth, in which the researcher captured the challenges they faced in accessing services from the healthcare system. The output of these two studies was used as input into a series of design thinking workshops conducted with mothers, midwives, systems designers and developers. Workshop participants were challenged, using the Technovation Framework developed as part of this study, to explore how technology could be used to innovate post-natal care. To triangulate the results, the finalised framework was tested in a different healthcare setting and this resulted in the development of a mobile application prototype.

Design science is research that results in the creation and evaluation of artefacts that solve identified organisational problems (Hevner et al., 2004). These artefacts include among others software, formal logic, rigorous mathematics and informal natural language descriptions. Vaishnavi and Kuechler (2015) distinguish between design science and DSR, arguing that the former is knowledge in the form of constructs, techniques and methods, models and theory. DSR, on the other hand, is research that leads to the development of this knowledge. Peffers, Tuunanen, Rothenberger, and Chatterjee (2008) argue that DSR must, out of necessity, follow a rigorous process in observing problems, asking research contributions, evaluating designs and communicating results.

Dalsgaard (2014) advocates the use of pragmatism as a philosophical stance when undertaking design-thinking studies, basing his arguments on how design thinking resonates with the work of pragmatist philosopher John Dewey. Pragmatism offers a “practical and outcome-oriented method of inquiry that is based on action and leads, iteratively, to further action and the elimination of doubt” (Johnson & Onwuegbuzie, 2004, p.17). Pragmatism allows the research to cope with the “dynamic, complex, and partially predictable multiple influences” (Johnson & Christensen, 2012, p.34) that one is likely to encounter in the environment, such as the one proposed for this project. This work is undertaken using a pragmatist and DSR philosophy.

Table 1: Research Approach			
Research philosophy	Pragmatism		
Research strategy	Design Science Research		
Theory	Service-dominant Logic, Design Thinking		
Data Collection	Focus Groups	Interviews	Participant Observation
Data Analysis	Content analysis		

Table 1 summarises the main research approach decisions.

1.8 Limitations and Bias

The limitations of the Technovation Framework developed in this study relate to the domain in which it was developed and validated and the solutions proposed. Although the Technovation Framework is applicable to any service industry, its development and validation were undertaken in a healthcare setting. Its applicability would need to be tested in other industries. Its use in any other industry would be governed by the industry rules that govern service delivery in that industry. Secondly, the framework was used to develop prototypes of mobile application solutions. While this was purely for practical reasons, its application for problems that employ any other technology solutions that meet the desired technology capabilities remains untested. Thirdly, the testing of the solution in a developing world setting meant that the solutions proposed were biased towards greenfield environments where there are few existing solutions. Using this framework in any other setting would have resulted in solutions that interfaced into many existing solutions. While the scoping of interfaces to other solutions is envisaged in the design, none of the prototypes proposed explored this.

1.9 Ethical Considerations

In considering an area to investigate, Oates (2006) recommends that one considers whether the work will be ethical. In this, one should consider whether the work could be done without breaking the law or bringing harm to self or others. Oates (2006) also recommends that the work being undertaken should remain within the ethical guidelines as agreed on by academic researchers. This work was guided by the recommendations of the Committee for Research Ethics and Integrity of the Faculty of Engineering, Built Environment, and Information Technology (see Appendix F), whose approval was sought at the start of the project. Further ethical approval to conduct research in the healthcare sector was granted by the Faculty of Health Sciences (see Appendix G)

Participants to this study retained the right not to participate if they so wished. They retained the right to withdraw if they no longer wished to continue with the study. Prior to giving consent, participants were informed of the purpose of the research, the drivers of the research, what would be involved, feedback that would be available and the purpose for which data was collected. Participants had the right to remain anonymous and their confidentiality was protected. As an ethical researcher, the researcher was committed to ensuring that no unnecessary intrusion took place, professional codes of conduct were followed and integrity was observed at all times. Bloomberg and Volpe (2012) point out that research should not embarrass or harm participants or place them in the way of political risks, even though results have been represented fairly and accurately. The guideline of Bloomberg and Volpe (2012) was followed in conducting this research.

1.10 Structure of the Thesis

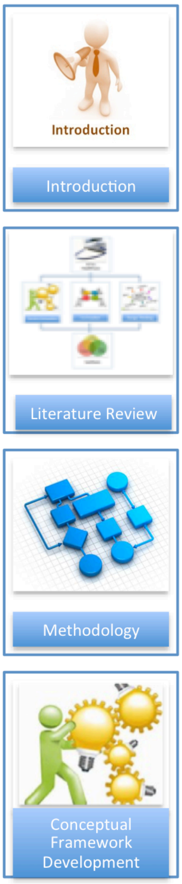
The focus of this study was to understand how ICT capabilities could drive improvements in service delivery. This thesis follows the structure proposed by Gregor and Hevner (2013) and is presented in seven chapters. Chapter 1 introduces the proposed work and justifies why it is necessary. This chapter also addresses the research approach in outline, touching on the philosophical stance, theory employed, limitations and bias, as well as ethical considerations.

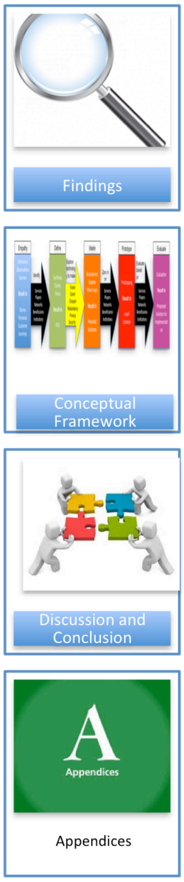
Chapter 2 of this work is a literature review, which begins with the description of a framework that is used to address the existing literature on the areas relating to this study. The ABCDEFS framework allows the researcher to delve into the aspects of what a concept is about, its background, complexities, description, examples of studies, findings and a synthesis of the different concepts being studied. Following this introductory section, this work proceeds to the review itself, which is broken up into four sections. The first section gives an overview of the work that has been done in the area of ICT in healthcare in order to derive maximum value from existing work. The rest of the sections that form the second chapter of this study give an overview of the tools that can be used to develop a framework for improving service delivery using ICT in healthcare. The three areas investigated as part of these sections are service innovation, co-creation and design thinking. The concept of service innovation is of particular interest, as service innovation is central to finding new ways of working, offering services, reaching out to customers or patients, remaining in contact with them or receiving feedback from them. Healthcare focuses on the provision of services to people and any innovation in this field should involve the people for whom the services are being designed. Therefore the concept of co-creation of services presents, in addition to service innovation, another area of interest. The final area of investigation is the use of design thinking and how it has previously been used or can be used to guide innovation in healthcare. While rooted in the information systems domain, theoretically this work borrows from work in marketing (innovation and co-creation) as well as the field of design.

The focus of Chapter 3 is the methodology adopted for this project, providing justifications for the use of pragmatism and a DSR approach, as well as the data collection tools employed. This section also discusses the approach taken in developing the Technovation Framework, whose actual development is documented in Chapter 4. Chapter 4 also discusses the usage of the Technovation Framework. Chapter 5 begins with an extensive study into post-natal care provision, which is used to refine the framework. The Technovation Framework is refined in the work that is presented in Chapter 5, which takes the reader through a series of design thinking workshops that employ the framework. Chapter 6 discusses the final Technovation Framework, incorporating knowledge gained from the empirical evaluation undertaken in Chapter 5. Chapter 7, the final chapter of this work, discusses the research journey and provides recommendations and reflections.

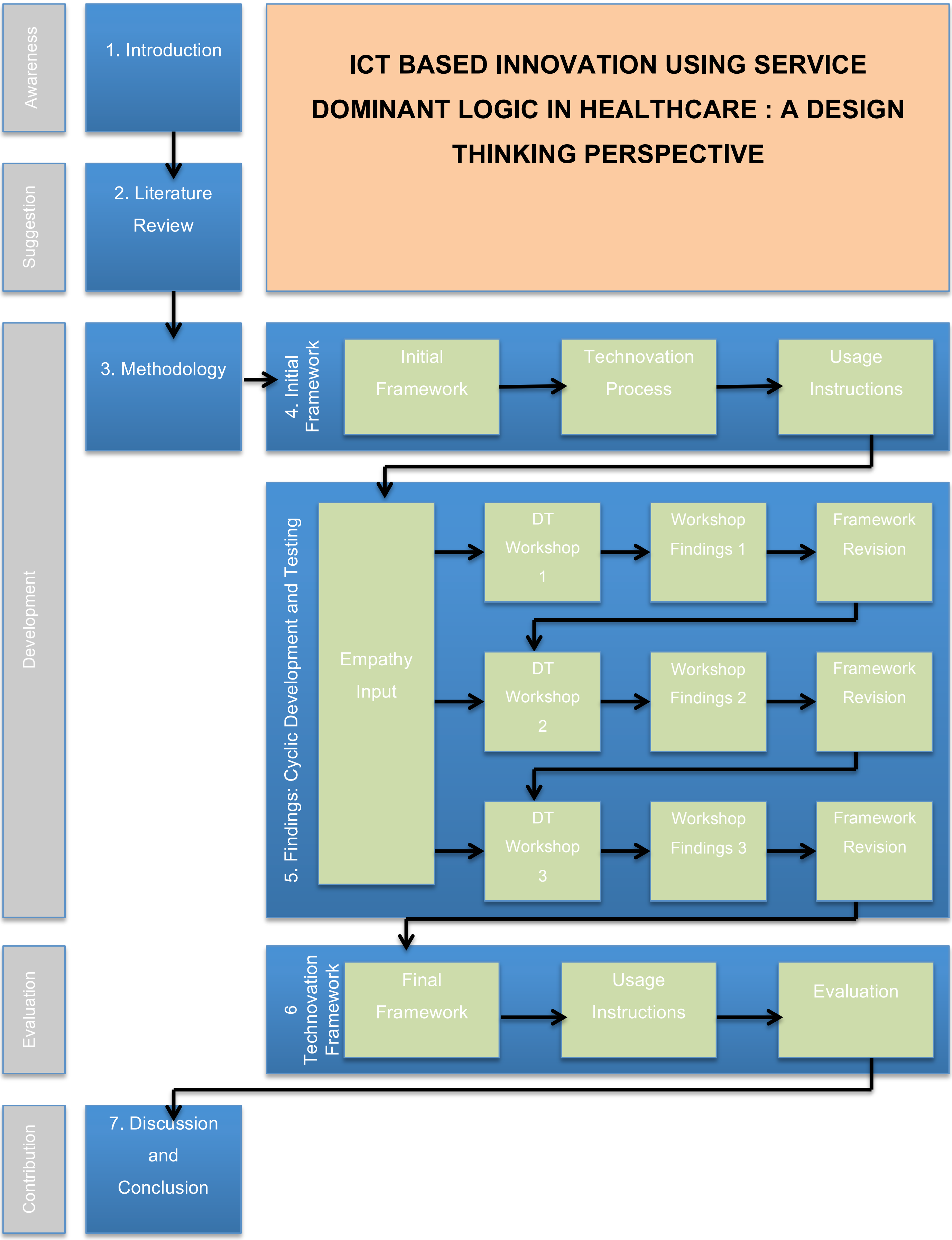
1.11 Summary

This chapter explored the use of ICT in healthcare and proposed the development of a framework that can be used in the deployment of ICT-based solutions. This chapter introduced the concepts of innovation, co-creation, and design thinking and explored some work that is already being done in researching the use of ICT in healthcare. Having presented this background, a number of questions were posed and a brief overview of how this research was conducted was provided. It is hoped that this work will not only add to the body of knowledge about the use of ICT in the healthcare sector, but also build much needed empirical evidence on the applicability of design thinking in the ICT sector. Co-creation in innovation is an area that continues to attract attention in various sectors and this work may be of relevance to innovation practitioners. The Technovation Framework developed as part of this study has been found to be effective in helping designers to gain a basic understanding of user requirements rapidly for use in further development work.



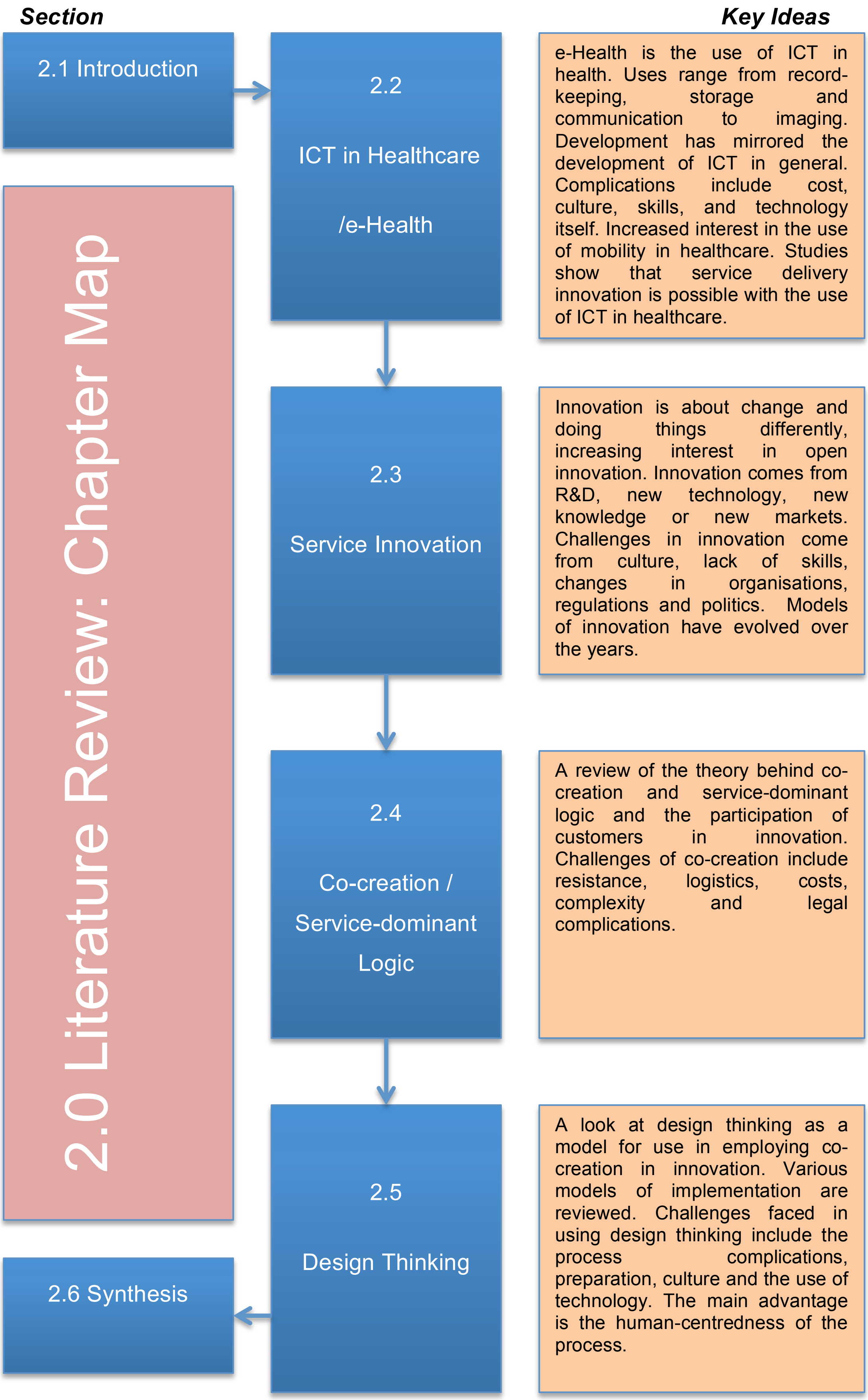


2.
Literature Review


Awareness
1. Introduction
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
Suggestion
2. Literature Review
Development
3. Methodology
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings: Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
Evaluation
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
Contribution
7. Discussion and Conclusion

If I have seen further it is by standing on the shoulders of giants.

Sir Isaac Newton

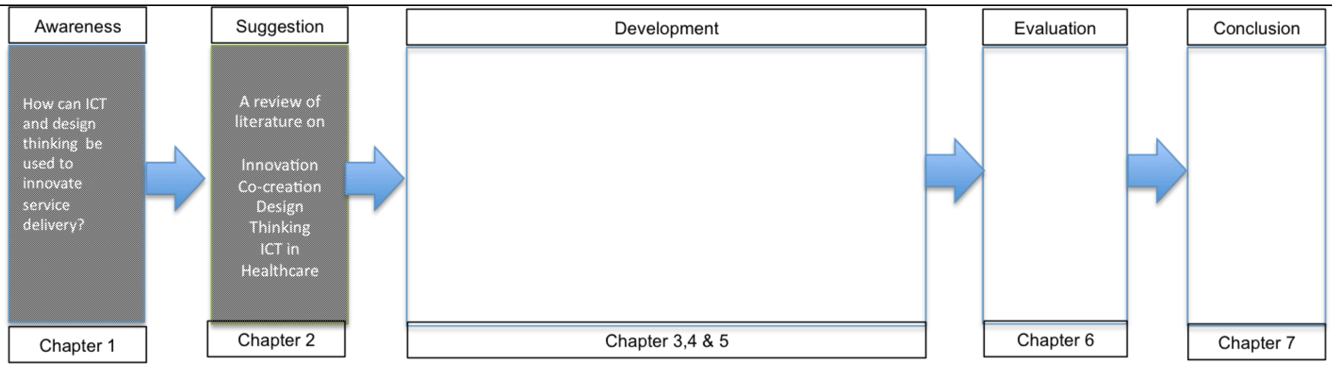

Section
Key Ideas
2.0 Literature Review: Chapter Map
2.1 Introduction
2.2
ICT in Healthcare
/e-Health
e-Health is the use of ICT in health. Uses range from record-keeping, storage and communication to imaging. Development has mirrored the development of ICT in general. Complications include cost, culture, skills, and technology itself. Increased interest in the use of mobility in healthcare. Studies show that service delivery innovation is possible with the use of ICT in healthcare.
2.3
Service Innovation
Innovation is about change and doing things differently, increasing interest in open innovation. Innovation comes from R&D, new technology, new knowledge or new markets. Challenges in innovation come from culture, lack of skills, changes in organisations, regulations and politics. Models of innovation have evolved over the years.
2.4
Co-creation /
Service-dominant
Logic
A review of the theory behind co-creation and service-dominant logic and the participation of customers in innovation. Challenges of co-creation include resistance, logistics, costs, complexity and legal complications.
2.5
Design Thinking
A look at design thinking as a model for use in employing co-creation in innovation. Various models of implementation are reviewed. Challenges faced in using design thinking include the process complications, preparation, culture and the use of technology. The main advantage is the human-centredness of the process.
2.6 Synthesis

2 LITERATURE REVIEW

2.1 Introduction

The main objective of this study is to develop a framework for ICT-based service innovation using design thinking techniques. The study considers the employment of SDL theory and ICT capabilities to improve design-thinking processes. Chapter 1 of this work creates awareness of the area of interest and the current chapter explores the literature to identify concepts that can be used to develop a conceptual framework for use by practitioners in this area.

Figure 6: The development journey: Suggestion and awareness



This chapter presents a review of the literature related to this study. The literature is presented according to the ABCDEFS framework developed as part of this study and summarised in Table 2. This ABCDEFS framework is based on the work of Boote and Beile (2005). In line with this framework, the goal is first to understand what a concept entails and then to provide the vocabulary associated with the concept. Secondly the background of the concept is investigated; in order to place the research in the historical context of the field and in the broader context of the scholarly literature and to distinguish what has been done and what needs to be done. The “C” section of the model focuses on the challenges and complexities of the concept articulating the important variables and phenomena relevant to the concept. A description of the concept (“D”) allows the researcher to examine the details of the concept, such as the methodologies and research techniques that are associated with it, their advantages and disadvantages, as well as related ideas and theories in the field to research methodologies. Examples of studies that have highlighted this concept are reviewed as part of the “E” section, while findings are highlighted in the “F” section, serving to rationalise the practical and scholarly significance of the concept being investigated. The final section synthesises the various findings and presents a new perspective on the literature while linking ideas concerning this concept to other concepts in the study. For the purposes of this review, a single synthesis “S” section is presented, consolidating all the concepts reviewed.

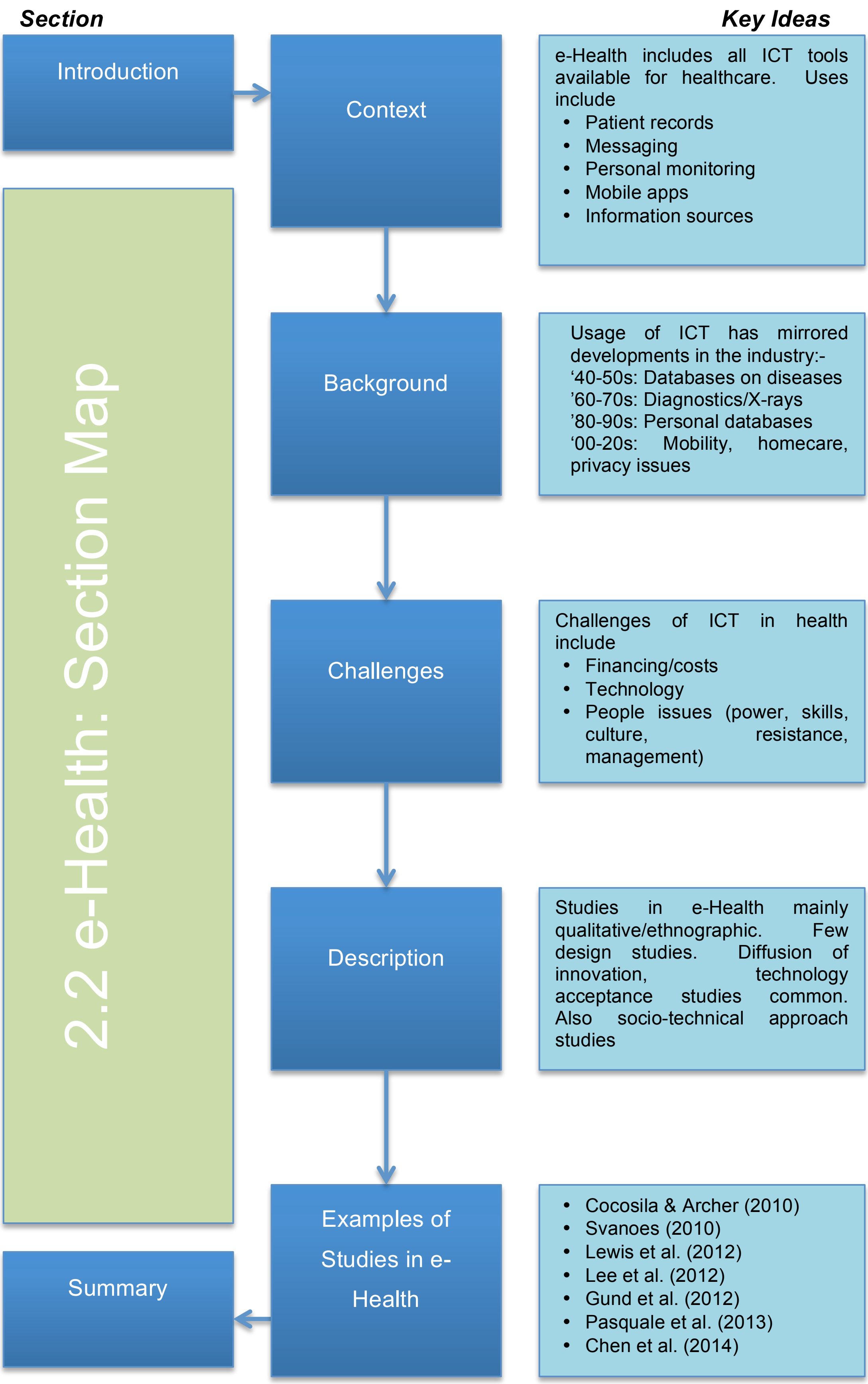
All the articles included in this review were retrieved through Google Scholar, accessed through the University of Pretoria's library site, to take advantage of the university's subscription to the various journals publishing the papers. While the use of Google Scholar for scientific research is frowned upon, especially for systematic reviews, several papers have been published that highlight the increasing efficacy of Google Scholar ((Mikki, 2009; Giustini & Boulos, 2013). Researchers advocate caution in using Google Scholar, citing the lack of scientific rigour in selecting articles that are presented, the use of machine algorithms to source and add materials to the database and lack of transparency in the operation of the search algorithms. Through the work conducted as part of the research, Google Scholar has been shown to be weak at handling dates, with many papers written after 2000 being classified as having been written in the 1900s. Among the reasons for choosing Google Scholar is its ability to track citations, its full text search, as well as its ability to search for a broader source of literature, including books, journals and conference proceedings, as well as reports.

Table 2: The ABCDEFS Framework for Reviewing Literature

(Adapted from Boote and Beile (2005)**)**

Section	Description	Purpose
About	What is?	Acquire and enhance the subject vocabulary Place the topic/problem in the broader scholarly literature
Background	What is the history behind this?	Place the research in the historical context of the field
Complexity	What are the challenges and complexities?	Articulate important variables and phenomena relevant to the topic
Description	A description of the methodologies associated with this concept.	Identify the main methodologies and research techniques that have been used in the field, and their advantages and disadvantages Relate ideas and theories in the field to research methodologies.
Examples	Empirical studies related to the concept.	Distinguish between what has been done in the field and what needs to be done.
Findings	Findings from the example studies.	Rationalise the practical significance of the research problem Rationalise the scholarly significance of the problem.
Synthesis	Identification of other studies that have linked the concepts in this study.	Synthesise and gain a new perspective on the literature. Link ideas concerning this concept to other concepts in the study, e.g. keywords for search.

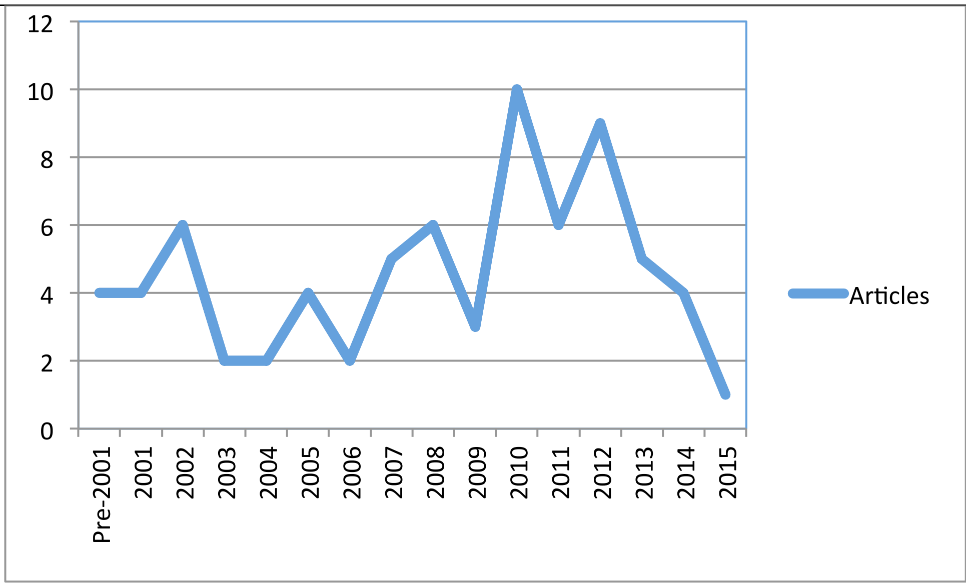
The first section (2.2) presents literature related to ICT in the healthcare sector. Subsequent sections present literature related to the three concepts used as the theoretical foundation in this study, namely co-creation, innovation and design thinking. Section 2.3 describes the concepts of co-creation and co-production of services. Section 2.4 provides an overview of innovation with a specific focus on service innovation, followed by a description of design thinking with particular emphasis on the use of design thinking in service sectors in section 2.5. The final section (2.6) of this chapter is a synthesis of ideas that connect the four concepts presented in the first four sections. The search for literature centred largely on peer-reviewed literature (journals and conference proceedings), supplemented by literature in books.


Section
Key Ideas
Introduction
Context
e-Health includes all ICT tools available for healthcare. Uses include
• Patient records
• Messaging
• Personal monitoring
• Mobile apps
• Information sources
2.2 e-Health: Section Map
Background
Usage of ICT has mirrored developments in the industry:-
'40-50s: Databases on diseases
'60-70s: Diagnostics/X-rays
'80-90s: Personal databases
'00-20s: Mobility, homecare, privacy issues
Challenges
Challenges of ICT in health include
• Financing/costs
• Technology
• People issues (power, skills, culture, resistance, management)
Description
Studies in e-Health mainly qualitative/ethnographic. Few design studies. Diffusion of innovation, technology acceptance studies common. Also socio-technical approach studies
Examples of Studies in e-Health
• Cocosila & Archer (2010)
• Svanoes (2010)
• Lewis et al. (2012)
• Lee et al. (2012)
• Gund et al. (2012)
• Pasquale et al. (2013)
• Chen et al. (2014)
Summary

2.2 ICT in HealthCare: e-Health

While this review is not a systematic review of the literature as defined by Grant and Booth (2009), it covers a wide range of material related to the subject, analysing it as proposed in the ABCDEFS framework. Articles were searched using the following search terms: "ICT in healthcare"; "ICT in health"; "Health informatics"; "Healthcare informatics" and "e-health". In a broadened search for earlier articles on the subject, the term "computers in medicine" was added. Articles relating to specialised equipment such as CT scanners and X-ray machines were excluded from the review. Papers included in this study ranged from those published in from 2001 to 2015, as illustrated in Figure 7.

Figure 7: Period distribution of e-health articles reviewed



2.2.1 About e-health: The Context of ICT in healthcare

Ricciardi et al. (2013) define e-health as a broad set of tools that are focused on consumers but encompassing all the ICT tools available for healthcare providers. These tools include electronic health record systems, portals, messaging systems, personal monitoring devices, mobile health apps and internet-based resources for health education, advice and peer support. Consumers in this definition are said to include patients and families, as well as caregivers. Al-Shorbaji (2008) provides a more formal definition, defining e-health, or the use of ICT in health, as "the use, in the health sector, of digital data transmitted, stored, and retrieved electronically for clinical, educational, and administrative purposes, both at the local site and at a distance". Idowu et al. (2008) provide a similar definition, focusing on the use of ICT in health for storage, retrieval, transmission and processing of data for clinical, educational and administrative purposes. Keizer and Ammenwerth (2008) refer to systems that allow healthcare professionals or even patients themselves to process patient-related data, information, or knowledge.

Older literature, such as Georgiou (2002), refers to health informatics or medical informatics, highlighting the integration of various disciplines such as biomedical sciences, computer sciences and healthcare policy, management and organisation. While the terminology may have changed, the essence of e-health remained the same. Imhoff et al. (2001) defined health informatics as development and assessment of methods and systems for the acquisition, processing and interpretation of patient data with the help of knowledge from scientific research. Norris (2002) defines health informatics as “the systematic application of information management and technology to the planning and delivery of high-quality and cost-effective healthcare” with the intention of achieving optimal balance between quality of service and cost-effectiveness. Haux et al. (2001) define health informatics as the discipline concerned with the systematic processing of data, information and knowledge in medicine and healthcare. This definition can be traced back to the definition provided by Collen (1986), whose definition focused on benefits that could be derived from better utilisation of knowledge bases available to healthcare workers.

Two things stand out in comparing the newer and older definitions of e-health. While the older definitions focused on the use of ICT for better acquisition, storage, and processing of information in health, the new definitions tend to bring into the equation the patients and their families as well as care givers. Secondly, the newer definitions show concern about information transmission, privacy and security, which indicate an interest in information moving in and out of the organisation. This change appears to be a reaction to the impact that the internet has had on technology in general and in this case e-health. There is agreement on “tacit understanding” of the meaning of e-health (Oh et al., 2005)

Despite the changes in terminology, the goals of e-health have remained the same. Wickramasinghe et al. (2005), while acknowledging the role that the internet has played in redefining the role of e-health, lists the goals of e-health as encompassing efficiency, quality of care and making healthcare more evidence-based. The internet introduced additional facilities such as empowerment of consumers of health services, education of physicians and widening the scope of healthcare. The developments relating to the internet introduced the potential to make the availability of healthcare more equitable by removing the need for those in remote locations to travel long distances to look for healthcare services. Mair et al. (2012), in line with the more recent definitions of e-health, point to healthcare providers as increasingly wanting to use “e-Health systems that employ information and communications technologies to widen access, improve quality and increase service efficiency”. Ricciardi et al. (2013) see the goal of e-health as empowering patients by giving them tools to “self-manage their conditions, coordinate care across multiple providers, and improve communication with their care teams.” Improvements in communication between healthcare providers can, according to

Murray et al. (2011), lead to a reduction in duplicated investigations. Cook et al. (2013) point to efficiencies that will arise from a more enlightened population as medical information becomes increasingly available through the internet, a view shared by Omona and Ikoja-Odongo (2006).

Kwankam (2004) sees e-health as presenting an opportunity to simplify the complexity that has been brought about by the large volume of information available to healthcare professionals. Meanwhile e-health allows providers of healthcare information to target information dissemination at only those who require or request it, transforming the lives and health status of many, including those in developing countries. Westbrook and Braithwaite (2010) acknowledge the role that technology has played thus far in improving the efficiency and efficacy of healthcare, mainly through automating previously manual processes. Yet they point out that these evolutionary improvements may undervalue the revolutionary potential of the use of ICT in healthcare. This includes opportunities for decision support for less experienced medical practitioners such as nurses, who with the help of such systems are able to match the quality of decisions made by doctors. The disruptive effect of these technologies is that systems will drastically change processes and allow the substitution of senior, experienced, and thus expensive resources to be substituted by less expensive resources.

The imperative for the implementation of e-health systems appears to be mainly economic and financial (Haux et al., 2002). Omona and Ikoja-Odongo (2006) argue that the continuing fall in the price of technology, coupled with an increase in capabilities, makes ICTs vital for all sectors of world economies, healthcare included. Yet both Bakker (2002) and Westbrook and Braithwaite (2010) point to the health sector as being slow in adopting ICTs compared to other economic sectors. Mair et al. (2012) blame this slow uptake on a mismatch between professional enthusiasm among policy makers and health officials against actual practice. This view appears to be consistent with the view of Westbrook and Braithwaite (2010) that disruptive adoption has not taken place because of the discomfort felt by healthcare professionals.

The full potential of e-health is yet to be reached (Wickramasinghe et al., 2005; Westbrook & Braithwaite, 2010). Both developed and developing countries stand to benefit from improvements that e-healthcare can bring (Wickramasinghe et al., 2005). Ricciardi et al., (2013) argue that while the full potential of e-health may not be understood, advances in ICT, increased adoption of ICT and improvements in health policy, all driven by social changes, as well as consumer expectations, are driving e-health forward. ICT will play a pervasive role as a stimulus for change and support for the healthcare system and individual practitioners (Georgiou, 2002). Westbrook and Braithwaite (2010) advocate a shift from simple automation of processes to innovation, a move from evolutionary changes to disruptive approaches in order to harness the full potential of e-health.

Norris (2002) defines a health information spectrum that starts from managerial information such as performance data, service planning data, demographic information and epidemiological data. In the administrative space, health information encompasses procurement information, contracting information, resource utilisation as well as education and training. In the clinical space health information encompasses test data, diagnostic information, evidence-based medicine as well as care pathways and procedures. The same study identifies stakeholders in healthcare as ranging from patients, their families and caregivers on the one end, and a broad spectrum of professionals, from nurses, doctors, researchers and academics to students, on the other end. Also involved in this community are vendors, consultants and the community at large. The activities in this sector are governed and regulated by colleges, professional bodies, regulators and unions. Management, owners and shareholders maintain as close an interest in the activities in this sector as does government at various levels, be it local or national. Hersh (2008) complements this work with a study on the opportunities and challenges for professions in this sector, cataloguing the different roles available in the health informatics sector. These studies mirror an earlier study by Imhoff et al. (2001), which puts the patient at the centre of a complex web of players providing health services.

Mettler and Raptis (2012) point out three areas as warranting attention with regard to ICT in healthcare, on which research should be focused. Personal health and independent living systems are concerned with care outside traditional medical facilities, while e-health and clinical systems are concerned with medical processes and treatments. The third area relates to cross-sectional topics such as the impact of ICT in healthcare on education, society, the economy and behaviour. In the area of personal health and independent living systems, Mettler and Raptis (2012) advocate the investment of research effort in home care and chronic diseases, patient safety, interoperability of consumer and clinical systems, ICT for personalised inclusion, consumer health informatics and personal guidance systems for people with impairments. In the area of e-health and clinical systems, they advocate research into patient-centred systems, clinical support systems, medical knowledge and decision support systems, bio-informatics, ICT for public health and inter-operability of medical and administrative systems. Cross-sectional topics are concerned with the social implications of human-computer interaction; standardisation and conformity; education, training and dissemination; security issues in health networks and the value of ICT in healthcare.

Table 3 presents the full research agenda for ehealth as presented by Mettler and Raptis (2012).

Table 3: Research Agenda in ICT in Healthcare (Based on Mettler and Raptis (2012))		
Personal Health and Independent Living	Homecare and chronic diseases	Smart devices for long-term care Social robotics Intelligent home
	Patient safety and quality improvements of medical treatments	e-Prescription Bio-signal processing Tele-monitoring
	Interoperability of consumer and clinical systems	Interoperability with care systems Security issues in health networks Re-use of personal health information
	ICT for smart and personalised inclusion	Social computing for people with impairments Brain-neural computer interfaces
	Consumer health informatics	Health information portals Personal health records Insurance protection and administrative assistance
	Personal guidance systems for people with impairments	Ubiquitous computing in healthcare Smart devices for people with impairments
e-Health and Clinical Systems	Patient-centred systems	Electronic medical records Tele-diagnostics Tele-medicine
	Clinical support systems	Patient referral systems Supply chain management Logistics
	Medical knowledge and decision support systems	Virtual/physiological/human Modelling and clinical pathways Advancements in image and text processing
	Bio-informatics	Clinical trial systems; coding and classification Bio-statistics and analytics
	ICT for public health	National health infostructures ICT for epidemiology
	Inter-operability of medical and administrative systems	Interoperability of different clinical and enterprise systems Re-use of electronic medical records and enterprise resource planning
Cross-sectional Topics	Human-computer interaction	Requirements engineering Usability and adoption studies
	Social implications	Ethics Culture Digital divide
	Standardisation and conformity	Internationalisation Research guidelines e-Health standards
	Education, training and dissemination	e-Learning Knowledge bases
	Security Issues in health networks	Privacy Legal aspects Secure data exchange
	Value of ICT in healthcare	Entrepreneurship, business models and cases, economic aspects, assessment methods

2.2.2 Background to e-health: A brief history of ICT in healthcare

Imhoff, Webb, and Goldschmidt (2001) trace the history of health informatics to the origins of medicine itself, pointing out four distinct stages of development. The early stages related to the recording of illnesses for purposes of communication between those in the healthcare sector. The second stage involved the handling of information relating to medicines in an effort to develop an empirical basis for the practice, leading to the development of systems for the acquisition, storage, processing, and communication of medical information. The third stage attributes the development and enhancement of knowledge of physiology, pathophysiology, diagnostics, medical devices, and therapeutic methods to progress in medical informatics. Currently auditing of information, quality control, standardisation and an evidence based owe their advances to the use of medical informatics.

The use of technology in medicine has evolved from the use of the telephone by doctors to get in touch with patients and motor vehicles to visit patients in the nineteenth century (Fieschi, 2002) to today's automated, remotely operated applications. Today technology is used in every aspect of the healthcare business, serving purposes as diverse as "hospital administration, billing and accounting, resource management, medical documentation, diagnostics and therapy, imaging, communication, information management and clinical decision support" (Imhoff et al., 2001). Collen (1986) traces the parallel development of the ICT sector from the development of punched cards, the first computers, programming languages and development of the internet alongside the use of these technologies in healthcare.

Computers as we know them today have been in existence since the late 1940s and early 1950s, with the term having been used hitherto to describe a person who worked with a mechanical calculator to compute figures (Collen, 2012). Lipkin (1984) describes punched cards, introduced in the 1940s, as being one of the early digital computing technologies adopted in the medical field, with punched cards being used for the automatic correlation of data in the "differential diagnosis of hematologic diseases". Imhoff, Webb, and Goldschmidt (2001) refer to work undertaken in the 1950s in biomedical research where computers were used to build simulation models and electrophysiology. Haux (2010) recounts work undertaken in the late 1950s on diagnostic decision-making as providing early thought leadership in the use of computers for decision support in medicine.

Imhoff, Webb, and Goldschmidt (2001) mention the introduction of the Medical Literature Analysis and Retrieval System (MED-LARS) in the 1960s as a milestone in the development of medical informatics, markedly increasing the availability of medical information to practitioners. While many of the developments in the 1950s were based on mainframe computers, the newer developments of the 1960s were in line with the development of mini-computers at the time, such as the Laboratory Instrument Computer (LINC) at Massachusetts Institute of Technology (MIT), the Programmed Data Processor developed by Digital Equipment Corporation and the 360 Mini developed by IBM. The early development of point-to-point networks contributed to the further development of the MEDLARS database into what has evolved into MEDLINE, an online version of MEDLARS. Fitzpatrick and Ellingsen (2013) link the development of the electronic patient record, an idea that has become central to the delivery of healthcare electronically, to work that began in the 1960s. The Massachusetts General Hospital Utility Multi-Programming System was developed in 1966 and provided an operating system, a database-management system for handling large volumes of information, and an easy user interface (Collen, 2012). At the same time, specialised medical databases became available as computing power and storage became cheaper and more easily available.

X-ray scanning was developed in the early 1970s and along with it came many improvements in diagnostic radiology (Imhoff et al., 2001). Continued development of mini-computers and the first personal computers, coupled with developments in connectivity such as Ethernet, continued to affect health informatics, most notably the sharing of patient information in hospitals and the development of medical databases. The National Library of Medicine was acknowledged as having built the largest database of medical information by the mid-1970s, offering services to medical practitioners around the world (Collen, 2012). The 1980s will be remembered for the explosion of personal computing, along with the ideas of client server computing, which led to the development of the internet in the 1990s. The ability to have systems “talk” to each other introduced the need for standards, which were necessary for interconnectivity. Privacy, confidentiality and security of patient data became topical legal issues that had to be addressed.

The internet became a household name in the 1990s, with hundreds of millions of users connecting to the increasingly international network every year. People went online to connect with friends via e-mail, to look for entertainment, as well as to educate themselves. Medical information became available online and users increasingly went online to search for information about diseases and their cures. Georgiou (2002) reported that in the USA, over 70% of users in 1999 searched for health and medical information online, with numbers growing at 43% per annum, even faster that the rate at which the internet itself was growing. The use of computers became ubiquitous in hospitals for most operations from patient administration, clinical services and ambulatory services. Such systems allowed physicians, for example, to place orders online and receive results from their workstations. Developments in processing speeds and large volume storage made it possible to access very large amounts of data, leading to the use of data mining techniques to access very large clinical databases to improve decision making (Collen, 2012). This ability to access large amounts of information led to evidence-based medicine becoming a central feature of medical and healthcare planning (Georgiou, 2002). The use electronic medical records continued to grow, and along with it the ability to offer electronic prescriptions. The new millennium has brought with it increased interest in usability and human-centred design (Viitanena et al., 2011).

While cell phone technology became widely available commercially in the 1990s, the availability of 3G technology in the early 2000s brought internet capability to the phone. This brought with it the ability to hold video conferences and resulted in the growth of telemedicine. Global positioning systems (GPS) functionality has made it possible for responders to emergency calls to locate callers instantly. Fourth generation (4G) mobile technology became available in 2010, offering much faster connectivity speeds than had been possible with 3G. Such technological advances have made it possible for doctors in the 2010s to download patient records while at a patient's bedside and place clinical orders from hand-held devices. Decisions made are supported by large volumes of medical information that is available to doctors from their hand-held devices, delivered by ubiquitously available connections (Collen, 2012).

ICT has changed the way in which healthcare and healthcare services are delivered (Fieschi, 2002), which can in no small measure be attributed to the huge investments that have been made in technology for healthcare (Fitzpatrick & Ellingsen, 2013).

2.2.3 Challenges and complexities of using ICT in healthcare

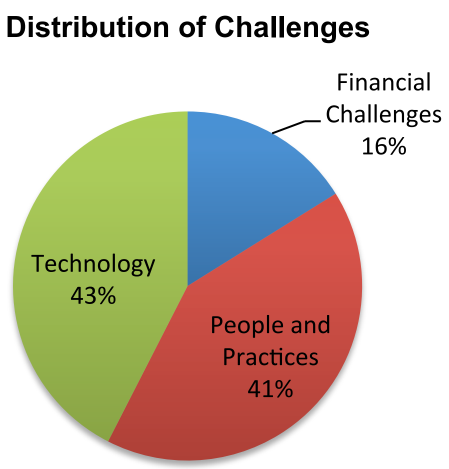
A substantial amount of work has been done to identify the challenges and complexities of using ICT in healthcare. This section analyses and summarises these findings. Two papers published in 2007 and 2008 respectively by Oak (2007) and Al-Shorbaji (2008), both focusing on the developing world, present comprehensive coverage of the challenges facing the sector. Other than a single paper by Wickramasinghe, Fadalla, Geislet, and Schaffer (2005), the analysis presented was therefore restricted to work undertaken after 2007/2008, as it was felt that many of the challenges encountered hitherto had been reported in the two papers, which were then used as a baseline.

The challenges identified appear to fall into three broad categories. Although technology and issues related to the efficacy of technology was cited as the most common challenge (43%), people and their practices were cited equally often (41%). Issues related to the financing of projects were cited least often of the three categories adopted (16%). Figure 8 illustrates the distribution of challenges in e-health.

2.2.3.1 Financial challenges

Wickramasinghe, Fadalla, Geislet, and Schaffer (2005) cite the cost-effectiveness of ICT in health as a challenge to its use, pointing to the need for ICT to be more cost-effective than other means of service provision to be considered at all. Al-Shorbaji (2008) argues that this lack of a believable business case with tangible benefits, coupled with the short-sighted view taken by many, make it difficult to mobilise finance for ICT initiates in healthcare. Oak (2007) points to the cost of utilisation as being a hindrance to the adoption of ICT, with even the most rudimentary platforms requiring that those using the service pay for telephone charges, internet charges or other rental charges associated with the service. Oak (2007) also points to a lack of resources required to access these services as becoming a hindrance to the provision of treatment and aftercare. The issue of resource constraints facing patients is also discussed by Ruxwana, Herselman, and Conradie (2010), whose work focuses on rural healthcare in South Africa. Idowu, Cornford, and Bastin (2008) describe the cost of peripherals as being prohibitive for the general populace in Nigeria, making access to healthcare via ICT a non-option for most Nigerians. This aspect of the digital divide and its impact on the deployment of ICT in healthcare is also highlighted by Mettler and Raptis (2012) in their paper on building a research agenda for ICT in healthcare.

Figure 8: Distribution of challenges in e-health identified in the literature



Ray and Mukherjee (2007) discuss the dual complication of ICT in healthcare being expensive to implement and the long payback period associated with its investment. This makes it difficult to justify investment in such projects against competing projects, leading to authorities pegging ICT in healthcare projects as low-priority areas for spending. Lewis, Synowiec, Lagomarsino, and Schweitzer (2012) discuss how both initial and continual costs are usually a deterrent for those looking to implement ICT projects in healthcare. Where donors have funded initial projects, scaling up becomes difficult unless sustained funding is provided. The issue of sustained funding is also discussed by Al-Shorbaji (2008), pointing to funding strategies as being key to the sustainability of such initiatives. Projects funded as pilot projects struggle to make the transition into fully functioning initiatives, suffering the same fate as projects funded as research initiatives. Funding of specific components of a health delivery system, making that part of the value chain more efficient than the rest of the chain, appears to add little value to the delivery of service. Al-Shorbaji (2008) argues for an integrated approach that takes the entire health delivery system into account as opposed to isolated elements in the implementation of ICT.

Al-Shorbaji (2008) also decries the lack of public-private partnerships in healthcare as contributing to the poor funding of ICT in healthcare initiatives. The private sector appears unwilling to fund joint initiatives with government, while government-funded projects tend to suffer from inadequate or inconsistent funding, leading to loss of interest by private sector players. Westbrook and Braithwaite (2010) blame this intermittent nature of funding for the disjointed landscapes that arise, consisting of hybrid paper and computer systems “that introduce new patient risks, staff frustration, and outcomes below expectation”. Avison and Young (2007) advocate reconsideration of ICT in healthcare, arguing that there is a dearth of robust, widely accepted methods for the evaluation of such projects.

2.2.3.2 People and practices challenges

Four people and practices areas stand out as posing challenges in the implementation of ICT in healthcare. The first refers to patients and those around them receiving the services of the healthcare sector and their ability to use these services. The second refers to issues of skills and the training available to those providing services. The third one relates to the culture and the attitudes of those affected by the implementation of such systems. The last area looks at issues related to management, processes, and legal as well as policy issues.

Wickramasinghe, Fadalla, Geislet, and Schaffer (2005) discuss the need for meaningful collaboration between providers and those receiving services, pointing to the need for better understanding of the balance between face-to-face interaction and virtual interaction. This should be coupled with an efficient mechanism for monitoring utilisation by remote patients. Ray and Mukherjee (2007) stress the need for a high degree of user-friendliness as being necessary for citizens to come back to services that they will have accessed online. Ruxwana, Herselman, and Conradie (2010) point to low literacy levels and a lack of knowledge and skills as being a hindrance to the utilisation of ICTs in healthcare by patients, especially in rural communities in Africa. This issue is also highlighted by Stephens-Reicher, Metcalf, Blanchard, Mangan, and Burns (2011) in an article that focuses on those that are hard to reach.

Oak (2007) discusses inequity among social grousp due to differences in gender, race, geography or other social distinctions as obstacles in the use of ICT in healthcare. Vida, Lupse, Stoicu-Tivadar, and Stoicu-Tivadar (2011) point to additional complications that arise when offering services to children in that their needs, be these physiological, psychosocial, or demographic, are likely to be different from those of adults. Vavilis, Petkovic and Zannone (2012) mention the issue of trust, questioning whether physicians can trust feedback on measurements taken by a patient at home. Patients also question the confidentiality of their data, demanding control over the privacy of their data.

Lack of adequate skills is a recurring theme in studies on ICT in health. Oak (2007) discusses the need for a complementary approach to human resources development, especially with respect to continuous training of health professionals. Systems in the sector fail because there is little or no training available to those using these systems. This limitation leads to complete failure of systems, the building up of unreliable data, which can also lead to systems failure, and in some cases lack of training imposing severe limits on the functions and further introduction of systems. Westbrook and Braithwaite (2010) and Al-Shorbaji (2008) point to lack of skills and limited training as hindering the spread of ICT in healthcare, with Mettler and Raptis (2012) cite failure to see health information systems as a discipline in universities as being partly to blame. Al-Shorbaji (2008) blames the lack of ICT training in undergraduate courses as being responsible for poor awareness of ICT among health professionals, an issue that is also highlighted by While and Dewsbury (2011) as problematic for nurses.

Zacharia, Affendi, and Zacharia (2010) urge managers to have plans to recruit, train and retain skills necessary to operate the complex and rapidly evolving systems that are coming into healthcare. Healthcare operators therefore need to look beyond the current skills pool in the sector at talented individuals from outside the sector who can work with health professionals to derive maximum benefit from these systems. Al-Shorbaji (2008) presents a counter-argument to this, arguing that ICT professionals with knowledge or hardware and software but limited understanding of the health environment can also cause failed implementations.

Culture is seen as a challenge in implementing ICT in healthcare. Oak (2007) points to cultures that limit access to the internet and world wide web. In particular, limiting access to illustrations of body parts that are seen as taboo limits the spread of ICT in healthcare in some regions. Fitzpatrick and Ellingsen (2013) point to culture as part of a bigger managerial problem associated with implementing ICT in healthcare. Wickramasinghe, Fadalla, Geislet, and Schaffer (2005) point to the language of presentation of ICT solutions as being an element of culture that can lead to the demise of ICT solutions in healthcare. Other elements of culture include attitudes to the use of technology, attitudes to accepting change in general as well as attitudes to entrepreneurship. Ricciardi, Mostashari, Murphy, Daniel, and Siminerio (2013) highlight the need for a cultural shift among both patients and service providers for ICT systems in healthcare to succeed.

Resistance to the use of ICT in health by professionals in the sector is seen as major drawback for implementation (Al-Shorbaji, 2008). While and Dewsbury (2011) note that despite positive findings related to the use of ICT in health, negative attitudes persist mainly because of concerns about costs and likely changes in work circumstances. This is coupled with a general reluctance to use computers in the profession. Idowu, Cornford, and Bastin (2008) note that while e-health is seen as a cost saver and an enabler of efficiency, healthcare workers have resisted its implementation, fearing loss of jobs in favour of those with ICT skills. Halford, Lotherington, and Dyb (2010) discuss likely disruptions in power balance, knowledge and identity brought about by the implementation of ICT platforms as resulting in the failure of the systems.

The management of ICT in health initiatives is also viewed as key to success. Fitzpatrick and Ellingsen (2013) note that the literature points to the management of cultural, sociological and financial issues being as great a challenge for implementation of ICT in health as technical issues are. Ray and Mukherjee (2007) single out leadership as a critical ingredient for success; this is necessary to bring about the necessary common understanding and concerted effort required. Al-Shorbaji (2008) associates poor project delivery with lack of political commitment, lack of vision, poor policy direction and poorly defined missions of ICT departments in the health sector. Avison and Young (2007) blame project failures on poor project management.

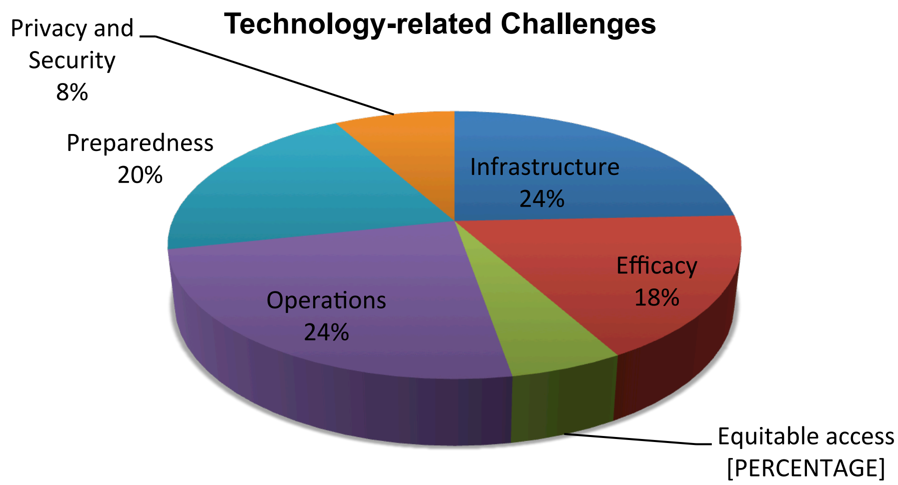
The processes associated with using ICT in healthcare can be a hindrance to its successful implementation. Svanoes, Alsos and Dahl (2010) point out that "due to concerns of privacy, ethics, and the possible fatal consequences of error", testing of systems can rarely be done in live environments and full-scale models have to be configured to replicate the live environment, which is a costly exercise. Jahan and Chowdhury (2014) decry the high level of coordination that is required in healthcare implementations as an implementation challenge, while Oak (2007) blames inconsistencies in processes as being to blame for poor data collection. This point is aptly illustrated by Ruxwana, Herselman and Conradie (2010), who discuss the example of the lack of a unique patient identifier, especially in rural areas in Africa, where patients may not have any form of unique identification. Al-Shorbaji (2008) gives the example of lack of public sector and private sector coordination being responsible for failure of large-scale ICT implementations in health.

Differences in national laws relating to the handling of patient data and its security can affect the success of ICT systems (Mettler & Raptis, 2012). In developing countries, enforcing legislation is usually harder (Oak, 2007), making it more difficult for stakeholders to trust the transformation that is brought about by ICT. Al-Shorbaji (2008) blames an ambiguous legal framework for a plethora of legal and policy issues that make it difficult to regulate ICT systems in healthcare and lead to "misinformation, unethical use, concealed bias, concealed self-dealing, fraudulent practices, and evasion of legitimate regulation."

2.2.3.3 Technology challenges

Technology-related challenges in ICT in health implementations seem to revolve around six areas. Equitable access to technology appears occasionally in the literature but appears to be the least challenging, and tends to be associated with implementations in the developing world. Privacy and security have become increasingly important as a result of the growth of the internet and the ease with which information can flow. The efficacy of ICT systems in health is also seen as important and appears regularly in the literature. Preparedness for technology in health implementations appears to occupy the minds of practitioners and appears to be the next most important challenge faced. The two areas of greatest challenge appear to be the operation of ICT systems in health and the infrastructure supporting it. Figure 9 summarises the relative incidence of technology challenges in e-health literature.

Figure 9: Technology challenges identified in e-health literature



Oak (2007) highlights the poor availability and visibility of research on ICT in health from the developing world as a challenge for ICT in health in the developing world. Al-Shorbaji (2008) points to cultural and language barriers associated with systems that are developed in the developed world being deployed in the developing world. Ray and Mukherjee (2007) and Wickramasinghe, Fadalla, Geislet, and Schaffer (2005) describe the challenges of ensuring equitable access to technology and information around the world.

Wickramasinghe, Fadalla, Geislet, and Schaffer (2005), while highlighting the need for systems to be secure, argue for a balance between connectivity (and availability of information) and privacy. Ray and Mukherjee (2007) point out that confidentiality and security pose a major challenge for those designing systems in health. Both Hersh (2008) and Al-Shorbaji (2008) highlight concerns about privacy and confidentiality, pointing to the lack of a guiding legal framework. While and Dewsbury (2011) refer to information security as a major issue inhibiting the adoption of technology in health.

The efficacy of an ICT system in health is frequently questioned in the literature. Oak (2007) discusses how poor data management can lead to unreliable databases, which in turn will result in spurious outcomes being generated by systems. This lack of attention to proper data management frequently results in challenges in data cleaning, analysis and interpretation. Fitzpatrick and Ellingsen (2013) point to technical issues related to functionality and interoperability as being a challenge for systems in health. While and Dewsbury (2011) also point to both functionality and operability as being a challenge for systems in health. Ray and Mukherjee (2007) identify lack of standardisation as a challenge for the interoperability of systems. Vida, Lupse, Stoicu-Tivadar and Stoicu-Tivadar (2011) point out that even where policies that should guide standardisation exist, healthcare systems do not appear to communicate with one another in a coherent and sustainable manner. Al-Shorbaji (2008) questions the efficacy of systems from the developed world when in use in the developing world. In the same vein, Avison and Young (2007) describe the lack of fit of applications that were developed for a different set of work practices, environment and culture from that they are expected to support. Mettler and Raptis (2012) question a technology view that tries to facilitate inter-operability through standardisation, which makes quick resolution of problems difficult. Stephens-Reicher, Metcalf, Blanchard, Mangan and Burns (2011) question the efficacy of systems designed for able-bodied patients when used on people with disabilities. Noir and Walsham (2007) warn that a process of decoupling the expected outputs of an e-health system allows organisations to hide other organisational failures on the efficacy of the e-health platform.

Wickramasinghe, Fadalla, Geislet, and Schaffer (2005) blame the lack preparedness of the health profession for upcoming technological developments as one of the key challenges for ICT in health. Lewis, Synowiec, Lagomarsino, and Schweitzer (2012) make the point that it is easier to enable newer institutions to utilise technology than to deploy it in organisations in which technology was never envisaged as being part of the service delivery process. The absence of inter-operability standards (Hersh, 2008), unified coding systems, data interchange (Al-Shorbaji, 2008) and integration (Ruxwana et al., 2010) all indicate lack of preparedness for the deployment of fully integrated systems. Avison and Young (2007) blame the lack of preparedness on a rush to deploy systems before pilot projects have been fully evaluated.

Al-Shorbaji (2008) blames poor data management, including failure to safeguard the security of data, for the failure of systems. Data that are collected are poorly handled, poorly analysed and in some cases not used at all. Scott (2007) attributes failure of systems on poor data preservation, including poor choices of storage options. Svanoes, Alsos, and Dahl (2010) advocate investment in understanding how the operation of systems integrates into the normal operations in health. Westbrook and Braithwaite (2010) also warn about the need to integrate systems seamlessly into complex clinical work processes, advocating a shift from simple automation to innovative approaches to achieving this integration.

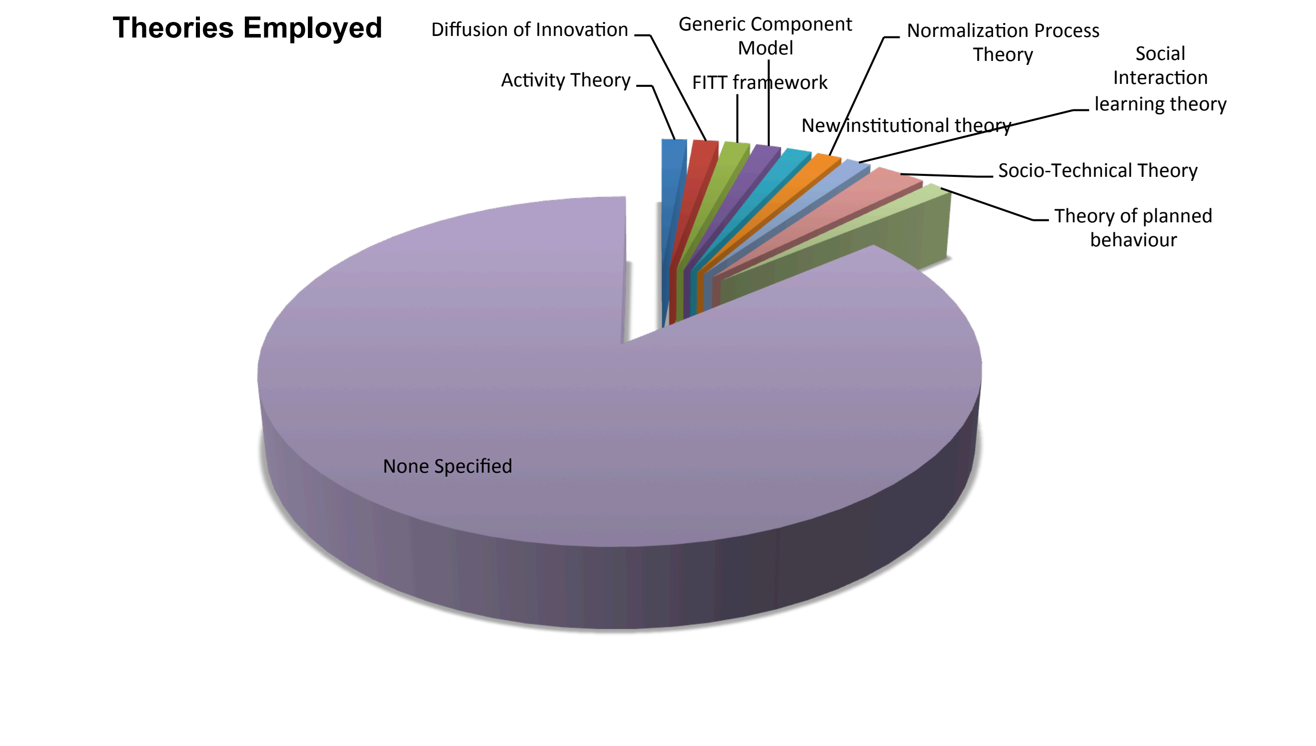
Oak (2007) singles out communication infrastructure as one of the key constraints to information sharing in e-health, blaming state-owned telecommunication entities in many developing nations for inhibiting the growth of innovation and technology adoption. Al-Shorbaji (2008) blames weak national information infrastructure, weak internet penetration and poor public-private partnerships for poor quality ICT infrastructure. The lack of wireless connectivity within and between health institutions, especially in rural areas, is also seen as a hindrance to the development of e-health (Oak, 2007). Jahan and Chowdhury (2014) blame a general lack of communication infrastructure, or where it is available, the high cost of access or problems in gaining access for slowing down the expansion of e-health availability, especially in developing countries. Lewis, Synowiec, Lagomarsino, and Schweitzer (2012) mention lack of availability of electricity, coupled with poor internet connectivity, citing this as a reason why in one example practitioners have moved from using computers to using cell phones, which are less reliant on on electricity and terrestrial internet. Idowu, Cornford, and Bastin (2008) blame an “epileptic power supply” in Nigeria, which has caused damage to equipment, as a key inhibitor to the spread of e-health solutions. In common with other parts of the developing world, Idowu, Cornford, and Bastin (2008) also blame lack of telecommunications services in general and poor internet connectivity for crippling e-health. Ruxwana, Herselman, and Conradie (2010) note that rural communities are constrained by not only lack of telecommunication services, but also lack of computers, expertise, and other supporting services. Al-Shorbaji (2008) identifies duplication of systems and the large amounts of data associated with e-health systems as some of the challenges in e-health.

2.2.4 Description of methodologies used in e-health studies

This section of the literature review identifies and describes the methodologies, research techniques and theories used in the field. Fitzpatrick and Ellingsen (2013) note that e-health studies span a wide range of settings and focus on many diverse areas of interest. Some studies have focused on coordination of service offering across space and time. Other studies have focused on different healthcare settings, from general practitioners’ rooms, hospitals, surgeries and homecare settings. Yet other studies have focused on the different players that participate in offering health services. There is increasingly less focus on prototype and design studies in general, with more focus on studies focusing on socio-technical issues, largely because of the life-critical nature of the work in healthcare and the ethical approval required to facilitate such work. A summary of the theories employed in studying healthcare is presented in Figure 10.

Fitzpatrick and Ellingsen’s (2013) review of e-health research finds that qualitative/ethnographic studies dominate the literature, using methods as diverse as interviews, surveys, design workshops and laboratory-based studies. Few studies made explicit mention of the theoretical underpinning adopted, with a combination of activity theory, actor network theory and information infrastructure dominating these. Design studies were less prevalent than studies focused on understanding, with some discussing design implications but few venturing to design, build, or deploy systems. This literature review was based on 72 papers published between 1972 and 2015. Consistent with the observation by Fitzpatrick and Ellingsen (2013), only one of the papers reviewed had an explicitly stated philosophical basis. Noir and Walsham (2007) adopt an interpretive stance in studying the effect of ICT as a legitimiser of development initiatives in the Indian health sector.

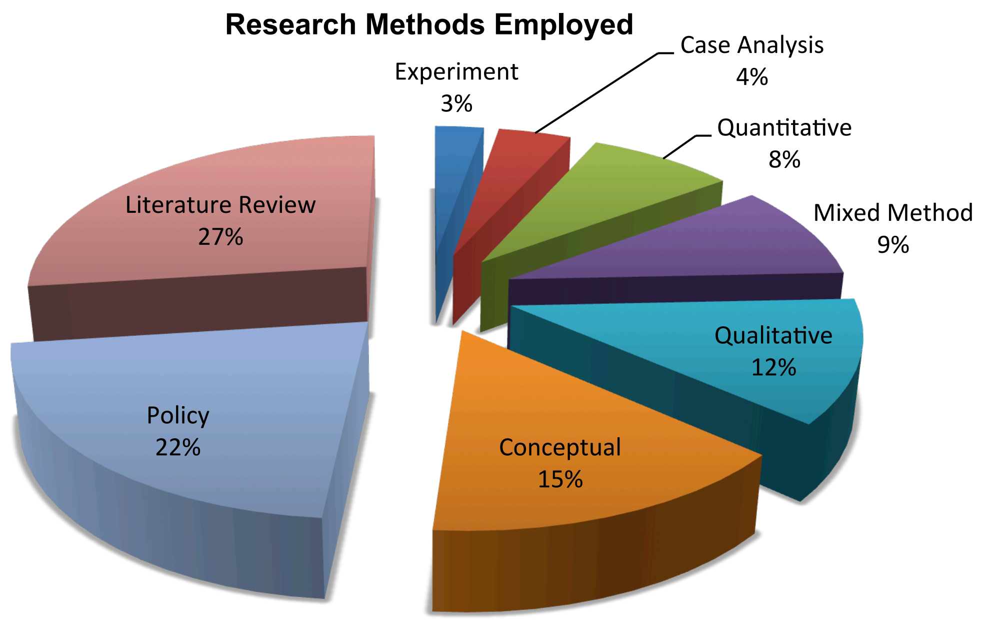
Figure 10: Theories employed in e-health studies



Of the 72 papers reviewed in the current study, only 10 (13%) explicitly state the theory that underpins their work. Berg and Toussaint (2003) and Li (2010) use socio-technical theory in their work. Berg and Toussaint (2003) adopt a socio-technical stance in their study to unravel models used to develop business processes in healthcare. Li (2010), on the other hand, uses the theory to help understand the complex relationship between technical and social systems in a longitudinal study of an ICT implementation in a health setting. Two technology acceptance studies that explicitly state the theory employed take rather different turns. Gurajan and Hafeez-Baig (2014), in trying to understand factors that motivate or limit the implementation of ICT in health, use the diffusion of innovation theory as a starting point. Heart and Kalderon (2013) investigate computer use by older employees and use this to validate the constructs of the theory of planned behaviour. Andersen and Jansen (2011) use social interaction learning theory. Social learning theory is a behavioural theory developed by Albert Bandura (1977), who argues that learning is a process that takes place as a result of people being cognisant of their social context; it can happen through direct instruction or observation, even without direct reinforcement or motor reproduction. Andersen and Jansen (2011) use this theory to understand the challenge of overcoming existing thinking (referred to as path dependency) with new thinking (referred to as path creation).

The study by Noir and Walsham (2007) use institutional theory to explain how a form of normative isomorphism is driving the adoption of ICT solutions in the health sector as opposed to "instrumental and technical rationality". Murray et al. (2011) use May's (2006) normalisation process theory that explains the social processes that come into play in the implementation, embedding and integration of technology in innovations in the health sector. Murray et al. (2011) use normalisation process theory to understand the challenges of implementing ICT in healthcare. Viitanena, Hyppönen, Lääveri, Vänskä, Reponen, and Winblad (2011) use activity theory, a theory that describes complex social behaviour, to describe the usability of e-health systems. Tsiknakis and Kouroubali (2009) use the "fit between individuals, task, and technology" framework developed by Ammenwerth, Iller, and Mahler (2006) to study the confluence of social, organisational, and technical factors that influence IT adoption in the healthcare domain. Lopez and Blobel (2009) employ the generic component model developed by Blobel (2000), which simplifies the description of any system by separating it into discrete domains that are described individually.

Figure 11: Research employed in e-health studies



The actual methods employed in the studies reviewed varied, as illustrated in Figure 11. Literature reviews were the most popular studies encountered and could be placed into three distinct categories. The first category, consisting of 27% of the papers reviewed, focused on a review of prior work, and sought to describe the state of the field. The second group, consisting of 22% of the papers reviewed, recommended some form of policy change based on a review of prior work that had been done. The final group of reviews, consisting of 15% of the reviewed papers, suggested a conceptual framework that resulted from a review of prior work.

Empirical work therefore formed the minority of the papers reviewed, contributing only 36% of the work reviewed. Qualitative studies were the most popular at 12%, followed by studies that had both a qualitative and a quantitative component at 9%. Quantitative studies formed 8% of the total while 4% of the studies were analyses of case studies conducted by the authors or by others. Finally, experiments were the least popular at 3%, a reflection of the caution exercised in studies involving life and health, as indicated by Fitzpatrick and Ellingsen (2013).

2.2.5 Examples of studies in ICT in healthcare and their findings

Empirical studies are clearly in the minority of papers published on e-health. The analysis in the last section showed experiments to be the least frequently reported studies in e-health. The study by Cocosila and Archer (2010) involved an experiment to deliver health information through cell phones, whose findings revealed that usefulness would encourage users to adopt technology while risk would discourage them. The study also found that even when usefulness was not immediately apparent, if the use of a technology was enjoyable, users would still accept it. The study by Svanoes, Alsos, and Dahl (2010) focused on the use of mobile ICT in clinical settings. Their main findings were that usability of mobile platforms went beyond the acceptance of a graphical interface, but also depended on issues of ergonomics, such as the ability to work with both hands free, and social aspects, such as the impact that the device had on face-to-face interaction between the service provider and the patient.

Three case studies by Pasquale, Padula, Scala, Biocca, and Paraciani (2013) on three EU-funded projects ("PICKFIBER", "HOST", "TeleSCoPE"), concluded that they all contributed to the “digital ecosystem” in e-health in different ways. The PICKFIBER project resulted in a knowledge management platform used to build up a knowledge base on food, obesity and related diseases. The HOST project looked at the use of mobile technology by older patients, adding to knowledge about how acceptance, confidence and trust can be built around such systems. The TeleSCoPE project resulted in a code of conduct aimed at guiding the deployment of e-health solutions. A case study by Chen, Wen, and Yang (2014) investigates the business side of innovation in healthcare, concluding that dividing services into “nice-to-have”, “had-better-have” and “must-have” will help service providers establish the willingness of consumers to pay for services. Lewis, Synowiec, Lagomarsino, and Schweitzer (2012), in a study on the use of ICT across 16 low- and medium-income countries, found that ICT was being used mainly to extend geographic coverage of healthcare, improve data management and facilitate communication between patients and physicians outside their offices. Other uses included improving diagnosis and treatment, mitigating fraud and abuse and streamlining financial transactions.

Among the six quantitative studies conducted, Omona and Ikoja-Odongo (2006), in a study of ICT in health in Uganda, concludes that technology alone will not make a difference unless it is accompanied by attitude changes, skills development, investment and economic empowerment of all and maturity of infrastructure development. Keizer and Ammenwerth (2008) study the quality of evaluation studies in e-health and conclude that there has been little improvement in the period under review (1982-2005). Lee, McCullough, and Town (2012), in a study of investments in ICTs by hospitals, point out that e-health may not lead to comparable improvements in productivity, but may lead to improvements in the quality of service being offered. Gund, Lindecrantz, Schaufelberger, Patel, and Sjöqvist (2012) investigate the attitudes of healthcare workers, concluding that most healthcare workers have positively received the use of ICT in offering services both within and outside hospitals and attribute the slow uptake of e-health to factors other than attitudes. Jahan and Chowdhury's (2014) study in Bangladesh assesses the attitudes of patients and their expectations and concludes that in remote areas, e-health can affect service delivery, especially where the cost of travel is likely to be prohibitive. Heart and Kalderon (2013) use a quantitative approach to understand the attitude of older adults to the use of technology in healthcare, concluding that older adults are reluctant to use technology, but cautioning that the 'new' old, who have grown up with technology, may have different attitudes.

Six mixed method publications were reviewed, dating back to 2009. The study by Tsiknakis and Kouroubali (2009) of organisational factors affecting successful adoption of innovative e-health services used both quantitative and qualitative data to explain the complexity in determining a fit between users and their role and how this affects the adoption of e-health systems. Chib (2010) used mixed methods to investigate the acceptance and efficacy of a mobile phone-based system used by midwives in Indonesia. The study concluded that mobile phones were beneficial in improving the healthcare system, allowing midwives to take advantage of their peer network, overcoming the challenges associated with the geographic spread of their work, its time sensitivity, and the insufficient knowledge and training that normally hindered their operations. Li (2010) laid the groundwork for the use of mixed methods to explore the impact of ICT in a clinical environment with special emphasis on the relationship between the social and technical systems at play. Halford, Lotherington, and Dyb (2010) also lay the groundwork for a mixed methods approach to understand the success and failures of e-health implementations. Müller, Meyer, Kubitschke and Delaney (2012) present an outline for an evaluation method that employs multi-methods and multiple perspectives from end-users, caregivers and service provider staff to evaluate ICT-enabled integration of social care and healthcare. Gururajan and Hafeez-Baig (2014) use mixed methods to study factors that motivate and limit the implementation of ICT in healthcare environments. The first part of the study, a quantitative one, provides a schedule of factors that motivate or limit the adoption of technology in healthcare, while a later study uses a qualitative approach to investigate the factors in greater depth.

Qualitative studies were the most prevalent of the empirical studies reviewed. Zhang, Xu, Shanga, and Rao (2006) used interviews and investigations to establish the state of the health informatics sector in China, noting the lack of standards as a hindrance to future development. Noir and Walsham

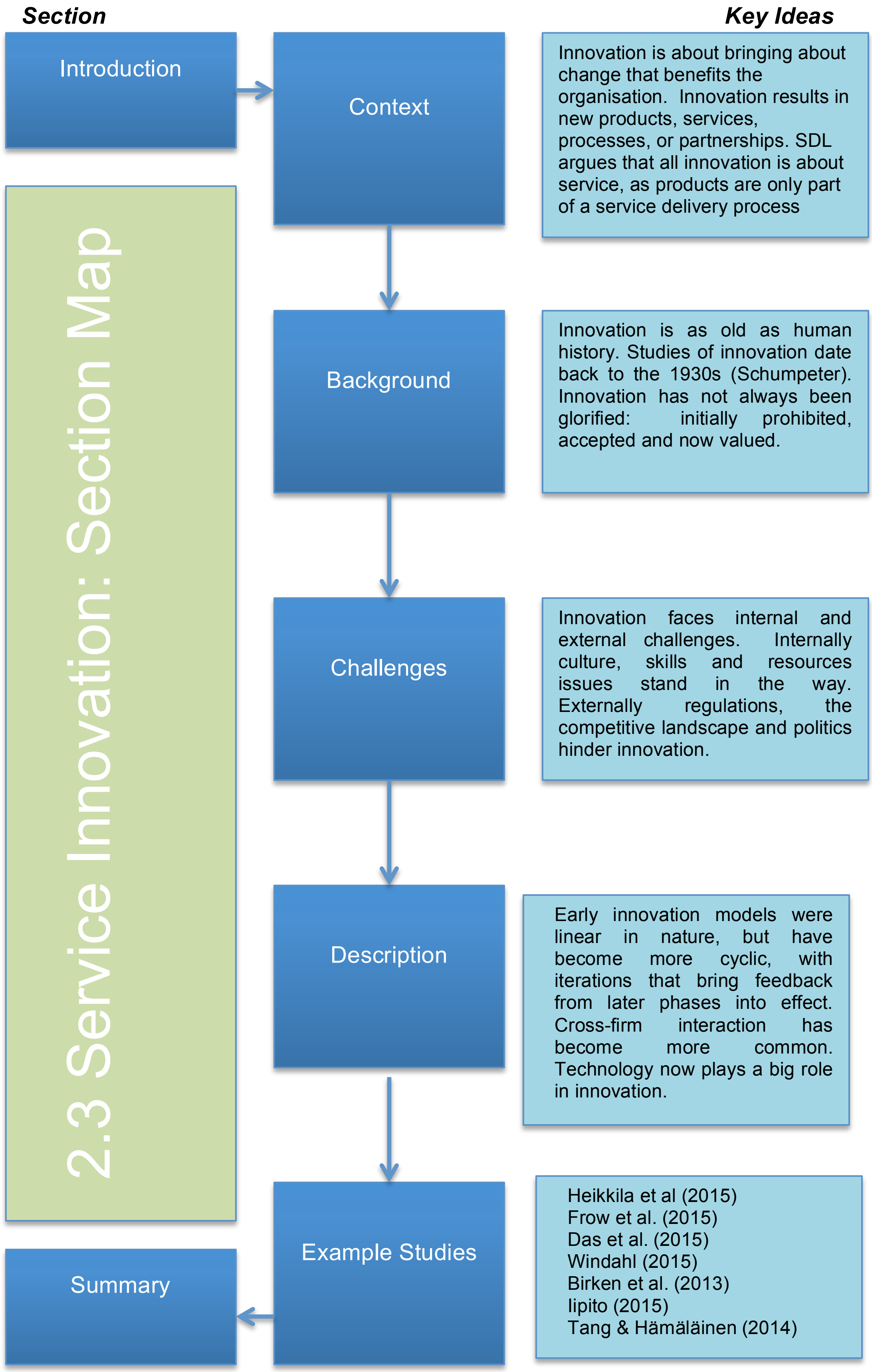
(2007) employ a qualitative approach to understand the status of e-health in India, reaching similar conclusions to McCullough, and Town (2012), that ICT in healthcare is not the silver bullet that it is often touted to be. Zacharia, Affendi, and Zacharia (2010) employ a qualitative case study to understand the factors influencing the implementation of an e-health platform in a hospital in Malaysia. Their study concludes that successful implementation and adoption of ICT demand effective communication, training and recruitment of appropriate skill, as well as the creation of a culture that supports change. Ruxwana, Herselman, and Conradie (2010) explore the uptake of mobile technology in the rural Eastern Cape in South Africa, concluding that sufficient investment in infrastructure needs to be made for e-health systems to be fully accepted, and that lack of information, insufficient ICT skills and general lack of access to technology would hinder further acceptance of the technology. Barjis, Kolfschoten, and Maritz (2013) explore the provision of a home-based healthcare delivery model for use in a rural community in South Africa. Their work leads to the development of an unstructured supplementary service data-based (USSD) patient monitoring system that exploits a decision support system to help healthcare workers in the monitoring of patients.

Murray et al (2011) set out to understand the experiences of those implementing e-health initiatives with a view to understanding why such initiatives succeed or fail. The study concludes that the views of implementers should continue to be sought if the process of implementing initiatives such as this one is to succeed. A further finding in the study by Ruxwana, Herselman, and Conradie (2010), which seems to explain the reluctance of the community in the Eastern Cape and confirms the findings of the study by Tsiknakis and Kouroubali (2009), is that initiatives with a good fit to organisational goals and staff skills, as well a positive impact on the patient-professional relationship, would have a greater chance of suceeding. The work by Andersen and Jansen (2011) uses a qualitative approach to understand a project to redesign the way in which psychiatric services are offered by incorporating a mobile-based e-health solution. The study contributes to the debate on the mechanics of the innovation process in e-health.

2.2.6 Summary of the literature on e-health

e-Health uses ICT to improve service delivery in healthcare. Early applications of ICT were in building up knowledge bases of diseases and their cures, and the focus shifted to building up integrated patient records as computers became more widely available and networking made information-sharing possible. The developments in the internet and mobile technology have made it possible to offer services from afar, leading to improvements not only in tele-medicine but also in maintaining a constant link between patients and physicians and other healthcare workers. Despite the opportunities that e-health offers, its implementation is fraught with challenges. The cost of implementing, running, and accessing e-health services has been cited as a challenge to its implementation. People's attitudes, their ability to utilise the systems and willingness to use the services, along with resistance from those who fear loss of power and status, have stood in the way of the rapid spread of e-health. This review of the literature has shown that the biggest impediments to the implementation of e-health concern technology itself. Challenges related to technology include preparedness, infrastructure and operation of the technology, its efficacy, as well as equitability of access.

Many different approaches have been used to study e-health, although empirical studies appear to be in the minority of papers reviewed. Only one paper reviewed indicated an explicit philosophical stance, while less than half of the empirical studies explicitly stated a theoretical base on which the study was built. Qualitative studies were published more frequently than quantitative studies, with many mixed method studies being noted.


Section
Key Ideas
Introduction
Context
Innovation is about bringing about change that benefits the organisation. Innovation results in new products, services, processes, or partnerships. SDL argues that all innovation is about service, as products are only part of a service delivery process
2.3 Service Innovation: Section Map
Background
Innovation is as old as human history. Studies of innovation date back to the 1930s (Schumpeter). Innovation has not always been glorified: initially prohibited, accepted and now valued.
Challenges
Innovation faces internal and external challenges. Internally culture, skills and resources issues stand in the way. Externally regulations, the competitive landscape and politics hinder innovation.
Description
Early innovation models were linear in nature, but have become more cyclic, with iterations that bring feedback from later phases into effect. Cross-firm interaction has become more common. Technology now plays a big role in innovation.
Summary
Example Studies
Heikkila et al (2015)
Frow et al. (2015)
Das et al. (2015)
Windahl (2015)
Birken et al. (2013)
Iipito (2015)
Tang & Hämäläinen (2014)

2.3 Service Innovation

This section provides an overview of the ideas behind innovation, with special focus on service innovation. It begins with a survey of various definitions of innovation and looks at different types of innovation, sources of innovation, how innovation spreads and why it is important. The background of innovation is investigated, looking at how innovation has reached its current state. The challenges and complexities of innovation are investigated with a view to understanding why organisations do not innovate more. One of the sub-sections in this chapter is devoted to understanding different models of innovation and how these have evolved over time. The last sub-sections focus on studies of innovation, aiming to understand how innovation has been studied, the methods used, the theories employed and finally the questions being asked and the findings from such studies.

2.3.1 About innovation: What innovation is

Definitions of innovation relate to the initiation of change that brings about benefits for the organisation, initiating change for their customers and other stakeholders as well. Basar, Ertek, Ackay, and Kahvecioglu (2011) define innovation as the origination of ideas that lead to new products, processes or services. Singh, Agarwal and Bhatnagar (2011) associate innovation with the transforming of ideas into wealth and employment. McKinley, Latham, and Braun (2014) highlight that successful innovation must result in a significant departure from the original product, service, or process that the organisation had before innovating. Soltani, Hosseini and Mirdamadi (2010) view innovation as a process of discovery and development that leads to changes, not just in products and processes, but also “institutional and systematic arrangements”. Chao, Lin, Cheng, and Tseng (2011) extend the scope of change to include organisational culture and behaviour.

Vargo and Lusch (2004) define service as employment of specialist knowledge and skills for the benefit of self or others. Lu, Yang, and Tseng (2009) relate service innovation to a change in the scope of the service offering, the methods of offering the service, its contents or the participation of new actors in the service delivery process. Giannopoulou and Gryszkiewicz (2013) associate service innovation with the introduction of a new idea, concept or practice into the service delivery process. Nijssen, Hillebrand, Vermeulen and Kemp (2006) note that service innovation is focused on procedures and concepts as opposed to new core technology. den Hertog and Bilderbeek (1999) describe four dimensions of service innovation as a new service concept, a new customer interface, a new delivery process or a new technology, all building up to an innovation in service. Berry, Shankar, Parish, Cadwallader and Dotzel (2006) argue that service innovation is unique in three ways. Firstly, service delivery staff are part of the customer experience and hence the innovation. Secondly, service innovation is local out of necessity, as it demands that the customer be present during the delivery of the service. Finally service innovations are typically not branded and will therefore not carry a name. Lusch and Nambisan (2015) disagree with this purported uniqueness of service innovation, arguing that the distinction between product and service innovation is no longer relevant, given that products are but a mechanism for delivering a service, a key principle behind SDL.

A number of different criteria have been used to define different types of innovation. Yang and Hsu (2010) describe radical innovation as making fundamental changes to the activities of an organisation and associates this type of innovation with technological imperatives. A classic example of this type of innovation is evidenced by the approach taken by Apple Inc. in the development of the its Mac and Ipad/Ipod/Iphone products and the claim by founder Steve Jobs that "… customers do not know what they want …" (Business Week, 1998). Incremental innovations tend to be market-related, are more gradual and tend to be associated with firms that are good at collecting and processing information from the market. Yang and Hsu (2010) also distinguish between technical innovation that relates to technology, products and services, and administrative innovation that relates to advances in procedures, policies and organisational structures. Nodari, Bo, Dorion, Olea, and Severo (2012) define organisational or managerial innovation as changes in the structure of a company, expertise of employees or the relationship with suppliers or customers. Soltani, Hosseini, and Mirdamadi (2010) identify product, process, marketing and organisational development as the four main types of innovation. They also point to technology and strategic innovation as sources of value creation for organisations. Chuang, Liu, Tsai, and Huang (2010) classify innovations as being technical, administrative, external relational, internal organisational, product/service and process innovation. Chen (2012) observes that innovation can be linked to a product, a process or a service. Herzlinger (2006) describes three types of innovations. The first relates to how consumers procure and employ innovations. The second relates to technology, while the third relates to business models. George, McGahan and Prabhu (2012) define inclusive innovation as the development and implementation of new ideas aimed at creating opportunities that enhance social and economic well-being for disenfranchised members of society.

The source of innovation varies between organisations. Abernathy and Utterback (1978) posit that an organisation's capacity for innovation is dependent on its position in the evolutionary process from a small technology-based producer to a high-volume producer. Audretsch and Feldman (1996) argue that new economic knowledge is a source of innovation. Cohen and Levinthal (1989) credit research and development (R&D) efforts as a source of innovation, together with an organisation's ability to acquire, integrate and make use of knowledge from the market. Henderson and Clark (1990), commenting on the architectural industry, note that organisations are often forced to innovate when there are changes elsewhere in their value chain. A change in a component specification may force an architect to change the design of a product using that component, leading to innovation. Cohen and Levinthal (1990) argue that outside sources are critical to the process of innovation, adding that innovations sometimes result from borrowing rather than invention. They further argue that innovation comes from an ability to integrate diverse knowledge structures, adding that diversity in the workplace fuels innovation. Brown and Duguid (1991) argue that the source of innovation lies at the interface of the organisation with the outside world. McKinley, Latham, and Braun (2014) point out that organisational decline can be a source of innovation, highlighting that organisations that fail to innovate in the face of decline, perish.

The process of innovation, according to Brown and Duguid (1991), includes the construction of a framework, which is applied to an environment and reflected in the outcome. Kandampully (2002) encourages firms engaged in innovation to create, preserve and destroy their philosophy, processes and systems in coming up with new ideas. Soltani, Hosseini, and Mirdamadi (2010) describe innovation as a process of discovery and development that leads to new products, technologies and organisations. Lusch and Nambisan (2015) describe a framework for innovation that is made up of three key components. The first component is a service ecosystem, through which participants build an organising logic for service and exchange and value creation. The second component is a service platform, which optimises the process of service exchange by providing the necessary resources required. The third is a mechanism for promoting value co-creation.

Johnson (2010) argues that certain patterns, characterics, or environments encourage innovation. The principle of the adjucent possible argues that innovations do not come as one huge jump, but arise from a series of adjustments that lead to something different. Johnson expands this with the principle of liquid networks, where components of a solution could reside in other peoples' minds; only through allowing these minds to interact can an organisation get to an innovation. The principle of the slow hunch extends the thinking that great ideas come in instalments, and an innovator needs to keep track of these to finally arrive at an innovation. The principle of serendipity argues that one has to be in the right place at the right time for all the pieces to come together, and organisations can harness this by creating the environment through with innovators can bring all the pieces of the puzzle together. The principle of errors welcomes mistakes as part of the process of innovation, while the principle of exaptation welcomes the adaptation of ideas in one industry in another. The final principle is one of open platforms, through which contribution to innovation is open to all.

Open innovation refers to the exploitation of innovative ideas that originate outside the organisation (Chesborough, 2006). Closed innovation is capital-intensive, typically backed by large research and development budgets, and is premised on the organisation being able to drive the process of developing, manufacturing, marketing, distribution and servicing of customers on its own. Boscherini, Chiaroni, Chiesa and Frattini (2013) attribute success in innovation to four dimensions. These relate to how the organisation relates to other organisations, how it is structured, how it evaluates innovations and how it manages knowledge. In a review of past studies, current debates and the future direction of open innovation, Lichtenthaler (2011) points to four streams of open innovation research. These relate to technology transactions, user innovation, business models and innovation markets. This study follows the path of user innovation, in which organisations collaborate with users on the exploitation of knowledge and ideas to build new products and services.

According to the theory of diffusion of innovation (Rodgers, 1995), the diffusion of innovation is influenced by the innovation itself, communication channels, time and the social system within which it will operate. The theory explains that certain attributes of innovations have an impact on their rate of adoption. These attributes include the relative advantage offered by the innovation, compatibility with existing technology, complexity, trial ability and observability. Tidd (2006) describes relative advantage as the extent to which an innovation has improved on the previous state. Compatibility is described as the extent to which the innovation fits in with the current environment, skills, existing products, values and norms. Innovations that are simpler to understand, convert to and use tend to be adopted faster than more complex innovations. Innovations that do not 'lock in' users, allowing users to put them to trial them on a temporary basis, tend to gain better acceptance. The last attribute, observability, relates to the opportunity for users to observe an innovation in use prior to making a commitment.

Adopters of innovations can be grouped into five groups that appear to take on innovations at different stages (Rodgers, 1995). Innovators are venturesome and are willing to take risks ahead of others, sharing their experiences with other innovators. Early adoptors are likely to be respectable people whom others look up to and who will influence the choices of others. The early majority are deliberate and are typically of average social standing and will take on an innovation after some time has passed. The late majority are skeptical, and will wait for the majority of the population to adopt a technology before they adopt it, not wanting to risk the little they have. Laggards tend to be socially isolated with little financial muscle and will stick to tradition in an effort to avoid change.

The literature agrees on the importance of innovation to an organisation, with Kandampully (2002) calling innovation the core competency of any organisation. Innovating forces the organisation to think on behalf of its customers, who do not value the innovation itself, but the value created by the innovation. Singh, Agarwal, and Bhatnagar (2011) argue that innovation and entreprenuership are the key drivers for generating wealth from knowledge. Idris (2009) refers to innovation as the most important measure of business performance, while Chen (2012) argues that innovation is a source of competitive advantage for organisations and thus contributes to the success and development of organisations. Continuous innovation and the ability to capitalise on the resulting opportunities is necessary for the survival of any business (Chen et al., 2011). Berry, Shankar, Parish, Cadwallader and Dotzel (2006) argue that innovation leads to the creation of new markets. A study by Weng, Huang, Kuo, Huang and Huang (2011) on the use of technology in hospitals concluded that innovation led to higher productivity and better organisational performance.

2.3.2 Background to innovation: The history of innovation

The ideas of creative destruction, generally associated with the work of Schumpeter (1934), have occasionally been hailed as the earliest documented ideas of innovation, as we know it today (Abernathy & Clark, 1985). Chesborough (2006) credits Schumpeter with giving impetus to the study of innovation. Fagerberg (2004) details the work of Schumpeter, starting with the seminal work "Theory of Economic Development", his classification of different types of innovation, through to his analysis of innovation diffusion. Yet innovation has been around since time immemorial. Johnson (2010) chronicles innovations that date back over seven hundred years. Innovations such as double entry accounting (1300-1400 AD), the printing press (1400), portable watches (1500), steam turbines (1500), telescopes (1600), mechanical calculators (1645), steam engines (1700), electric batteries (1800) and the telephone (1876) all fit the bill of what one recognises as innovations today. Johnson chronicles all the major innovations up to the end of the 1990s, when the internet was beginning to become mainstream technology.

In "The Myth of Innovation" (Berkun, 2010), Scott Berkun attempts to dispel the myths associated with innovation. Innovations are never an epiphany (myth #1); they take time to develop, despite the popular myths of innovations being associated with particular events in time (myth #2). Berkun dismisses the myth that there is a method to innovation, explaining that there are too many variables outside the control of the innovator for one to be in total control of the innovation process (myth #3). In addressing popular culture, Berkun describes the dissonance between the popular belief that all innovations are loved and the reality that innovations are often rejected by those at whom they are aimed. Innovations are often attributed to individual inventors, such as Einstein, Mozart, or Picasso, yet their work is the result of many people's ideas coming together over a period of time (myth #5), a concept that resonates with the principle of liquid networks described by Johnson (2010). Berkun (2010), dispels the myth that good ideas are rare (myth #6), arguing instead that good ideas are generally killed by human filters of what people have accepted as good and what they accept as bad and unwillingness to commit to ideas. The myth that senior staff know better than junior staff stifles innovation (myth #7). Many hold the view that the best innovations are the most successful (myth #8) and that solutions are more interesting than the problems they solve (myth #9). The final myth is that all innovations are good, while the reality is that innovations can actually be bad for society.

In the book "Innovation Contested: The Idea of Innovation over the Centuries", Godin (2015) makes similar points to Berkun, debunking the myths about innovation. While over the years innovation has become glorified as the solution to all ills, early commenters looked down on innovation, viewing it as destructive and subversive when compared to invention. Godin describes three epochs, which he terms episteme, when the meaning of the word innovation changed. In the prohibition episteme leading up to the nineteenth century, innovation was against the law and frowned upon by the church. In the instrument episteme, innovation underwent a "semantic and instrumental" rehabilitation, gaining acceptance and being viewed as a non-controversial practice and an organising principle for both thought and action, throughout the nineteenth and twentieth centuries. In the current age, or the value episteme, innovation itself is seen as a value, the word innovation being associated with honour and pride.

Innovation has spread to every aspect of daily life. A search on Google Scholar (Saturday, 19 September 2015) returned 57 000 hits on articles and books of a scholarly nature discussing innovation that were published in 2015. Articles on open innovation, innovation in the financial services field, service innovation, healthcare innovation and national innovation feature prominently. Other areas of innovation research include technology, public sector innovation, innovation in the hospitality industry, innovation and the structure of companies. The track record of the literature appears to show that innovation as a concept has reached a stage of mainstream acceptance.

2.3.3 Challenges and complexities

Challenges in innovation appear to revolve largely around the nature of organisations and their ability and capacity to initiate, manage and exploit innovation. The environment in which an organisation operates also appears to influence its ability to innovate.

Bureaucractic organisations tend to discourage innovation (Shieh, 2010). Such organisations restrain individual efforts at innovation, making it difficult for the organisation to transform itself against competitors. Chuang, Liu, Tsai, and Huang (2010) point out that the more centralised and formalised an organisation is, the less innovative it is likely to be. A study by Wang and Feeney (2014) points out that organisations that are highly centralised, focused on work routines and encumbered by inflexible personnel rules, struggle to innovate. Erbil and Akinciturk (2010) note that organisations that are unwilling to take risks, such as a willingness to canabilise existing sales (Nijssen et al., 2006), do not innovate. Erbil and Akinciturk (2010) also point out that organisations that are heavily regulated tend to discourage innovation. Orgnisations that do not have the ability to assimilate new knowledge are incapable of innovating (Tsai, 2001). Orgnisations that are not focused on human performance also seem to discourage innovation (Berry et al., 2006). Organisations that innovate successfully develop cultures that allow individuals to take risks and share ideas freely with others in the organisations.

Cabello-Medina, Carmona-Lavado, Perez-Luno and Cuevas-Rodriguez (2011) associate companies that fail to innovate with failure to retain highly skilled, creative staff who are willing to develop new ideas and knowledge. Failure to retain institutionalised knowledge in the form of operating procedures, routines and scripts is also associated with failure to innovate. Similar to the findings by Berry, Shankar, Parish, Cadwallader and Dotzel (2006), Cabello-Medina, Carmona-Lavado, Perez-Luno and Cuevas-Rodriguez (2011) argue for the development of strong internal capital in the form of high-quality relationships between staff as necessary for innovation. These findings seem to contradict the earlier finding by Shieh (2010), which argues against bureaucracy. Chao, Lin, Cheng, and Tseng (2011) relate failure to innovate to a leadership style that stifles free thinking.

Price and St John (2014) point to the lack of an innovation culture, characterised by a lack of accountability for dissemination and adoption of tests in a laboratory environment, as a barrier to innovation. Poor communication, an ineffective decision-making process and poor implementation planning also have an impact on an organisation's ability to innovate. Page (2014) suggests that smaller groups in organisations are more adept at innovation than larger groups, where commnication is difficult and getting approval to make any adjustments may be difficult. This suggestion is consistent with the finding by Boschma (2005) that proximity is an enabler for innovation. Page (2014) also blames the education system in the United Kingdom (UK), which he blames for straight-jacket thinking among those leaving school.

Finance appears consistently in the literature as as barrier to innovation. Henderson and Clark (1990) observe that innovation demands time and resources and in larger organisations can be more expensive. Singh and Singh (2009) point out that companies face the dilemma of investing in innovation that may not improve service delivery or cause the organisation to lose money. In some cases, organisations simply cannot afford to invest in innovation activities (Idris, 2009; Erbil & Akinciturk, 2010). Innovations that are undesirable to customers add to the organisation's costs without adding any value to the customer or the organisation (Erbil & Akinciturk, 2010). McKinley, Latham and Braun (2014) warn that innovation activities are capable of draining an organisation's much needed resources, hastening the demise of already distressed organisations. Ogbo, Okechukwu and Ukpere (2012) warn that innovation without the right strategic focus can divert essential resources and cause the organisation to lose focus. Several authors warn against innovations that may not be received positively by customers and thus lead to negative payback for the investing organisations (Markic et al., 2011; Idris, 2009; McKinley et al., 2014; Jacobs & Zulu, 2012).

The process of innovation is highly unstructured and is therefore difficult to manage and control. Bitner, Ostrom, and Morgan (2008) observe that service innovation typically involves imprecise processes and impromptu decision-making. Nodari, Bo, Dorion, Olea, and Severo (2012) note that measuring service innovation is particularly difficult because of the challenges of detecting the newness of changes in the quality of services. Service providers struggle to innovate because there are no effective and comprehenisve processes for service innovation (Zali et al., 2012).

Pointers to the environment as an inhibitor of innovation are made by Snowdon, Bassi, and Scarffe (2015) after studying a change-resistent culture in Canada. The same study also points to lack of competition as inihibiting innovation, since organisations find no reason to innovate. Erbil and Akinciturk (2010) mention political uncertainty as discouraging innovation, while also stating that international markets actually force innovation, a point that is in line with the findings of Snowdon, Bassi, and Scarffe (2015). Herzlinger (2006) argues that innovation is influenced by six forces. Industry players can make or break an innovation. These are typically the members of an ecosystem or supply chain that can reject an innovation before it succeeds. Equally influential are the users of an innovation, who may also reject the innovation, an assertion that agrees with the finding by Erbil and Akinciturk (2010). Other factors that may help or hinder innovation include public policy, accountability and technology.

While innovation, both in products and services, is generally accepted as positive, organisations struggle to implement innovations, for reasons both internal and external. Internally, culture, skills and resources stand out as the biggest barriers to innovation. The difficulties of managing and controlling innovation also stand in the way of innovation. According to Abernathy and Utterback (1978), the innovation environment of an organisation changes as it develops, making management of innovation even more difficult. The results of innovation activities may not be obvious and in some cases may not be noticed by customers, leaving organisations to question the wisdom of innovation activies. Externally, the competitive landscape, regulation and the political environment determine the innovativeness of an organisation. Despite these setbacks, Kandampully (2002) describes a form of innovation inflation, where innovation by an organisation creates the expectation of more innovation by its customers.

2.3.4 Description and processes

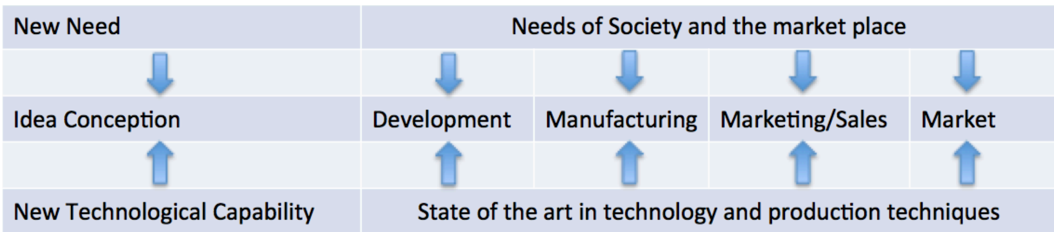
Understanding models of innovation is necessary, as it helps shape the way processes are followed and managed (Tidd, 2006). Debate about the nature and efficacy of innovation models has been conducted since Schumpeter (1934) spurred the quest for knowledge about innovation. This section explores the various models of innovation and briefly summarises the main arguments in the discourse on innovation models.

Tidd (2006) describes five generations of models. The first- and second-generation models, illustrated in Figure 12, were linear, depended on a push-and-pull mechanism and saw innovation as a sequence of activities. Marinova and Phillimore (2003) describe first-generation models as “black-boxes”, associating them with refusing to look inside the innovation box and focusing on the inputs and outputs of the innovation process. Scholars who used this type of model focused on the benefits that arose from innovation activities without delving into the innovation activities themselves. Second-generation innovation models are associated with the initial interest in the innovation process itself. These models saw innovation as a process through which basic science was converted into applied technology, which resulted in manufacturing of new products, their marketing and ultimately sales of products (Marinova & Phillimore, 2003). Innovations were seen as arising out of innovation activity such as R&D and pushed into the market, or alternatively the market demanded that certain innovations be brought about. The notion of a linear model is dismissed by Kline (1985), citing the lack of a feedback loop in linear models. Nightingale (1998) describes linear innovation as being "long dead", because of its failure to explain how the science of today can be turned into technology tomorrow.

Figure 12: Linear model of innovation

Third-generation models, according to Tidd (2006), incorporate feedbacks loops as proposed by Kline (1985), allowing interaction between different elements of the model, as shown in Figure 13. Johannessen (2009) describes linear models of innovation as being simplistic and argues for a move to systemic or interactive approaches. Marinova and Phillimore (2003) describe interactive models as consisting of complex networks of communication paths that allow for exchange of ideas within the organisations, externally, with the scientific and technology community and the market.

Figure 13: Interactive model of innovation



Fourth-generation or parallel line models emphasise integration within the firm, upstream with suppliers and downstream with demanding customers, emphasising linkages and alliances (Tidd, 2006). Also known as system or cyclical models, these treat the model as a starting point for a systemic approach through which repeated testing is undertaken to refine the model. While linear models focused on explicit knowledge, system models exploit linkages between research and development activities, tacit knowledge, culture, social processes, suppliers and customers, among other components of the innovation ecosystem. Marinova and Phillimore (2003) argue that systems models allow small organisations with small budgets to exploit the innovation efforts of other organisations in their network, forming the basis of what are known as national systems of innovation. Fourth-generation models are often associated with other concepts, such as innovation chains in which members of a supply chain network collaborate to innovate. Strategic networks refer to long-term relationships in which members of an alliance look to gain competitive advantage over players outside their alliance in the long term.

Fifth-generation models exploit the use of technology to integrate systems of innovation, allowing for the building of extensive networks offering flexible and customised feedback that allows for continuous innovation. Marinova and Phillimore (2003) describe fifth-generation models as being evolutionary in nature, attributing their development to an understanding of biology, thermodynamics, organisational theory and heterodox approaches in economics. In a sixth generation of innovation models, known as an innovation milieu, generic know-how and specific competencies are combined with territorial organisation to come up with techno-economic innovation (Marinova & Phillimore, 2003). These models help to explain why small businesses can remain at the leading edge of innovation, and why certain localities are associated with high levels of innovation. Godin (2015) argues that models are continuously being invented, reviewed, criticised and succeeded, but their role remains the same, namely to give form to a reality, interpreting it and attaching a conceptualisation to it.

2.3.5 Examples of studies in innovation: Methodology used

This section of the review of the literature explores how current research into innovation is being conducted. A search on Google Scholar for articles on innovation returned millions of articles published (3,37 million hits as at 10 October 2015 12:15). A series of filters was applied to narrow the search down. The search was therefore reduced to articles published since 2014, which had the following terms in the article: “Service innovation”, “healthcare”, “ICT”, “co-creation”, and “design thinking”. This narrowed the search down to about two dozen journal articles, reports and books. Three dominant classes of articles/books reviewed emerged. The first consists of theoretical studies or reports that set a research agenda or review national innovation initiatives. The second consists of empirical studies that led to frameworks for use in the development or evaluation of innovations. The last class consists of design science studies that led to the development of some artefact.

An article by Barrett, Davidson, Prabhu and Vargo (2015) reviews the literature on service innovation, placing particular focus on information systems research, and uses this to set an agenda for research in this area. The authors devote a section of the article to challenges that are specific to innovators in the developing world. The report by Sangiorgi, Prendiville and Ricketts (2014) reflects on the state of the service design sector in the UK and helps set an agenda for future research. A similar report, “Shaping the future through co-creation” (Katsigiannis et al., 2014), sets the agenda for innovation in Australia, encouraging the public sector to take a lead role in driving innovation. Tonurist, Kattel and Lember (2015) investigate the role of the public sector in innovation, focusing on the use of innovation laboratories worldwide. The study itself is conducted as a two-step process, the first step being a survey of innovation laboratories world-wide and the second made up of interviews with 11 heads of innovation laboratories from Europe, North America and Australia. The World Bank guideline on citizen-centred innovation (Eskelinen et al., 2015) presents an agenda for innovation especially in the area of smart cities, basing its arguments on case studies on conceptualisation, building strategy and ensuring participation through co-designing and ensuring the sustainability of initiatives. The collection edited by Marcus (2015) presents articles on design, user experience, and usability and follows the discourse on design based on the output of conference proceedings of a conference held in Los Angeles in August 2015. The study by Salmelin (2014) contributes to better understanding of the challenges of service design in the public sector, based on a case study of elderly care in Finland.

An article by Frow, Nenonen, Payne, and Storbacka (2015) falls into the second class of articles, where the study led to the development of a framework. Beginning with an extensive review of the literature on co-creation, the study follows the co-design activities of six firms engaged in business-to-business and business-to-customer initiatives. Through a series of meetings, followed by workshops, the authors develop a framework that organisations can use to map the scope of co-creation activities. Das, Bøthun, Reitan and Dahl (2015) engaged five patients in detailed sessions, where they used generative techniques: users were not only interviewed, but also observed. In this study, two designers/researchers assume the role of facilitator and observer respectively. A workbook for the patient is sent in advance and is followed by semi-structured interview sessions in the patient's home. The observer takes notes and pictures and sessions lasting two to three hours each are recorded. The interviews focus on patients' perspectives of their past and present lives with regard to health and their interaction with healthcare services. The sessions also look at the patients' perspective of likely future scenarios. The main contribution of the study is observations about the use of generative and co-creation techniques with hospital out-patients.

A study by Tang and Hämäläinen (2014) extends the ideas of open innovation and develops the concept of living laboratories in which research and innovation are conducted according to a user-centric approach. Recognising the difficulties of user involvement in research and innovation, Tang and Hämäläinen (2014) develop a model and a methods taxonomy for use in such innovation studies, which is then tested in a case involving the care of the elderly. An article by Heikkilä et al. (2015) undertakes a brief review of innovation literature and through interviews with 12 stakeholders involved in three cases studied, come up with a framework for evaluating the viability of innovation initiatives. Windahl (2015) undertakes a longitudinal study of an innovation initiative in a business over a five-year period. Using documents, interviews and observations as sources of data, the author creates a framework through which the obstacles and difficulties involved in solution innovation can be better understood. In a case study of three Finish cities, Jappinen (2015) describes service innovation initiatives and proposes a framework for engaging the public in service re-design. Birken, Lee, Weiner, Chin, Chiu, and Schaefer (2015) employ a mixed methods design to survey 120 managers, followed by interviews with 16 managers to understand how senior management support affects commitment to innovation by middle managers in healthcare settings.

The rest of the articles reviewed fall into the third class, where the study leads to the development of an artefact. The article by Yoo et al. (2015) focuses on user experience design. Adopting a pragmatic philosophical stance, this design science study employs the double diamond design process model, a design thinking methodology to understand the complications of offering bedside services, from the perspective of eight patients, three nurses and three caregivers. Based on this experience, the team developed a system for use in providing care for bedridden patients. The study by Stickdorn, Frischhut and Schmid, (2014) employs the concept of mobile ethnography to study the behaviour of hotel guests from initial contact with the hotel to after their stay. Through the use of a mobile application (myServiceFellow) developed for the study, the authors were able to collect a rich trail of information regarding the interaction of guests with service providers, their feedback, geospatial data and their post-service activities. The study by Iipito (2015) uses the double diamond model employed by Yoo et al. (2015) to come up with a prototype for a mobile-based platform for promoting reproductive health in South Africa.

2.3.5.1 Examples of developing world based innovation studies

An expanded search for articles reporting on innovation work in the developing world returns a large number of examples of such work. A search for articles using the terms "service innovation", "developing world", health, ICT and co-creation on 7 November 2015 at 11:20 returned 30 articles published since 2011. On closer inspection, while many of these make a passing reference to the developing world, a small number were actually focused on the developing world environment. Even fewer articles refer health or healthcare, indicating lack of focus on healthcare research in the developing world. More than half of the emperical studies identified were centred on the use of mobile technology and were based on the experiences of Kenya.

Xing, Ness, and Lee (2013) overlay SDL and systems theory to develop a framework for service innovation, the ecosystem model. This model is tested in rural settings in China and the Phillipines to investigate how the community can improve access to services, among others healthcare. Lewis, Synowiec, Lagomarsino and Schweitzer (2012) report on a study of innovations in developing countries that employed ICT through self-reporting of WHO-funded programmes. Melles, Thomas, Kuys, and Ranscombe (2014) use a series of interviews to study socially responsible design and sustainability in small enterprises in India. Atun (2012) uses a series of case studies to examine how diffusion of innovation is influenced by the complexities associated with innovation, institutions, and health systems. Terio (2014) examines reverse innovation and collaboration in Uganda. An ethnographic approach is adopted for the data collection, with unstructured interviews being collaborated with observations over a period of two and half years; all of which are recorded in a journal. Weng, Huang, Kuo, Huang and Huang (2011) describe a quantitative study based on secondary data about Taiwanese hospitals to understand the drivers of technological innovation and their effect on hospital performance.

The use of mobile technology is investigated by Linna (2012) in a study of the mass-market appeal of mobile phones and their effect in driving innovation in that segment. The author undertakes exploratory case studies in Kenya, focusing on successful innovations involving mobile technology by local entrepreneurs. Data are collected through interviews and this is augmented by workshop attendance, news extracts and reference to business publications. Linna also explores the entrepreneurship potential for social innovation using mobile technology in another article with Ritcher (Linna & Richter, 2011). The study by Mercer (2012) into bottom-of-the-pyramid innovation also focuses on Kenya, with data collected from slum dwellers in interviews on their lifestyle aspirations and water and sanitation usage. The focus on Kenya and mobile technology is maintained in a study by Otieno (2012), whose study focuses on the link between mobile-based innovation and entrepreneurial opportunities. Building on the work of Linna (2012), Otieno undertakes a quantitative survey to understand the drivers for mobile-based innovation and entrepreneurship better. Gregersen and Trischler (2014) conduct semi-structured interviews with 14 enterprises and 12 instituitional actors in a field study in Nairobi in a study that focuses on business model innovation in the energy sector in Kenya. Mate (2011), in a case study of Equity Bank in Kenya, investigates the role of flatteners such as outsourcing, workflow software and mobile technology in the banking sector.

2.3.5.2 Theories used in innovation studies

Most of the literature reviewed in this study is silent on the theoretical roots of the work, other than stating that it is rooted in innovation literature. Where the theoretical base is explicitly stated, the literature studies follow three dominant themes: general theories about innovation, diffusion of innovation and technology acceptance studies and lastly those building on SDL. The last group arises from a deliberate search for literature focusing on co-creation approaches.

Jappinen (2015) uses open innovation (Chesborough, 2006) to study citizen participation in healthcare initiatives. Kohlbacher, Herstatt, and Levsen (2015) study innovation among older citizens and how opportunities arise from the demographic changes related to older people, without explicitly stating any theoretical foundation. Jacobs and Zulu (2012) build their work on the theory of value innovation (Kim & Mauborgne, 1999) to study innovation in small agribusiness in Africa. Hwang and Christensen (2008) use the theory of disruptive innovation to come up with a framework for business model innovation in the healthcare sector. The work of Terrio (2014) is built on the ideas of reverse innovation, an emerging theory, to explain the diffusion of innovations developed for developing world markets into the developed world. Otieno (2012) uses innovation theory (Schumpeter, 1934) and Alfred Marshall's theory of entrepreneurship to develop a framework for linking mobile application innovations to entrepreneurial opportunities in Kenya. Musara and Fatoki (2010) use economic efficiency theory to study the effects of technological innovation on banks.

Iipito (2015) uses the diffusion of innovation theory (Rodgers, 1995) as a basis for his study to investigate the use of ICT by youth to obtain information on reproductive health in South Africa. Huang and Lin (2014) employ a combination of the technology acceptance model and diffusion of innovation (Rodgers, 1995) to study individual innovativeness and their propensity to adopt tele-health services. Erbil and Akinciturk (2010) use the diffussion of innovation theory to study the process through which innovation is disseminated in architectural firms.

Vargo, Wieland and Akaka (2014) employ a combination of institutional theory (Giddens, 1984) and SDL to explore the role of institutions in service innovation. Frow, Nenonen, Payne, and Storbacka (2015) build on the ideas of SDL to develop a framework for managing co-creation design. Stickdorn, Frischhut and Schmid (2014) use SDL as one of the guiding principles in their study, which leads to the development of an application that supports mobile ethnography. The work of Xing, Ness and Lee (2013), in which they come up with a service innovation model, is based on systems theory and SDL.

2.3.6 Findings

2.3.6.1 Developing world studies

The success of mobile technology in East Africa in the late 2000s has given rise to interest in how mobile technology can be exploited for profit or improvement in service delivery in the developing world. Many innovation studies in the developing world have centred on the use of mobile technology and with few exceptions have been undertaken in Kenya. In one such study, Otieno (2012) finds that market needs, profit motives, and supportive systems were drivers of mobile application development in Kenya. The study also found that entrepreneurship in this area was aided by a thorough understanding of the industry, a supportive ecosystem and continued ICT infrastructure development. Linna (2012), in a study of base-of-the-pyramid (BOP) markets as a source of innovation, finds that the profitability of BOP innovations is still questionable. A number of challenges still exist in this market, such as finding the right business model, the ever-changing market of the mobile industry, which is being used to drive many of these innovations, as well as identifying the best way to diffuse these innovations, especially where rural and remote communities are concerned. The study also identifies the process of innovating at the BOP itself as a challenge, requiring deep understanding of target markets.

Gregersen and Trischler (2014), in a study of the renewable energy sector in Kenya, find that firms engage in process, supply and market innovation, but predominantly incremental innovation. The study also identifies unique characteristics of business models prevalent in the sector. These include customer-centric design, bundling of products and micro-distribution, all of which are key for the commercialisation of innovations. Mercer (2012) finds that consumers have the ability to convey their aspirations, which can lead to the design of products. The study also observes that meeting some user needs can lead to the development of other products.

The study by Iipito (2015) finds that innovations must be context-sensitive to the environment they are aimed at if they are to remain relevant. Cultural sensitivity was found to be particularly relevant and service designers were advised to pay attention to this. A number of characteristics were identified as appropriate for a mobile application designed for use by the youth. These characteristics included clarity and readability, colourfulness, fun and entertainment, simplicity and being interesting, using the right language, ensuring the right privacy and confidentiality and cultural sensitivity. Jacobs and Zulu (2012) find that there is little knowledge of what value innovation is among small farmers in South Africa and they therefore recognise few signs of value innovation.

2.3.6.2 General innovation studies

Cabello-Medina, Carmona-Lavado, Perez-Luno and Cuevas-Rodriguez (2011), in a study of innovation in Spanish firms, find that innovative firms employ highly skilled employees who are creative and willing to develop new ideas and knowledge. The most successful innovators have strong institutional knowledge storage in the form of procedures, routines and scripts. Highly innovative firms have been found to have strong internal social capital, characterised by quality relationships among individuals involved in innovation activities. Finally, the study demonstrates a strong correlation between firm performance and innovation activity.

Chao, Lin, Cheng and Tseng (2011), studying the effect of leadership on innovation, find that leadership style directly affects the capacity of employees to innovate. Furthermore, they conclude that the culture of an organisation has an impact on both the leadership style and the innovative capacity of the organisation. Markic, Likar, Mesko, Rasic and Zivkovic (2011) study the impact of innovation policy on the success of small businesses in Slovenia. The study concludes that innovation policy, particularly in terms of the frequency of introduced changes, co-financing, financial support initiatives, promotional programmes and innovation planning, has a positive impact on small business performance. The study by Ogbo, Okechukwu, and Ukpere (2012) into innovation in the telecommunication sector in Nigeria collaborates the finding by Markic, Likar, Mesko, Rasic, and Zivkovic (2011) on frequent introduction of changes leading to innovative behaviour by firms.

Kohlbacher, Herstatt and Levsen (2015) investigate opportunities that arise from demographic changes, for example in ageing populations, giving greater insight into exploitation of opportunities related to demographic change, management of innovation related to older users, opportunity recognition and exploitation. The study by Stickdorn, Frischhut and Schmid (2014) finds that the use of mobile technology for ethnography study yields deeper, richer and more valid data beyond what online reviews would be able to provide.

2.3.6.3 Findings from healthcare studies

Weng, Huang, Kuo, Huang and Huang (2011), in their study of Taiwanese hospitals to understand the drivers of technological innovation and their effect on hospital performance, found that market factors have little impact on the technological innovation adopted by hospitals, while the size of a hospital, its ownership and teaching status are critical factors in the conduct of innovation. Technological innovation itself was found to have a positive impact on ambulatory performance, emergency performance as well as the in-patient performance of hospitals. Birken, Lee, Weiner, Chin and Schaefer (2013) studied the role of middle managers as change agents in healthcare innovation implementations, finding that success was closely related to their commitment, evidenced through proactiveness in implementation. In a subsequent study, Birken, Lee, Weiner, Chin, Chiu and Schaefer (2015) investigated how senior managers' support increased the commitment of middle managers to innovation in hospital settings. The study found that communication, resource allocation and leveraging performance management systems helped ensure commitment of middle managers to implementating innovations.

The study by Huang and Lin (2014) on the effect of innovation on the acceptability of tele-health services finds that individual innovativeness encourages acceptance of new technology through more positive attitudes, higher perceived usefulness and higher perceived ease of use as predicted by the technology acceptance model. Price and St John (2014) focus their work on innovation in laboratory service in healthcare, concluding that innovation in healthcare should be focused on meeting the needs of the patient and those responsible for the patient's care.

2.3.7 Summary

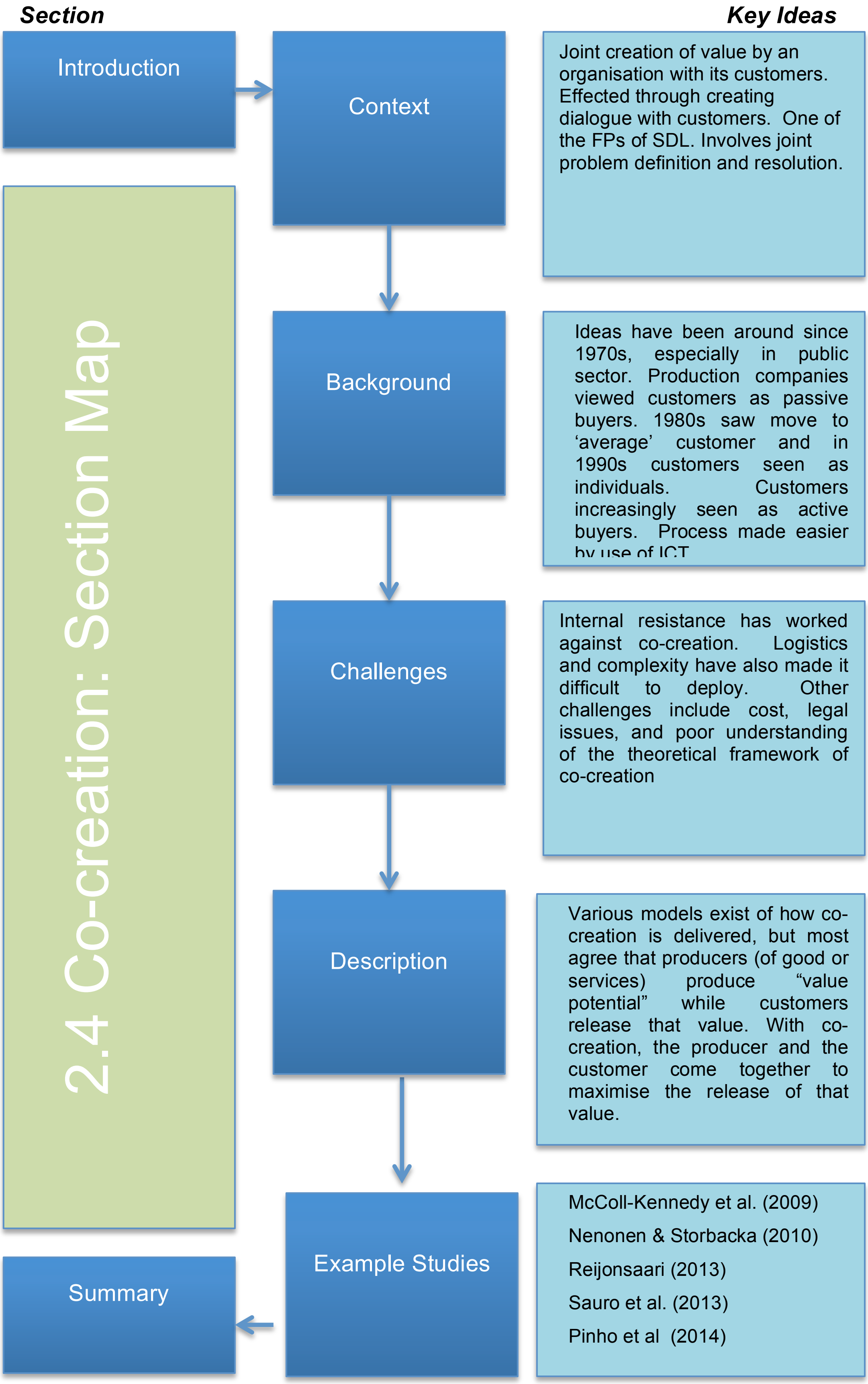
Innovation encompasses the initiation of change that results in benefits for the organisation initiating the change, as well as its customers and other stakeholders. Innovation includes products, services, processes, organisations, markets, technology, business models or administrative structures. Viewed differently, innovation could be seen as radical, resulting in completely new products or services, or incremental. The term reverse innovation has been used to describe a process through which innovations in the developing world are being employed in the developed world. The source of innovation could be new knowledge or understanding, new technology, research and development work, diversity in the workplace or simply a change somewhere in the value chain that forces a change in the way things are done elsewhere. The use of the market as a source of innovation has led to the growing trend of open innovation and co-creation as a basis for coming up with new ideas that organisations can exploit.

While innovation has been around since time immemorial, the most prominent studies of innovation date back to the work of Schumpeter (1934) and have continued to evolve over the years. Current innovation studies focus on all aspects of life, from financial services, healthcare, technology and public services to hospitality. While innovation is now seen as a must-do activity for businesses, this has not always been so. Innovation has gone from being illegal and a crime against humanity prior to the nineteenth century to becoming a necessary instrument for business and its current status as a source of value in itself.

Although innovation, both in products and services, is generally accepted as positive, organisations face a myriad of challenges in trying to implement innovations, for reasons both internal and external. Internally, culture, skills and resources stand out as the biggest barriers to innovation. The difficulties of managing and controlling innovation also stand in the way of innovation. According to Abernathy and Utterback (1978), the innovation environment of an organisation changes as it develops, making management of innovation even more difficult. The results of innovation activities may not be obvious and in some cases may not be noticed by customers, leaving organisations to question the wisdom of innovation activies. Externally, the competitive landscape, regulation and the political environent determine the innovativeness of an organisation. Despite these setbacks, Kandampully (2002) describes a form of innovation inflation, where innovation by an organisation creates the expectation of more innovation by its customers.

Models of innovation have evolved over time as more effort has gone into understanding the process of innovation. While the earliest models saw innovation as a black box, or a linear process that moved basic research into products and services, later models incorporated feedback, representing innovation as a set of cyclical processes. More recent models have focused on the effect of collaboration on innovation, both upstream and downstream, the effect of technology, as well as understanding of other disciplines such as biology, thermodynamics and organisational theory. The emergence of innovation hot spots such as Silicon Valley has elicited interest in location-specific innovation.

Current academic work in innovation is producing output in three main areas. Several studies have been undertaken that lay out a research agenda for innovation in the future, with the areas of smart cities, living laboratories and co-innovation taking centre stage. While over the last few years a number of frameworks for guiding innovation work have been produced, examples of studies producing useful artefacts have also been cited. The success of the mobile-based M-Pesa system in Kenya has spawned interest in innovations that use the mobile phone and a number of studies in East Africa have followed this route. Most of the literature reviewed in this study is silent on the theoretical roots of the work, other than stating that it is rooted in innovation literature. Where the theoretical base is explicitly stated, the literature studies follow three dominant themes: general theories about innovation, diffusion of innovation and technology acceptance studies and lastly those building on SDL.


Section
Key Ideas
Introduction
Context
Joint creation of value by an organisation with its customers. Effected through creating dialogue with customers. One of the FPs of SDL. Involves joint problem definition and resolution.
2.4 Co-creation: Section Map
Background
Ideas have been around since 1970s, especially in public sector. Production companies viewed customers as passive buyers. 1980s saw move to 'average' customer and in 1990s customers seen as individuals. Customers increasingly seen as active buyers. Process made easier by use of ICT
Challenges
Internal resistance has worked against co-creation. Logistics and complexity have also made it difficult to deploy. Other challenges include cost, legal issues, and poor understanding of the theoretical framework of co-creation
Description
Various models exist of how co-creation is delivered, but most agree that producers (of good or services) produce "value potential" while customers release that value. With co-creation, the producer and the customer come together to maximise the release of that value.
Example Studies
McColl-Kennedy et al. (2009)
Nenonen & Storbacka (2010)
Reijonsaari (2013)
Sauro et al. (2013)
Pinho et al (2014)
Summary

2.4 Service-dominant Logic and Co-creation

2.4.1 About co-creation/co-production: What is co-creation/co-production

The EU (2014) describes co-creation as joint creation of value by an organisation and its customers, allowing all customers to co-construct the service experience to suit their own context. This definition is consistent with an earlier definition by Prahalad and Ramaswamy (2000) who add that co-creation involves problem definition and solving by creating an atmosphere through which dialogue is possible and customers experience variety and innovative personal experiences. Vargo and Lusch (2004) build on the work of Prahalad and Ramaswamy (2000) in describing all interaction between customers and organisations as being part of the service delivery process. Vargo and Lusch (2004) describe eight foundational premises (FPs) that describe this emerging “service-dominant logic”. These are later expanded to 10 premises (Lusch & Vargo, 2006; Lusch & Nambisan, 2015) as illustrated in Table 4. One of these premises (FP_6) explicitly identifies the customer as a co-producer in every service delivery process. Zwass (2010) distinguishes between sponsored co-creation, in which customers participate in co-creation activities at the behest of companies, and autonomous co-creation, in which customers participate at their own volition as part of the consumption process.

Table 4: Fundamental Premises of Service-dominant Logic

(Lusch & Vargo, 2006; Lusch & Nambisan, 2015)

FP_1	Service is the fundamental basis of exchange
FP_2	Indirect exchange masks the fundamental basis of exchange
FP_3	Goods are a distribution mechanism for service provision
FP_4	Operant resources are the fundamental source of competitive advantage
FP_5	All economies are service economies
FP_6	The customer is always a co-creator of value
FP_7	The enterprise cannot deliver value, but only offer value proposition
FP_8	A service-centred view is inherently customer-oriented and relational
FP_9	All social and economic actors are resource integrators
FP_{10}	Value is always uniquely and phenomenologically determined by the beneficiary

In Service-dominant logic 2025 (Vargo & Lusch, 2017), the authors return to their 2004 work and offer a simpler, more succinct presentation of their original proposition that in their own words has undergone a genesis of its own. The FPs are repositioned as five axioms, focusing not only on service as the basis of value exchange, but also the roles of the various actors that have an impact on the exchange of value. The five axioms of SDL are summarised in Table 5.

Table 5: The Axioms of Service-dominant Logic (Vargo & Lusch, 2017)	
Axiom $_1$	Service is the fundamental basis of exchange
Axiom $_2$	Value is co-created by multiple actors, always including the beneficiary
Axiom $_3$	All social and economic actors are resource integrators
Axiom $_4$	Value is always uniquely and phenomenologically determined by the beneficiary
Axiom $_5$	Value co-creation is coordinated through actor-generated institutions and institutional arrangements

Bovaird and Loeffler (2013) describe co-production as a way of getting professionals and citizens to 'milk' each other's capability to maximise use of the other's assets, resources and contributions to achieve better outcomes. Terblanche (2014) distinguishes between co-creation and co-production by limiting co-creation to the use of customer knowledge as an input to the service creation process, while in co-production the customer participates in the production and delivery of a product. Terblanche (2014) argues that while co-creation is consistent with the service-dominant logic proposed by Vargo and Lusch (2004), co-production is more akin to a goods-dominant logic (GDL) (see Table 7 for a comparison of SDL and GDL). Hilton and Hughes (2008) argue that co-production is only a part of the co-creation process, relating to the customers' experience prior to, or during the usage or consumption of a service, as opposed to the entire customer experience. McColl-Kennedy, Vargo, Dagger, and Sweeney (2009) argue that co-creation is an unavoidable and multi-party value creation process while co-production is a less compulsory but more effortful involvement of customers in the value creation process, as is found in self-service activities. Despite these arguments, a systematic review of the literature on co-creation and co-production by Voorberg, Bekkers and Tummers (2013) shows that co-creation and co-production have been used and continue to be used interchangeably, a position that is adopted by this study.

Prahalad and Ramaswamy (2004) caution that while co-creation encompasses customer engagement, it is not about customer focus or assuming that the customer is always right. While co-creation involves co-construction to suit a customer's context, it is distinct from good customer service. Co-creation should be active dialogue with customers, resulting in joint problem definition and problem-solving as opposed to transferring activities from the firm to customers. The focus of co-creation should be on customising the customer's experience as opposed to customising products or creating a segment of one. While companies must still engage in meticulous market research and demand side innovation, co-creation allows the business to co-create personalised experiences and provide an innovation platform for customers (Table 6).

Table 6: What co-creation is and is not (Prahalad & Ramaswamy, 2004)	
What co-creation is not	What co-creation is
Customer focus Customer is king or customer is always right	Co-creation is about joint creation of value by the company and the customer. It is not the firm trying to please the customer.
Delivering good customer service or pampering the customer with lavish customer service	Allowing the customer to co-construct the service experience to suit his/her context
Mass customisation of offerings that suit the industry's supply chain	Joint problem definition and problem-solving
Transfer of activities from the firm to the customer as in self-service Customer as product manager or co-designing products and services	Creating an experience environment in which consumers can have active dialogue and co-construct personalised experiences; product may be the same (e.g., Lego Mindstorms) but customers can construct different experiences
Product variety	Experience variety
Segment of one	Experience of one
Meticulous market research	Experiencing the business as consumers do in real time Continuous dialogue
Staging experiences	Co-constructing personalised experiences
Demand-side innovation for new products and services	Innovating experience

The EU (2014) credits co-creation with providing a source of ideas for innovation while providing a platform for cross-fertilisation of ideas and idea generation through sharing of experiences. Through co-creation, companies are able to arrive at innovations that are less risky for both companies and their customers and are likely to offer greater benefit to both parties. Companies are likely to go to market faster, at lower cost, with greater product quality, leading to lower prices and greater satisfaction for the customer. Indirect benefits include greater customer loyalty, increased perceived value and increased chances of positive word-of-mouth communication leading to greater competitive advantage for the firm.

While co-creation in the private sector dates back to the early 2000s, the idea has been explored in the public sector since the early 1970s (De Witte & Geys, 2013). De Witte and Geys (2013) describe co-creation/co-production as an attempt to move away from a "relieving logic" in which citizens are mere consumers of governments services to an "enabling logic" in which citizens are empowered to co-produce services with service providers. Sauro, Sara, and Alberto (2013) describe co-production in healthcare as the contribution of service users to the production of services, noting that this redefined relationship between professionals and users challenges the expert-layman equation, since the users are seen as the experts in their personal circumstances. Pinho, Beirao, Patricio and Fisk (2014) study the complexity of co-creation in healthcare, noting the many interactions and collaborations that are necessary between doctors, nutritionists, dieticians, pharmacists, physiotherapists, social assistants and families. This acknowledgement of complexity confirms earlier findings by McColl-Kennedy, Vargo, Dagger, and Sweeney (2009) that co-creation activities involve numerous members of a service delivery network, including family, friends, other patients, health professionals and the outside community. These players come together to carry out not only core activities related to the service being provided, but also proactive activities that are performed beyond the confines of the current service provision.

Table 7: Goods-dominant vs. Servicedominant Logic

(Vargo et al., 2008)

	Goods-dominant logic	Service-dominant logic
Value driver	Value-in-exchange	Value-in-use or value-in-context
Creator of value	Firm, often with input from firms in a supply chain	Firm, network partners and customers
Process of value creation	Firms embed value in ‘‘goods’’ or ‘‘services’’, value is “added” by enhancing or increasing attributes	Firms propose value through market offerings, customers continue value-creation process through use
Purpose of value	Increase wealth for the firm	Increase adaptability, survivability and system wellbeing through service of others
Measurement of value	The amount of nominal value, price received in exchange	The adaptability and survivability of the beneficiary system
Resources used	Primarily operand resources	Primarily operant resources, sometimes transferred by embedding them in operand resources and goods
Role of firm	Produce and distribute value	Propose and co-create value, provide service
Role of goods	Units of output, operand resources that are embedded with value	Vehicle for operant resources, enables access to benefits of firm competences
Role of customers	To ‘use up’ or ‘destroy’ value created by the firm	Co-create through the integration of firm-provided resources with other private and public resources

Table 7 summarises the arguments of Vargo, Maglio and Akaka (2008), that while value is exchanged in GDL, value is created during use in SDL. The role of creator of value moves from the firm to a co-creation model in SDL. The role of the firm is reduced to that of proposing value and the creation of value being effected during use. While in GDL firms attach a price as a measure of value, in SDL the adaptability and survivability of the offering matter. Resources used in creating value in GDL are primarily operand resources while in SDL, operant resources are used with operand resources embedded. Whereas customers use up or destroy value in GDL, customers co-create value in SDL.

2.4.2 Background to co-creation/co-production: The history of co-creation/co-production

Co-production as a concept has been around since the 1970s in the public sector when public administrators began to take advantage of the involvement of citizens in the design of services (De Witte & Geys, 2013). Initially developed by academics led by Ostrom at Indiana University, the team focused on identifying the role of users in service delivery (Dunston et al., 2009). Cahn, who developed this work further, worked with volunteers to create time banks for the volunteers' benefit. In the 1980s, the ideas of co-production were employed in the health sector in the UK to help understand the relationship between healthcare workers and their patients. Further development of co-production in the UK in the 1990s was driven by a need to find a more effective and efficient method of service delivery in health (Realpe & Wallace, 2010).

The period since the 1970s has been one of evolution and transformation of customers and the way companies view them (Prahalad & Ramaswamy, 2000). In the 1970 and early 1980s, customers were viewed as passive buyers with predetermined roles of consumption. Companies viewed customers as part of an average statistic, with groupings pre-determined by the company, and one-way communication was targeted at the customer. In the 1980s customers were viewed as individual (as opposed to average) statistics in transactions, with companies shifting from selling to the use of help desks, call centres and customer service programmes to help identify customer problems. Products were subsequently designed based on feedback from these customer interactions. Two-way communication became mainstream, with companies building up databases of their customers, leading to lifetime bonds with customers. In the 1990s customers were seen as individuals, with companies taking steps to cultivate relationships and trust. Companies set out to observe users and identify solutions based on the needs of lead users, reconfiguring products and services based on a deeper understanding of the customer.

The work of Prahalad and Ramaswamy and others in the 2000s resulted in companies regarding customers as active players, who participate in the value creation process as co-creators. Co-creation dates back to the late 1990s when it was defined as "engaging customers directly in the production or distribution of value" (Kambil et al., 1996). In addition to extracting business value from interactions with companies, customers are collaborators, co-developers and even competitors. Customers have moved from being individuals to become part of a broader social and cultural tapestry developing personal experiences based on their interaction with companies. Active dialogue has become the norm for companies that recognise these phenomena.

The proliferation of ICTs and web technologies specifically allowed co-creation to become mainstream in the later 2000s and beyond (Zwass, 2010). Communities of volunteer developers are being incorporated in businesses along with the products these communities have developed. Companies are tapping into communities of practice set up by users, from which they are deriving substantial knowledge for use in the development of their products. Blog aggregators have built online newspapers that serve the very community that contribute the content. Companies such as CNN have set up platforms such as iReport, where anyone armed with a phone camera can report on events in their own community. Game companies provide platforms through which gamers set up virtual lives that build monetary values for the companies maintaining the platforms.

In the public sector, the return of co-production and co-creation to the mainstream after a lull in the 1980s has come at the behest of public reforms brought about by scepticism in target- and process-based models of public service delivery (Needham & Carr, 2012). Other drivers include calls for devolution of power down to front-line staff and citizens, pressure to increase efficiency and reduce costs and an increasing respect for user-generated knowledge. Linders (2012) notes that while efforts at co-production in the past were limited by governments' ability to coordinate citizens and the ability of citizens themselves to self-coordinate, the internet has enabled growth of co-production to unprecedented levels. Although academic work has trailed behind the actual implementation of these trends, practice has welcomed co-production with both the Obama administration in the USA and the Cameron government in Britain working on initiatives, in the words of David Cameron, "… to put government in the people's hands" (Linders, 2012).

Voorberg, Bekkers and Tummers's (2013) systematic review of co-creation and co-production literature shows a predominance of research from education and health among the empirical studies reviewed, showing increased interest in co-creation in health. Bovaird and Loeffler (2013) discuss a number of contemporary co-creation initiatives in the UK and Spain in the health domain. Similar recent studies have been conducted in Sweden (Elg et al., 2012), in Australia (Dunston et al., 2009), in the UK (Hewison et al., 2012) and in Italy (Sauro et al., 2013), all of which demonstrate the growing interest in co-creation in the health sector around the world. This study adds a developing world dimension to knowledge about co-creation in healthcare.

2.4.3 Challenges and complexities

Six broad areas stand out as presenting challenges in the implementation of co-creation initiatives. Issues of resistance are most frequently cited in the literature, followed by issues related to the logistics and general complexity of the ideas of co-creation. At least two publications reviewed point to cost as a challenge for co-creation and another two draw attention to the legal minefield that has to be negotiated. Lack of a strong theoretical understanding of co-creation is also cited as problematic.

Co-creation challenges the power relationship that exists between the service provider and those that have typically been seen as consumers of the service, but who are now participating in the creation of the service. In expert-based scenarios such as those found in healthcare (Dunston et al., 2009) the doctor or nurse, who has traditionally been the expert, now has to share the stage with the patient, who is in essence the expert in his or her own circumstances. This has led to resistance to this power-sharing on the part of the traditional expert, a phenomenon that has also been observed in the public service (Osborne & Strokosch, 2013). Hardyman, Daunt, and Kitchener (2015) regard this resistance as stemming not only from threats to power, but also threats to professional status and competing perspectives on knowledge, serving to influence the direction and outcome of co-creation activities. Isett and Miranda (2014) attribute resistance by professionals to reluctance to implement changes proposed by less knowledgeable customers, which may lead to poor service delivery. Needham and Carr (2012) observed in their study of social care transformation that initiatives occasionally fail as a result of resistance from staff to participate in co-creation activities.

Resistance on the part of those who have typically been recipients of services arises from reluctance to be ordered around in the manner in which employees can be ordered to follow certain procedures (Linders, 2012). Citizens viewing co-creation activities as efforts to off-load work from public service providers to them have also been known to resist efforts at co-creation (Linders, 2012). Linders (2012) also attributes resistance to participation in co-creation activities to being uncomfortable with the process. Needham (2008) attributes resistance to co-creation to a blurring of responsibility between service providers and users, leading to a potential shifting of costs and risks to users.

Logistical issues are also seen as a challenge to successful co-innovation. Osborne and Strokosch (2013) question organisations' ability to ensure that both service providers and customers have access to the right tools and training required to make co-creation a reality. Hewison, Gale, and Shapiro (2012) cite difficulties in organising and arranging meetings between service providers and customers, pointing out that access to customers is not a given. Osborne and Strokosch (2013) state that setting up a mechanism for co-creation is no guarantee that the mechanism will be used. Linders (2012) highlights that even when given the opportunity, very few customers actually participate in initiatives. Linders (2012) also points out that where user participation happens, participants are typically the more educated and the wealthier, eliminating a large portion of the population. Needham and Carr (2012) argue that because of the stronger emphasis on relationships when compared to traditional service delivery, co-creation demands staff continuity, which may be difficult or costly to achieve.

Issues of complexity are a major challenge to co-creation activities. Prahalad and Ramaswamy (2000) describe customers as complicated and heterogeneous individuals who are difficult to understand, making it difficult to shape services around them. While issues of culture make customers even more difficult to engage (Dunston et al., 2009), Prahalad and Ramaswamy (2000) encourage companies to engage customers actively on an on-going basis, recognising their diversity. Prahalad and Ramaswamy (2000) argue that successful companies are those that understand the purpose, meaning and quality of dialogue from a customer perspective. Nenonen and Storbacka

(2010) point to the complexity of coordinating value creation between insiders and outsiders as inhibiting co-creation activities. Elg, Engstrom, Witell and Poksinka (2012) place the burden of managing this complexity on the host companies, arguing that they should re-engineer their process to accommodate customers as opposed to expecting customers to re-shape themselves to allow co-creation to happen.

Customer preferences are not necessarily aligned with the company's goals (European Union, 2014). This mismatch presents a dilemma for the organisation. Meeting the customers' preferences may prove costly, inefficient and undesirable for the organisation, yet ignoring their wishes may paint the organisation as uncaring and unconcerned about their customers' desires. Vargo and Lusch (2004) argue that co-creation involves a change in perspective by both the customer and the company, which change may not be easily forthcoming. Etgar (2007) argues that companies need to understand fully how and why customers engage in co-creation activities, integrating this with deep understanding of the products and processes that can benefit from the introduction of co-creation activities.

Co-creation presents the risk of destruction of value for the company, the customer, or both (Terblanche, 2014). While co-creation presents the customer with an opportunity to gain economically and the opportunity for the company to create an emotional bond with the customer, co-creation efforts may lead to high stress for employees and lower job satisfaction. Increased customer participation means less control by the company, which may lead to failure of initiatives. Customers may lack the necessary skills and knowledge to appreciate the company's value proposition fully, leading to the failure of co-creation activities. A co-creation effort that goes wrong may therefore result in an unhappy customer lost for life. Voorberg, Bekkers and Tummers (2013) point to a need to understand customers' motivation fully if a company wishes to embark on co-creation activities. In addition to understanding customers' risk appetite, firms need to understand their participating customers' characteristics such as skills, marital status, family composition and level of education, as well as their desire to become part of something meaningful and their appreciation for adding value to social capital.

The issue of cost is also highlighted by Needham and Carr (2012) as a hindrance to successful implementation of co-creation initiatives, as sustained, secure funding is required to keep such initiatives running. The EU (2014) cites cost as a deterrent for smaller companies wishing to embark on co-creation initiatives, pointing out that online communities, which are necessary to create such initiatives, take time and money to build. The EU (2014) also highlights that customers feel more inclined to co-create with better-known businesses, yet small businesses struggle to get the funding required to build the exposure that customers expect. Osborne and Strokosch (2013) warn that co-creation may not lead to lower costs for companies because of service fragmentation and over-customisation.

Legal issues present an added complication to co-creation, especially where multiple regulatory authorities are concerned (European Union, 2014). Firms engaging in co-creation therefore need to be prepared to negotiate through a "minefield" of laws between different counties. Even in circumstances where only one jurisdiction is concerned, the conditions that relate to the provision of a service when customers co-create a service may include additional legal complications that may not have been anticipated by either the customers or the company (Etgar, 2007)

Lack of a solid theoretical understanding of co-creation is a challenge that affects its proper implementation. Hardyman, Daunt and Kitchener (2015) point to the lack of conceptual clarity and widespread disagreement about 'participation' and what it means. McColl-Kennedy, Dagger, and Sweeney (2009) point out that while there is little empirical research about the participation of customers in co-creation, there is enough evidence to point to a failure to optimise customers' roles in co-creation. Gronroos and Voima (2012) argue that there is no consistent understanding of value and the nature of value co-creation. Reijonsaari (2013) refers to lack of qualitative research linking customers' participation in co-creation activities and the value they derive from such activities. Saarijaarvi, Kannan, and Kuusela (2013) question who the beneficiaries of a co-creation exercise are, questioning the measures used to determine the value creation. The authors go on to question the methods employed, resources employed and the effort required by either party as issues that are yet to be empirically addressed. Nenonen and Storbacka (2010) refer to lack of understanding of the interface through which participants in a co-creation exercise interact and what resources each party is expected to bring to the table.

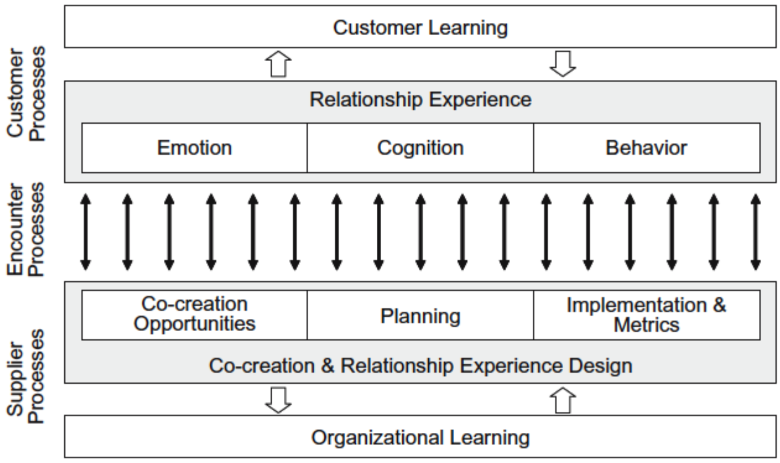
2.4.4 Description and processes

A number of papers have been published in the last 10 years that attempt to capture and describe the process of co-creation. Etgar (2007), in a theoretical paper, describes the process of co-production, highlighting five discrete stages. The first stage involves the establishment of what Etgar calls "antecedent conditions", or the conditions necessary for co-production to take place. These include environmental factors, cultural factors, encouraging technological innovations, situational factors, as well as consumer and product factors. The second stage involves the development of motivational factors that will encourage customers to participate in co-production activities. These include the development of economic, psychological and social drivers, while minimising any risk customers may view as being associated with participating. The third stage involves the evaluation of costs versus benefits associated with participation, followed by an activation stage. The fourth stage, activation, includes all activities that include design, assembly, manufacturing and construction, along with distribution and logistics, resulting in the consumption of a good or use of a service. The fifth and final stage is an evaluation stage, in which the co-producing parties evaluate the success of failure of their initiative.

Payne, Storbacka, and Frow (2008) describe a conceptual framework (Figure 14) for managing value co-creation, in which customers and companies learn from interacting with one another. In this process, customers bring to the table their emotions, cognitive abilities and behaviour. Companies contribute co-creation opportunities, planning, implementation and metrics. Payne, Stobacka and Frow (2008) describe three types of encounter processes through which value is co-created: communication encounters, usage encounters and service encounters. Their paper argues that value co-creation is maximised by optimising encounter design such that customers understand a company's value proposition better, and companies on the other hand have a better understanding of customer drivers.

Figure 14: A conceptual framework for value co-creation

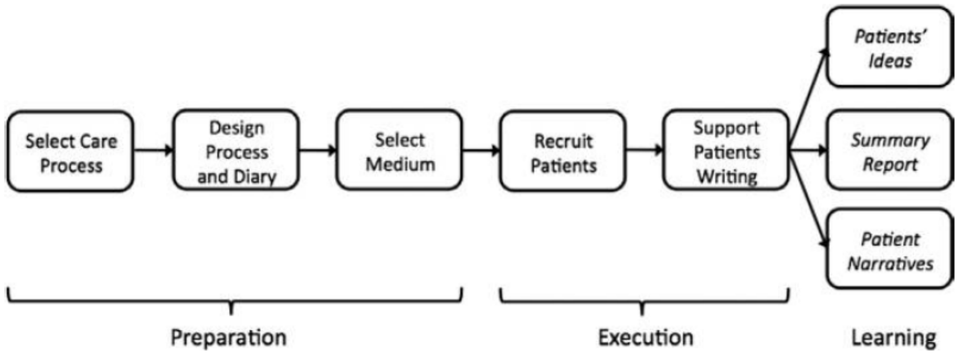
(Payne et al., 2008)



The idea of co-learning is also explored in a model for co-creation and learning developed by Elg, Engström, Witell, and Poksi (2012), as shown in Figure 15. In their model, healthcare providers select a care process, design a process and diary, and select a medium of delivery as part of the preparation process. In executing the planning, patients are recruited and support is provided for patients. In the learning phase patients' ideas and narratives are captured and a summary report is produced. The researchers, who use the model to follow 53 patients in orthopaedic, rehabilitation and gastroenterology care, position the model as a means to document patient feedback, as well as a means to develop healthcare services with patient input.

Figure 15: A model for patient co-creation and learning

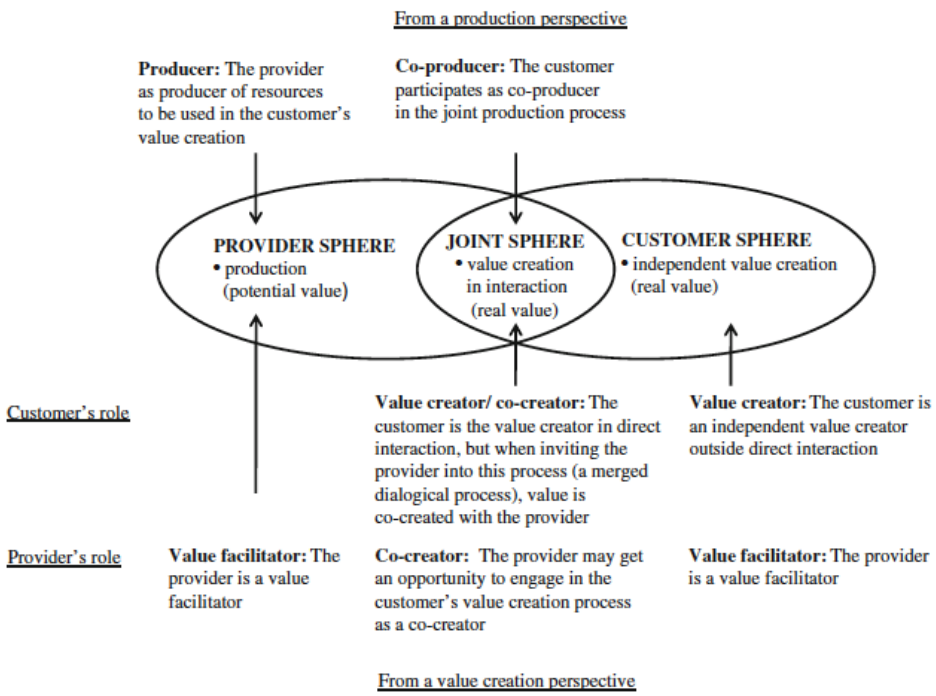
(Elg et al., 2012)



Gronroos and Voima (2012) depict co-creation (Figure 16) as occurring in three spheres. In the provider sphere, value-in-exchange is created during the process of design, development and manufacturing (which typically happens in the back office) and delivery (front office). In the customer sphere, value-in-use is created during consumption of a product or use of a service. Viewed from a production perspective, the provider is seen as a producer of resources to be used in a customer's value creation process while the customer acts as a joint producer in a joint sphere. Viewed from a value creation perspective, the provider's role is to act as a value facilitator, with an opportunity to work with the customer in the joint creation of value in the joint sphere.

Figure16 : The locus of value co-creation

Source : Gronroos & Voima (2012)

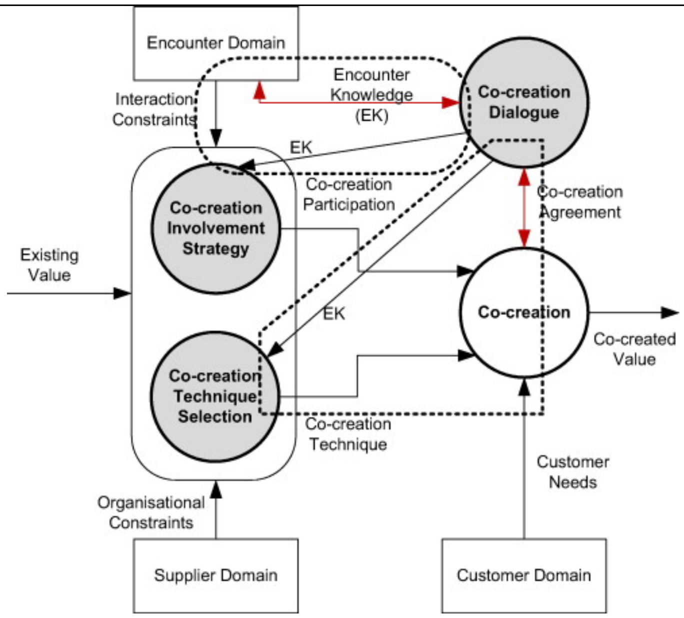


Durugbo and Pawar (2014) propose a unified model of the co-creation process (Figure 17), identifying three domains that are similar to the three spheres from the work of Gronroos and Voima (2012). The customer domain is characterised by customer requirements, while the supplier domain is characterised by organisational constraints. The encounter domain is characterised by interaction constraints. The co-creation process takes as its input the value that would have been obtained without co-creation and through an appropriate engagement strategy and technique, with the necessary co-creation dialogue, produces co-created value.

Sauro, Sara and Alberto (2013) describe a co-creation process with four concurrent phases, namely co-design, implementation, experimentation and evaluation. This process is shown with no starting point, allowing activity to start at any point and end at any point. In the co-design phase, the focus is on scoping, ideation and elicitation through workshops, interviews, brainstorming, ideas competitions and crowdsourcing. Tools employed include mind mapping, questionnaires, brain writing and role-playing. The implementation phase includes engineering, exploration and development using tools such as mock-ups and prototyping. The experimentation phase consists of screening, recruitment, exposure and data collection through observation. Other tools in use include diary keeping, interviews, emotion cards, shadowing, trials and simulation. Evaluation includes analysis and validation, insight generation and drawing up conclusions and outcomes. Expert evaluation, ergonomic evaluation, focus groups and usability tests are among the tools used in the evaluation phase.

Figure 17: A unified model of the co-creation process

(Durugbo & Pawar, 2014)

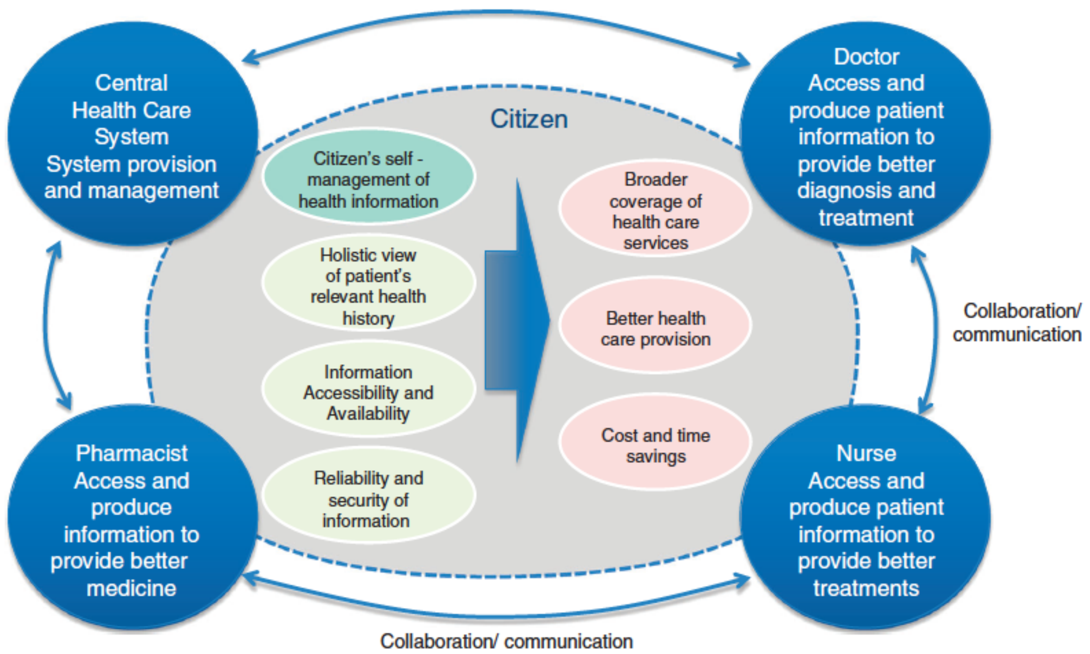


The co-creation Living Lab methodology described by Sauro, Sara, and Alberto (2013) marks a significant departure from the three-sphere models encountered thus far, focusing instead on interaction that customers have with products that allow them to co-create value, highlighting the role of the user as an active participant in the value creation process. The research team uses the methodology to develop and test a patch that works with a mobile application to collect vital patient information in a health setting. A major finding from the study was that while the patch collected vital information that could be used in delivering services to patients, patients appeared to value the application more, as it provided them with additional information about their health

Pinho, Beirao, Patricio, and Fisk (2014) return to the traditional three-domain model, identifying a citizen domain, a service provider domain and a collaboration domain (Figure 18). In a study on the use of electronic health records, citizen self-management of health information is used to present a holistic view of the patients' history leading to improved, cost-effective service delivery. Service providers through the collaboration domain have better access to information, allowing them to make more effective decisions on diagnosis, treatment, medication and other services.

Figure 18: Value co-creation through electronic health records

(Pinho et al., 2014)



While numerous models have been proposed for co-creation, many of them are focused on the three worlds of the service provider, the customer and an interaction zone. Different terminology is used in the different models, but most of the models reviewed appear to agree that both parties in each of these zones create value. In the service provider domain, the service provider is the dominant partner, while in the customer domain, the service provider is less dominant. In the interaction domain, both parties come together to work on creating value. These ideas are in line with the idea of an actor-to-actor network in a service ecosystem as proposed by Lusch and Nambisan (2015).

2.4.5 Examples of studies in -creation/co-production and their findings

A number of empirical studies have been conducted into co-creation, looking at various aspects of the process of co-creation and in the process validating some of the conceptual work conducted in the 2000s.

Nenonen and Storbacka (2010), in a review of the literature, followed by interviews with 12 managers in international businesses, investigate business models that incorporate co-creation. The study concludes that co-created value is maximised when both the provider of services and the customer configure their business models, both internally and externally, to fit each other. This finding appears consistent with the findings of Chen, Tsou and Ching (2011), who survey 157 sales managers from information technology (IT) businesses in Taiwan, focusing on co-creation of value in a business-to-business setting. Their study concludes that the value generated is dependent on the compatibility of the partner businesses, the history of relations between the parties, effective communication and expertise. The doctoral study by Reijonsaari (2013) looks at the effects of co-creation in a healthcare setting, focusing on the effect of a physical activity intervention on sickness, absence and work productivity. The study concludes that although interaction between service providers and consumers is necessary for co-creation, interaction by itself is not co-creation. The research highlights the needs for co-creation to be tailoired to suit the circumstances and the consumer, a finding that resonates with that of Chen, Tsou, and Ching (2011), as well as that of McColl-Kennedy, Vargo, Dagger, Sweeney, and Van Kasteren (2012).

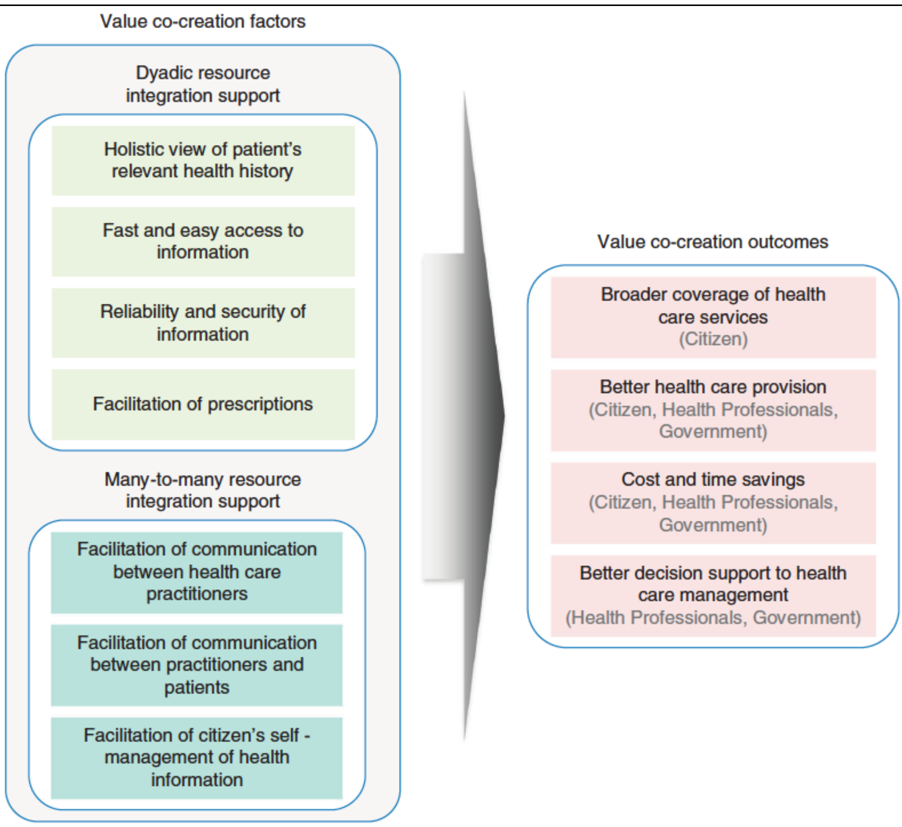
McColl-Kennedy, Vargo, Dagger, Sweeney and Van Kasteren (2012) propose a theoretical framework linking customer co-creation styles to outcomes based on 20 interviews and focus groups with patients. Their findings suggest that six different co-creation styles: “team manager”, “isolate controller”, “partner”, “spiritualist”, “adaptive realist” and “passive compliant”. Each of these demonstrates a unique ability to co-create, with some styles being associated with a high quality of life as opposed to others.

Elg, Engström, Witell and Poksi (2012) undertake an action research study to understand co-creation in healthcare services development using 53 patients. The study proposes a model for co-creation, focusing on how diaries can be used as a means to learn from patients and the use of information can be generated to innovate service delivery. The co-creation Living Lab methodology described by Sauro, Sara and Alberto (2013) focuses on the interaction that customers have with products that allow them to co-create value, highlighting the role of the user as an active participant in the value creation process. The research team uses the methodology to develop and test a patch that works with a mobile application to collect vital patient information in a health setting. A major finding from the study was that while the patch collected vital information that could be used in delivering services to patients, patients appeared to value the application more, as it provided them with additional information about their health.

The research by Bendapudi and Leon (2003), based on an experiment with university students, showed that the more closely related consumers were to a firm, the more they saw themselves as co-creating joint value with a company as opposed to engagement as self-service. Pinho, Beirao, Patricio and Fisk (2014) report on a qualitative study into co-creation in the Portuguese health service focusing on the perspectives of the multiple actors involved in delivering and receiving services. Their study identifies a number of attributes related to value co-creation through an electronic health record such as availability of a comprehensive view of a patient's history, easier access to information, realiability of information and easier access to prescription information. The study also identifies a number of attributes (Figure 19) that support co-creation in this setting, such as communication between patients and healthcare providers, communication between healthcare providers and self-management of patient information.

Figure 19 : Value co-creation in value networks

(Pinho et al., 2014)



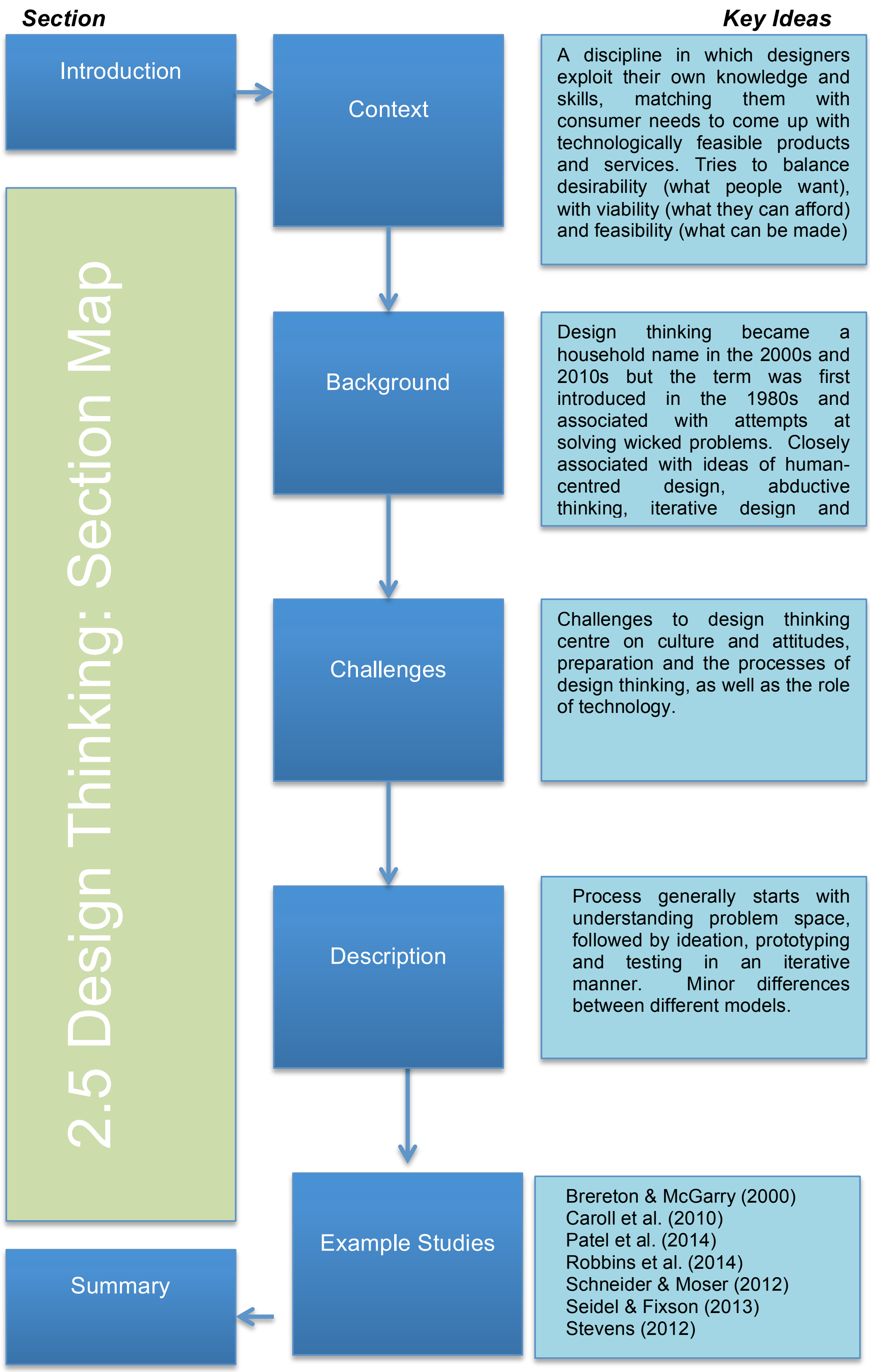
Zhang and Chen (2008) use a quantitative approach to study the mechanism of co-creation in a study of 300 companies in China. The study provides emperical evidence that shows that companies that co-create are better placed to meet customer needs, referred to as having better customerisation capability, and have a better service capability. Nordgren (2009), using mainly secondary data and her own experiences, studies co-creation in health in Sweden. The study concludes that co-creation in health leads to improvements in quality of life, accessibility of health services, trust, communication, avoidance of suffering and avoidable deaths.

2.4.6 Summary

The essence of co-creation lies in getting companies and their customers to work together to create value, preferably for both parties. SDL encapsulates this thinking by redefining value creation from being production of goods to a process of delivering a service in which the recipient plays a part. Work done in the period since the early 2000s has consolidated the thinking on co-creation and research since then has contributed to creating better understanding of how co-creation should be conducted and what the challenges arising from co-creation are likely to be. Various models of co-creation have been proposed, with many of these focusing on different aspects of a three-'zone' model consisting of a provider zone, a customer zone and an interaction zone. The ideas of co-creation have been applied to all industries, both product-based and service-based.

The health sector has been one of the industries that experimented with co-creation. Studies have shown numerous benefits associated with co-creation for both service providers and healthcare customers. The sector has not been immune to the challenges associated with co-creation, with healthcare workers, traditionally the experts in healthcare, in the form of doctors, nurses and pharmacists, feeling threatened by newly empowered patients who are experts in their own circumstances. Issues of costs, legal aspects, logistics and general resistance have been cited as standing in the way of successful implementation of co-creation activities.

A number of empirical studies have strengthened the case for co-creation. These studies have shown that managing the engagement process is at the heart of successful co-creation. Companies that are able to model themselves into a form that make it easy for customers to engage, and are able to engage customers that are able and willing to participate, make for successful co-creation relationships. Companies that maintain long-term productive relationships with their customers are also able to derive maximum value from co-creation activities.


Section
Key Ideas
2.5 Design Thinking: Section Map
Introduction
Context
A discipline in which designers exploit their own knowledge and skills, matching them with consumer needs to come up with technologically feasible products and services. Tries to balance desirability (what people want), with viability (what they can afford) and feasibility (what can be made)
Background
Design thinking became a household name in the 2000s and 2010s but the term was first introduced in the 1980s and associated with attempts at solving wicked problems. Closely associated with ideas of human-centred design, abductive thinking, iterative design and
Challenges
Challenges to design thinking centre on culture and attitudes, preparation and the processes of design thinking, as well as the role of technology.
Description
Process generally starts with understanding problem space, followed by ideation, prototyping and testing in an iterative manner. Minor differences between different models.
Example Studies
Brereton & McGarry (2000)
Caroll et al. (2010)
Patel et al. (2014)
Robbins et al. (2014)
Schneider & Moser (2012)
Seidel & Fixson (2013)
Stevens (2012)
Summary

2.5 Design Thinking

2.5.1 About design thinking: What design thinking is

The book "Change by Design" by Tim Brown (2009) discusses the way in which design thinking helps transform organisations by fostering innovation. Brown (2008), in a Harvard Business Review article, defines design thinking as a discipline in which designers exploit their own knowledge and skills, matching them with consumer needs to come up with technologically feasible products and services. Key to this method of design is a thorough understanding of people's wants and needs that comes from observing their lives. This process is conducted in an environment that tries to balance desirability (what people want), with viability (what they can afford) and feasibility (what can actually be produced) (Brown, 2014). Cooper, Junginger, and Lockwood (2009) associate design thinking with three essential aspects of thinking: thinking of, thinking about and thinking through. In design thinking, one imagines, visualises and dreams, which are all aspects of thinking of something. Design thinking is also associated with considering, reflecting and deliberating, the essence of thinking about something. Finally, in thinking through, one tries to understand, grasp or work something out; all of which are also associated with design thinking.

According to Lindberg, Koppen, Rauth, and Meinel (2012), design thinking differs from analytical thinking in three key ways. Where analytical thinking depends on a thorough understanding of a problem, design thinking employs intuitive and preliminary information about a problem, allowing for multiple and sometimes conflicting perspectives of different stakeholders. Problems are seen as "wicked" and attempts are made to "tame" the problem as opposed to structuring it as in an analytical approach. Martin (2010) argues that neither analysis nor intuition alone is enough, putting forward the argument that successful companies balance analytical mastery with intuitive originality that is design thinking. Design thinking is more commonly associated with abductive thinking, in which designers think about what could be, as opposed to focusing on past data (Leavy, 2010). Kimbell (2009), quoting widely from the literature, characterises the modes of reasoning in design thinking as being a combination of inductive, deductive and abductive thinking, a balancing of divergent and convergent thinking and a mode of design that is based on new possibilities as opposed to selecting between alternatives.

A key distinction of design thinking is a focus on learning about the problem from stakeholders as opposed to applying the knowledge of experts. Seidel and Fixson (2013) add that in design thinking, multidisciplinary teams, representing the different stakeholders, can use design methods to address a broad range of innovation challenges. Brown (2008) argues that one does not have to be a designer to benefit from design thinking. At the heart of design thinking is a process by which options are created and choices are made. Design thinking depends on observing how people actually use products and services. Design thinking forces those involved to think about how more can be done with less. Design thinking urges those responsible for shaping products and services to take into account the needs of the world at large, the environment included, in coming up with their designs. Increasingly the line between product and service and the line between consumer and producer are blurred. Design thinking enables a human-centred approach to the design process. This ethos means that innovation must be driven by thorough understanding, derived from observation, of what people need and want, what they like or dislike about the way the products/services they use are made, packaged, marketed, distributed and supported.

While the traditional designer has come from design school, design thinkers today come from all fields where innovation matters, a definition that includes a wide variety of fields. Design thinkers distinguish themselves by showing empathy, the ability to put themselves in the shoes of others. Design thinkers imagine the world from the perspective of colleagues, customers and end users, taking a people-first stance and observing the world in minute detail. Great design thinkers are, in the words of Steve Jobs (Temin, 2011), echoing the ideas of Martin (Martin, 2009), able to hold opposing views in their minds, using their integrative thinking ability to bring together the salient aspects of contradictory positions to develop novel solutions that go beyond existing solutions. Design thinkers exhibit great optimism, allowing them to continue to look for solutions where others have long given up. Design thinking does not progress in incremental steps, but looks for solutions in places that more conventional thinkers do not consider related to the problem. This calls for collaboration with professionals in different professions, bringing together engineers, marketers, anthropologists, sociologists and professional design engineers to work together on common problems.

Although over the years various models of design thinking have been proposed, the core of design thinking is built on three fundamental processes (Brown, 2008). The process of inspiration starts by identifying what the problem is and where the opportunity for improvement lies. It involves observing the world going about its business, what people want and need, why, how, where and when. Design thinkers try to understand the constraints, such as time, money, and market size, that affect the problem at hand, introducing the perspectives of different disciplines. This process tries to uncover the hidden assets that the business can bring to bear on solving problems: technology, expertise, intellectual property, assets and ideas. Ideation is a process through which options are put on the table, starting with brainstorming for ideas. Creative frameworks allow order to be created out of a chaotic environment by applying the ideas of integrative thinking, leading to quick prototypes that are tested, taking into account the observations of the world made during the inspiration phase. Finally, implementation is the execution of the strategy developed, with extensive communication both internally and externally. Throughout the life of a design thinking process, one repeatedly goes through a process of building up options and making choices, a process described as alternating between divergent and convergent thinking.

The Hasso Plattner Institute of Design at Stanford University (d.school, 2016) describes a five-'mode' process, which begins with empathising, in which designers observe, engage, watch, and list those for whom they are designing. Empathising leads to a define mode in which the things that stood out during observations are synthesised to build up a point of view that frames the question the designers want to answer. Ideation is the first attempt at finding solutions to the question(s) posed. An attempt is made to move away from obvious answers and to explore the unexpected. The prototyping mode involves the narrowing down of potential solutions and building up of prototype solutions. These are 'quick and dirty' solutions built with the user in mind, and meant to demonstrate what is possible. In addition to testing possibility, prototypes help the team start new conversations, communicate what is in their minds and decide quickly what must be abandoned before too many resources are devoted to it. Finally designers must move into test mode, in which solutions are shown to users and experiences that users can compare are created.

Brown (2014) sets out five principles that guide design thinking. Design thinking is human-centred, focusing on what will make life easier or more fruitful for those for whom solutions are being sought. Secondly, the process of design thinking emphasises learning from making things, putting prototyping at the centre of a design thinking initiative. Building prototypes is seen as an aid that speeds up thinking while making it possible to go to market quickly. Thirdly, design thinking encourages more than just storytelling, emphasising movement, participation, collaboration and even the showing of emotions as a way of bringing participants to the centre stage of building the design. Fear is eliminated by encouraging creative confidence, building trust and tolerating playfulness. Finally, asking the right questions ensures that the right problem is defined, and ultimately an appropriate solution is procured. Kolko (2015) summarises these principles into three core ideas: "empathy with users, a discipline of prototyping, and tolerance for failure." The principles outlined by both authors are aligned with an earlier specification of what a design thinker should look like (Brown, 2008). Brown describes design thinkers as demonstrating empathy, or the ability to imagine the world from multiple perspectives, placing themselves in the shoes of clients, colleagues, customers, and end users, observing the world in minute detail. Design thinkers are capable of experimentalism, willing to look for solutions beyond existing solutions, and moving beyond an incremental improvement mind-set. Design thinkers must have integrative minds, thinking beyond either/or answers, seeing the salient points of a problem and acknowledging any contradictions that may arise in how the problem is presented. Design thinkers must be willing to collaborate, bringing in skills from many different industries to bear on a problem. Finally, design thinkers must be optimists, willing to pursue at least one solution that is better than the current solution.

Table 8 summarises the characteristics of design thinking as documented by Owen (2007). Design thinking goes beyond what needs to be done and investigates why it is being done. Designs must be centred on beneficiaries of service as opposed to the firm that proposes the service. Design thinkers regard the impact of their designs as beyond the current offering, focusing on the big picture but without being unreasonable dreamers. Design thinkers are adaptive, offering solutions that have multiple benefits, arising from having a systemic view of the world around them. Design thinkers possess an affinity for teamwork and are able to use language as a tool for communicating their ideas. Design thinking avoids forcing users into making a choice, but allows a multitude of views to prevail.

Table 8: Characteristics of design thinking

(Owen, 2007)

1.	Conditioned inventiveness.	Design thinking goes beyond the 'what' and considers the 'why'.
2.	Human-centred focus.	How is what is being created going to respond to the end user?
3.	Environment-centred concern.	What will be the impact of the design on the environment?
4.	Ability to visualise.	Design thinkers must be able to bring a common view to a concept such that all those involved are able to see the bigger picture.
5.	Tempered optimism.	Designers must have an optimistic outlook, but should not be unreasonable dreamers.
6.	Bias for adaptivity.	Design should be adaptive to the evolving needs of users.
7.	Predisposition toward multifunctionality.	Design thinkers must come up with design that have multiple benefits (keeping the big picture in mind) and not have a single focus in their designs
8.	Systemic vision.	In line with predisposition toward multifunctionality, design thinking must consider a systemic view as opposed to a single focus
9.	View of the generalist.	While designers may be specialists in design, design thinkers must have as broad a world-view as possible, allowing them to reach out across multiple disciplines.
10.	Ability to use language as a tool.	Visual, verbal and mathematical language must be combined and used as tool to help tease out and suggest ideas in the design process.
11.	Affinity for teamwork.	Design thinking demands the ability to work in teams with people from different disciplines. Good designers are those who are able to work in such environments
12.	Facility for avoiding the necessity of choice.	Design thinking avoids forcing users to make a choice but incorporates all the requirements into a broader solution.
13.	Self-governing practicality.	Design thinkers explore what is possible but limit themselves to what is practical.
14.	Ability to work systematically with qualitative information.	Ability to work systematically with qualitative information.

For ICT practitioners, design thinking is not about building systems that they think users will want, but about building the systems with them. Prototyping is central to design thinking. Users get to touch and feel what they are going to get, while the astute designer observes not just their words but also their reactions, their emotions and their body language and uses this information to refine the design. Design thinking lies at the heart of co-innovation, allowing the end product to be a product of not only the designer, but the designer and those for whom the product is designed.

2.5.2 Background to design thinking: The history of design thinking

Design thinking has gained in popularity (Kolko, 2015) since the late 1980s when Rowe wrote a book titled “Design Thinking” (Rowe, 1987), focusing on the architectural industry. Its application has spread from traditional design fields such as architecture to ICT, business, education and even medicine. Although “Wicked Problems in Design Thinking” (Buchanan, 1992) is credited with bringing the term design thinking to prominence (Olsen, 2014), Buchanan in turn credits this thinking to earlier work in the 1960s by Horst Rittel, a German mathematician, designer and former teacher, who sought to find an alternative approach to the then predominant linear design process, in which design was regarded as being made up of a problem definition and a problem solution phase. Problem definition was seen as an analytic sequence in which all elements of requirements were specified. This was followed by a synthetic sequence in which requirements were combined and balanced against one another to reach a solution.

This sequencing was found to be inappropriate for wicked problems. Rittel (Buchanan, 1992) outlined wicked problems as a special class of social problems, which were poorly formulated, with confusing information being presented by many stakeholders with often conflicting values (Table 9).

Table 9: Rittel's Properties of "Wicked Problems"

(Buchanan, 1992)

1.	Wicked problems have no definitive formulation, but every formulation of a wicked problem corresponds to the formulation of a solution.
2.	Wicked problems have no stopping rules.
3.	Solutions to wicked problems cannot be true or false, only good or bad.
4.	In solving wicked problems there is no exhaustive list of admissible operations
5.	For every wicked problem, there is always more than one possible explanation, with explanations depending on the worldview (Weltanschauung) of the designer.
6.	Every wicked problem is a symptom of another, “higher level” problem.
7.	No formulation or solution of a wicked problem has a definitive test.
8.	Solving a wicked problem is a one-shot operation with no room for error.
9.	Every wicked problem is unique.
10.	Solvers of a wicked problem have no right to be wrong – they are fully responsible for their actions.

Singling out the work of Rittel may appear to belittle the work of other significant players wo have influenced the discourse on design thinking. In “The Sciences of the Artificial” (Simon, 1996), Simon, while focusing on artificial Intelligence, devotes space to an exploration of the science of design, arguing that anyone wishing to change his/her cause of action is a designer, a core tenet (Brown, 2008) of design thinking.

> “*Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artefacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences”*
>
> (Simon, 1996, p.111)

McKim’s “Experiences in Visual Thinking” (McKim, 1980) discusses an iterative prototyping process as being crucial to design. Archer (1979) discusses a designerly way of thinking in which problems are ill defined, with insufficient information available to define requirements fully. The article describes a way of thinking in which the designer’s attention “oscillates between emerging requirement ideas and developing provisioning ideas” (Archer, 1979, p.17). The use of imagery and modelling are put forward as ways to advance the design process. One of the earliest references to the term “design thinking” can be traced to Archer’s book "Systematic Method for Sesigners" (Archer, 1984).

The May 1991 workshop held at the Faculty of Industrial Engineering Design at Delft University of Technology in the Netherlands (Cross et al., 1991) on Research in Design Thinking brought together designers, engineers, a psychologist and an information systems researcher who shared their experiences in design thinking. This workshop showcased work being undertaken in various domains on design thinking at the same time that IDEO (Brown & Wyatt, 2010; Eng, 2013), a company that has become synonymous with design thinking, was being formed by David Kelly, a Stanford University professor, and others. In the latter half of the 2000s increased interest became evident as design thinking came to be accepted as a tool that could be used in solving business and social problems. Several books were published during this period that placed design thinking at the centre of innovation in organisations. These books included “The Opposable Mind” (Martin, 2009), “Outliers: The Story of Success” (Gladwell, 2008), “Change by Design” (Brown, 2009) and “Design Thinking : Integrating Innovation, Customer Experience and Brand Value” (Lockwood, 2010).

The Hasso Plattner Institute for IT Systems Engineering in Potsdam, Germany, working together with Stanford, in 2007 established a design thinking programme and began publishing an annual volume of research output on design thinking. In addition to increased interest in the business education sector (von Korflesch, 2012; Dunne & Martin, 2006), design thinking is increasingly being used to tackle highly unstructured problems in the field of social innovation (Brown & Wyatt, 2010) and healthcare (Czechowicz et al., 2013), among other fields.

Johansson-Skoldberg, Woodilla and Cetinkaya (2013), in an article reflective of the state of design thinking research, note that what is commonly known as design thinking is not a homogenous body of work, but a number of different discourses straddled between traditional academia and management thinking. Within the academic stream, the authors identify five distinct discourses, each with unique epistemological roots (rationalism, post-modernism, pragmatism, practice perspective and hermeneutics) that take a slightly different perspective on design thinking. One such approach, referred to as designerly thinking, is contrasted with the less rigorous approach adopted by the management thinkers who appear to follow three schools of thought. The IDEO-led school is focused on design thinking as a way of working to foster innovation, the Rotman School of Business focuses on design thinking as a necessary problem-solving tool for management, and the school led by Borland and Collopy (2004) views design thinking as part of management theory.

The development of design thinking, along with other innovation approaches such as scrum and agile (Rigby et al., 2015), may owe some of their roots to the work by Hirotaka and Ikujiro (1986). Aspects of design thinking, such as cross-functional teams, bear close resemblance to self-organising project teams in Hirotaka and Ikujiro's (1986) work. The concept of design spaces or modes in design thinking bear close resemblance to Hirotaka and Ikujiro's (1986) overlapping design concept. The ideas of trial and error relate very closely to prototyping in design thinking. It is not inconceivable then to assume that this seminal work will have influenced the conduct of design work in the years that followed.

2.5.3 Challenges and complexities

Interest in design thinking has grown recently (2005-2015), especially in the business community. Articles published on design thinking, including those in the academic literature, appear to extol the virtues of design thinking with little focus on the challenges, complexities, pitfalls and barriers to implementing design thinking projects (Liedtka, 2014). Some writers have argued against design thinking, arguing that it lacks a theoretical foundation, is lacking in "scientific rigor in terms of data assessment, analysis and interpretation" (Badke-Schaub et al., 2010) and is in fact a fad (Carlgren, 2013). This section sums up some of the challenges and complexities that have been highlighted by scholars in this field. This study finds that there are five broad areas in which design thinking projects become unstuck. These broad categories are culture and attitude factors, factors related to prepation for design thinking projects, factors related to the process of conducting design thinking projects and matters relating to the use of technology in design thinking.

2.5.3.1 Culture and attitudes

Brown and Wyatt (2010) point to the fear of failure as a major impedement to the successful deployment of design thinking projects, while assuring potential adoptors that failure should be an acceptable by-product of experimentation, a core tenant of design thinking. Carson, Carson and Hodge (2014) highlight the lack of desire for real change as an impediment to successful design thinking projects. Leifer and Steinert (2011) draw attention to general resistance to change not just within the design thinking project team, but within the greater community that may be affected by an innovation.

The design community struggles to shift from a focus on designing things (or "objects") to designing Things ("socio-material assemblies") that are tyically associated with design thinking projects (Bjögvinsson et al., 2012). Bjögvinsson, Ehn and Per-Anders also point to the shift from design for a community, to designing with a community as challenging for traditional designers. While acknowledging this as a challenge, Bjögvinsson, Ehn and Per-Anders (2012) note that an even greater challenge exists where the target social community is not in view and design is by proxy. In line with this thinking, Carson, Carson and Hodge (2014) point to a culture of operating in isolation as a barrier to successful implementation of design thinking initiatives.

According to Leavy (2010), organisations' bias toward reliabile solutions (as opposed to "valid" solutions) tends to drive them towards analytical thinking as opposed to abductive thinking that is encouraged in design thinking. Organisations therefore tend towards reliable solutions that produce known outcomes more predictably as opposed to solutions that produce desired outcomes. In arguing that design thinking is a failed experiment, Nussbaum (2011), argues that in implementing design thinking projects, large corporates that were sold the idea of a process that would deliver disruptive innovation soon turned it into "a linear, gated, by-the-book methodology that delivered, at best, incremental change and innovation". The result was that very few of these projects led to success. This observation resonates with the shift to 'reliability' observed by Leavy (2010). A similar argument is presented by Goldschmidt and Rogers (2013) who argue against rigidity in sticking to tried and trusted methods in favour of more fluid approaches in design thinking.

Cooper, Junginger and Lockwood (2009) decry design thinking projects as focusing more on the thinking and less on the making. Carr, Halliday, King, Liedtka and Lockwood (2010), in discussing the influence of design thinking on business, argue that differentiating between design thinking and design is a source of contention in organisations, which may lead to failure of design thinking projects.

2.5.3.2 Preparation for design thinking projects

Praparing for design appears to be as much a challenge for designers as the process itself. Koria and Karjalainen (2012) highlight the size and complexity of the players that are involved in design thinking projects, noting that many of them are likely to be new to design. An added complexity presented by these new players is that they have training and practices that are specific to their own areas of expertise and may be at odds with the traditional designer. Those brought into the team must have the right mix of skills and expertise to create the right environment for the creativity required (Lugmayr et al., 2014). Those planning design thinking initiatives must be able to generate the right “team spirit, awareness and attitude” for the project to succeed.

The ownership, leadership and resourcing of design thinking projects have been a challenge and have occasionally resulted in failed projects. In some organisations, the ownership of design thinking projects is disputed, leading to failure of the projects (Carr et al., 2010). The lack of visible local leadership, especially in the public sector space, is also seen as an inhibitor to success in design thinking projects (Carson et al., 2014). Rylander (2009) points to the challenges of getting highly experienced and qualified people from different disciplines to work together in a design thinking exercise without employing the normal bureaucratic forms of control. Adams, Daly, Mann and Dall'Alba (2011) mention the lack of a guiding framework for the development of design professionals as a challenge to design thinking.

Lugmayr, Stockleben, Zou, Anzenhofer and Jalonen (2014) refer to the logistical aspects of preparing for design thinking projects. Among the challenges facing design thinking teams are the creation of the right physical environment to encourage communication, provision of the necessary resources, including prototyping tools, and the selection of the participants in the exercise.

Being specific enough about the definition of a design challenge is important to ensure that the process runs smoothly. A design project may fail because of failure to set a specific enough design challenge at the start (Lugmayr et al., 2014). Cooper, Junginger and Lockwood (2009) note that those planning design thinking projects must be able to explain the “values and roles” of design in the organisation, while defining what design means for the organisation.

2.5.3.3 The design thinking process

The process of design is fraught with challenges that make many design thinking projects falter before completion. Kimbell (2009) argues that there is no “single authoritative definition or description of design or design thinking”, leading to confusion among potential users. Leading players in the industry argue about the exact meaning of design thinking, reflecting lack of coherence in the academic literature. Collins (2013), while acknowledging the potential value of design thinking, notes that design thinking faces the practical difficulty of being implemented by people who have been trained to work to a methodology and a series of processes such as total quality management and just-in-time manufacturing. This point resonates with the difficulties of 'processising' design thinking as alluded to by Leavy (2010), Nassbaum (2011), Goldschmidt and Rogers (2013) and others.

Seidel and Fixson (2013) argue against the excessive use of brainstorming in design thinking projects, highlighting that this can be counter-productive. Similarly, reflectivity, a tool used to put the activities of design thinking into context, can be highly inefficient, and in a study was found to lead to less successful results (Seidel & Fixson, 2013), especially during concept selection. Beckman and Barry (2007) attribute failure of some design thinking projects to the large amounts of data collected, especially during the observation phase, and state that making sense of this data, presented in numerous forms and formats, can be problematic for design teams.

Schon (1991) refers to the difficulties of communicating that hinder the smooth progress of design thinking projects. Koria and Karjalainen (2012) highlight the difficulties associated with operating in an increasingly global ecosystem of business networks, where building trust and assessing the ability of partners to keep their promises are difficult. This shift presents a problem for designers who have previously operated in restricted environments and currently have to cope with wider networks.

Bjögvinsson, Ehn and Per-Anders (2012) concern themselves with the challenges associated with engaging a broad spectrum of stakeholders engaged in the design thinking project, especially as co-designers. Equally challenging is the fact that not every potential consumer of a design is involved. Thus, while "envisaged use" by a representative sample of users maybe be useful, this may be at odds with actual use. Given the diversity in the backgrounds of participants in design thinking, one of the challenges in the design thinking process is the acceptance of fellow team members as peers (Lugmayr et al., 2014). Equally daunting is the need for people to accept themselves as peers of fellow participants, irrespective of their backgrounds, and the ability to set one's ideas free and not restrict them by prejudging them as being inferior to the ideas of others on the team.

2.5.3.4 Technology in design thinking

Technology affects design thinking work in a number of ways. Technology in this sense refers to the technology that could potentially be put to use in designs on which design thinking teams could be working. Lugmayr, Stockleben, Zou, Anzenhofer and Jalonen (2014) argue that design thinking sits at the intersection of business, user-centred design and technology. With this in mind, they point to the selection of appropriate technology for use in a design thinking project as being a challenge for those planning such projects. Teixeira, Patricio, Haung, Nobre-ga, Constantine and Fisk (2013) express concern at the rapid changes in technology and the impact this has on designers' ability to come up with technology-appropriate designs. Romme (2004) points out that technology feasibility (Brown,

2014) is an overriding constraint that designers much keep in mind in their designs. This overaching concern appears to limit the creativeness of design teams. In a study by Seidel and Fixson (2013), users reported that a concern with technical feasibility and viability limited their ability to design creative solutions.

Written response example of not benefitting:
"We got caught up with [whether] the technology or given budget is going to make this doable or sellable, which sort of limited our creativity a little."

(Seidel & Fixson, 2013)

Collins (2013) argues that designers must be constantly curious about developments in technology in order to open their minds to what can be incorporated in their designs. Leifer and Steinert (2011) note that end users, who may be part of a design team, may become confounded by the technology choices available, making it difficult for them to provide valuable input for the design process.

2.5.3.5 Summary of challenges in design thinking

Despite the large and growing fan base around design thinking, critics exist, with scholars such as Nassbaum (2011) leading the charge; these critics think that the time for design thinking is past. Design thinking faces challenges such as cultural attitudes that are routed in an inclination towards process-based thinking that leads to predictable results as opposed to the unpredictable 'chaotic' nature of design thinking. The ownership, leadership and resourcing of projects are as problematic as the management of the actual design thinking process. Technology, which lies at the heart of many new innovations, presents a problem for some design thinkers and has been shown to constrain creativity in some design thinking projects.

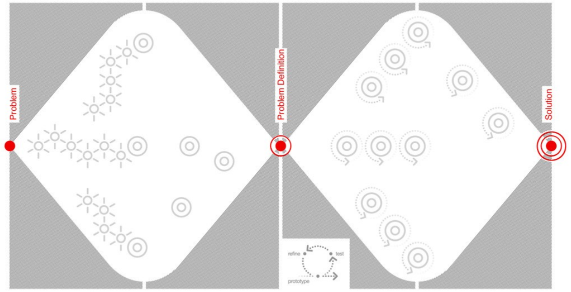
2.5.4 Description and processes

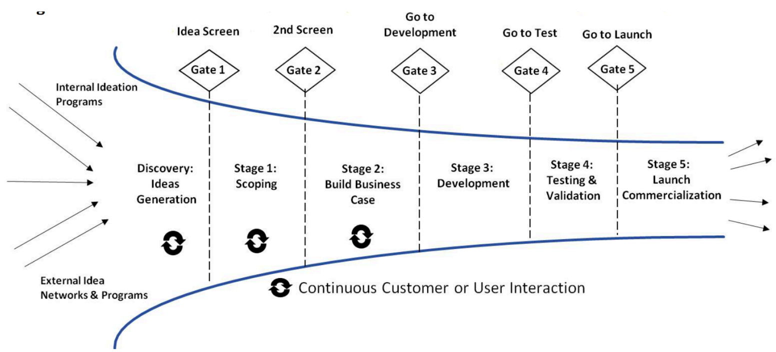
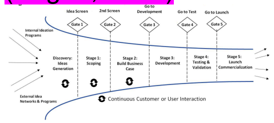
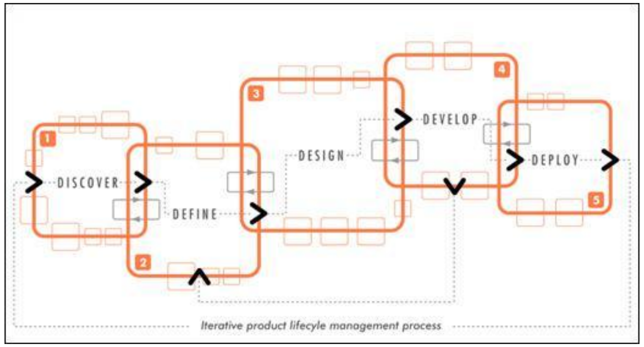
This section explores the "how to" of design thinking. A number of models are explored and a detailed look taken at a few that meet the criteria of design thinking as described in the introductory section above.

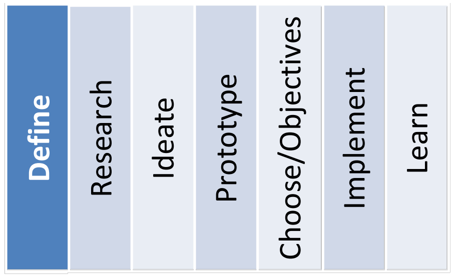
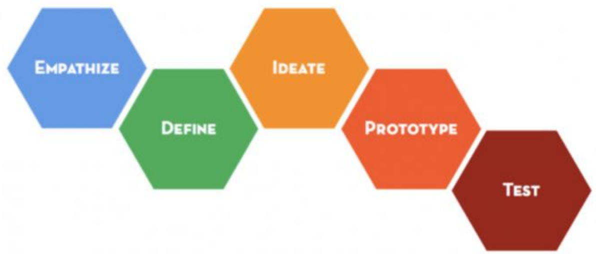
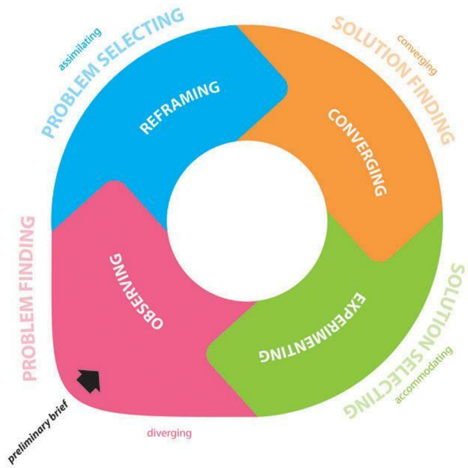
Brown and Wyatt (2010) describe the design thinking process as comprising spaces as opposed to a sequence of steps. Razzouk and Shute (2012) define the process of design as "iterative, exploratory, and sometimes chaotic", starting with a "brief" and terminating with a "product specification". Beckman and Barry (2007) define the process as being one of problem finding, problem selecting, solution finding and solution selecting.

2.5.4.1 Design Thinking Methodologies

The following section (Table 10) lists some of the models that have been used to guide design thinking processes. While the list is based on one found online, titled “Design Thinking Methodologies”, found at http://designthinkingmethodology.weebly.com/ (Yavari & Williams, 2012), the sources and descriptions provided below are based on original research. A detailed look at these methodologies reveals that only three follow what could strictly be classified as design thinking methodologies as defined in the introductory section about design thinking above. These are the Double Diamond by the Design Council, Bootleg by the d.school at Stanford and Designing for Growth by Liedtka and Tim (2011). These models, and two others not listed below, are described in more detail later in this section. The rest of the processes described below are either software development methodologies or new product innovation methodologies. All these models have been researched and are listed to provide an audit trail to the original list provided by Yavari and Williams.

Table 10: Design Thinking Methodologies **Source :** (Yavari & Williams, 2012)			
#	Name	Source	Description
1	Double Diamond 	(Design Council, 2007)	Double Diamond Designed by the Design Council in 2005, the model represents a process, which is divided into four distinct phases: discover, define, develop and deliver. The model tries to map the divergent and convergent thinking that design teams go through, allowing for short iterative loops to incorporate feedback within the phases. A study by the council (Design Council, 2007) into the design practices of 11 major corporations confirmed the use of similar processes.
2	4D 	(Trigent, 2016)	4D 4D is a software development methodology developed by a USA/Indian software development firm based on the waterfall method described later in this paper and bears a striking resemblance to the Double Diamond methodology described above. Activities are broken down into four phases: discover, design, develop and deploy. These activities allow the organisation to manage large teams for improved cost management, risk management and project documentation.
3	DeepDive 	(Boynton & Fischer, 2005)	DeepDive Based on the book "Virtuoso teams: Lessons from Teams that Changed their Worlds", this methodology provides a way for teams to dig into an issue quickly and develop innovative solutions. Teams are taken through a process in which they have to understand a situation (various tools may be used for this), observe people in real situations, visualise what a possible future could be like, evaluate and refine prototypes and finally implement their planning. Deloite holds a trademark on this methodology.

4	Stage Gate 	(Edgett, 2014) 	<u>Stage-Gate</u> A product development methodology, this model is focused on the management of the process of taking ideas to product launch. The process takes an innovation through several distinct phases, starting with an idea generation phase, followed by five distinct project phases. Scoping, largely desk-based, is followed by a detailed investigation in the build the business case phase. The development phase includes the actual design and development of the product, followed by testing and validation, leading to the product launch.
5	Pentathlon 	(Goffin & Mitchell, 2005)	<u>Pentathlon</u> The Pentathlon framework builds on the idea of an innovation process as an ideas funnel, taking many ideas through an ideas phase, prioritisation, and implementation, generating at the end innovations in the form of products, processes, or services. The Pentathlon framework adds two dimensions, innovation strategy (what the goals are, how they are communicated, what technology is used and how is it measured) and people and orientation dimension, which addresses the issues of culture, motivation and appraisal.
6	5D 	(Neubloc, 2014)	<u>5D</u> Although the author could not find a reference to a 5D methodology in innovation or design thinking in any of the libraries associated with the University of Pretoria or on Google Scholar, one company, Neubloc (Neubloc, 2014) describes a 5D methodology similar to the one described here. The company uses the methodology to design and develop software. The methodology starts with a discovery phase, in which the project scope and high-level requirements are defined. In the define phase, tasks and user interfaces are defined along with the content required to complete the solution. This leads to a design of the system that is then developed and deployed. While this bears resemblance to the Double D methodology with elements of the 4D

			methodology, this appears to be an adaptation that is focused only on software development projects.
7	Simon Herbert 	(Simon, 1996)	Simon Herbert Attributed to Simon Herbert, with a reference to the book "Sciences of the Artificial" (Simon, 1996), a casual examination of the book shows no reference to the model described; however, the concepts appear consistent with the ideas presented. The methodology defines a series of steps, starting with definition leading to implementation and learning.
8	Bootcamp Bootleg 	(Hasso Plattner Institute of Design at Stanford, 2010)	Bootcamp Bootleg (Stanford) This methodology appears to be one of the most comprehensively described methodologies on design thinking. A section of this paper is devoted to a detailed description of this process.
9	Donut 	(Beaumont, 2009),	Donut Based on an unpublished article by Beaumont (2009), the donut design methodology claims to be an iterative design process with four main "categories": problem finding (observing and research), problem selecting (reframing and contextualising), solution finding (converging and establishing core user needs), and solution selecting (experimenting and prototyping). The article argues for a model that promotes the same values with which design thinking is associated, such as user involvement throughout the design process, bringing together technology and human values, iterative design and experimentation.

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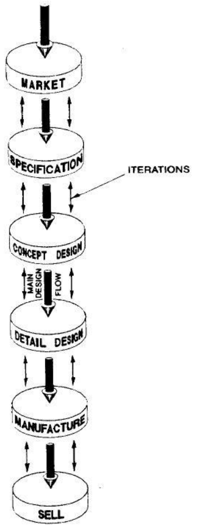
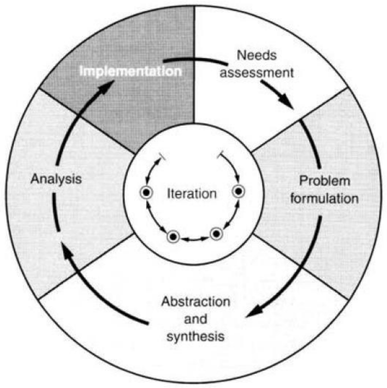
<td>10.</td>
<td>Stuart Pugh



</td>
<td>(Pugh, 1990)</td>
<td><u>Stuart Pugh</u>
Focusing on engineering projects, the book by Pugh describes a methodology that can be used in coming up with innovations through the use of a methodology that focuses on core design activities. These activities begin with a market assessment, production of a specification, concept design and detailed design leading into manufacture and ultimately marketing and selling. Similarities with other design thinking models are the use of convergent and divergent thinking, iterative processing and prototyping</td>
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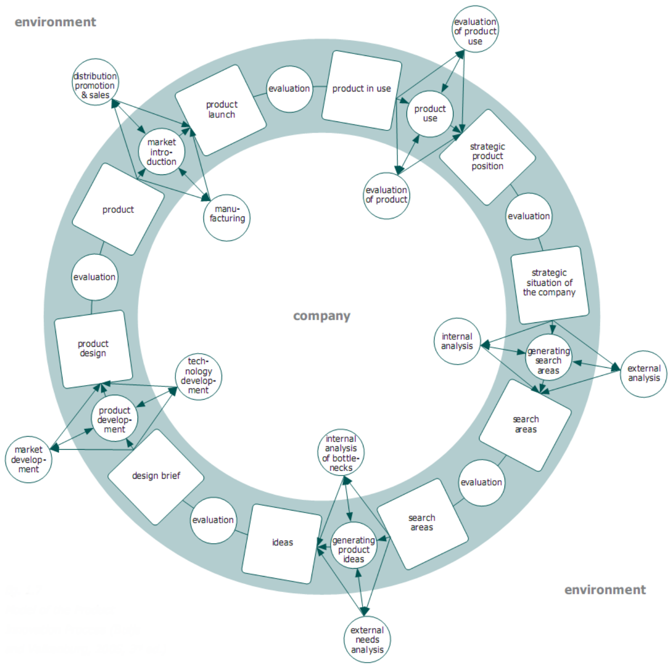
<td>11</td>
<td>Circular Chaos

</td>
<td>(Buijs, 2003)</td>
<td><u>Circular Chaos</u>
Based on an earlier linear model by the Delft Design School, the 2003 paper by Bujis presents a model that demonstrates the real life chaotic nature of innovation projects. The model takes the user through 26 design elements. These include product use, commercial/technical evaluation of product use, product positioning, the company's strategic situation, external/internal analysis, needs analysis, generation of product ideas, design briefs and product design, generation of product briefs, manufacturing, market introduction, product launch, distribution, promotion and sales.</td>
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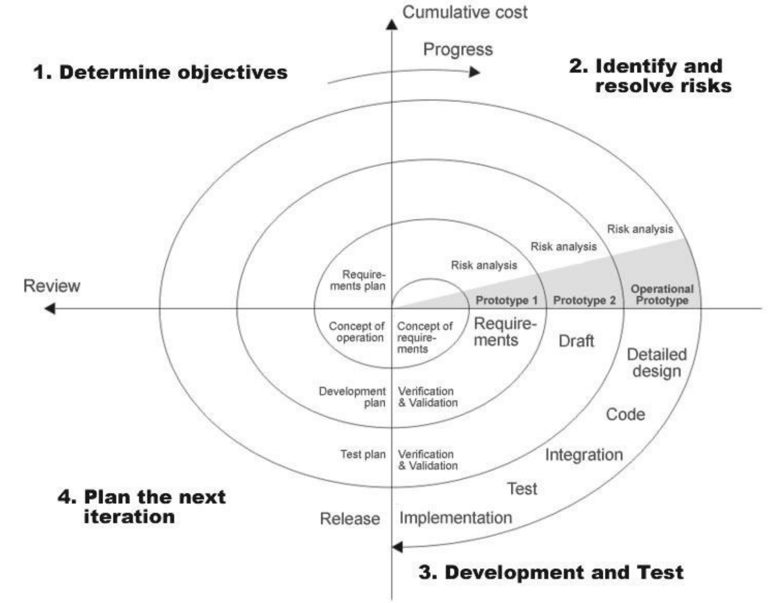
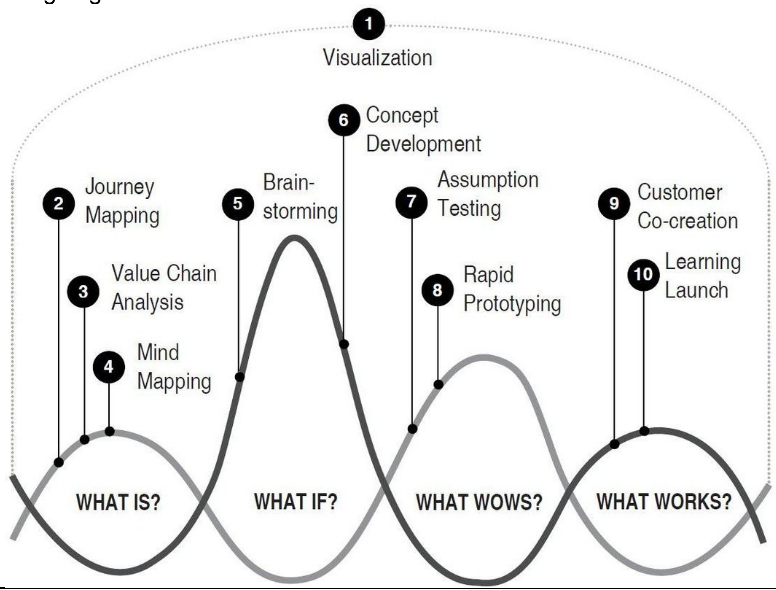
<tr>
<td>12</td>
<td>Spiral

</td>
<td>(Boehm, 2000)</td>
<td><u>Spiral</u>
The spiral model is based on a framework used for software development projects. In this model, ideas are taken through various iterations, each of which is assessed for risk and a prototype is developed. This process ends with an operation prototype, which is, then unit-tested, integration-tested and passed through user acceptance testing and finally implemented.</td>
</tr>
<tr>
<td>13</td>
<td>Designing for Growth

</td>
<td>(Liedtka & Tim, 2011)</td>
<td><u>Designing for growth</u>
This methodology mirrors some of the common design thinking methodologies, but reduces them to four key stages that answer specific questions. “What is” addresses the current reality, whereas “what if” envisions a future state. “What wows” is about making choices while “what works” is about taking products to market. The uneven waves in the model mirror the convergent and divergent nature of design thinking The model is equipped with a number of tools that help users manage the innovation process.

This model will be reconsidered in greater detail later in this thesis.</td>
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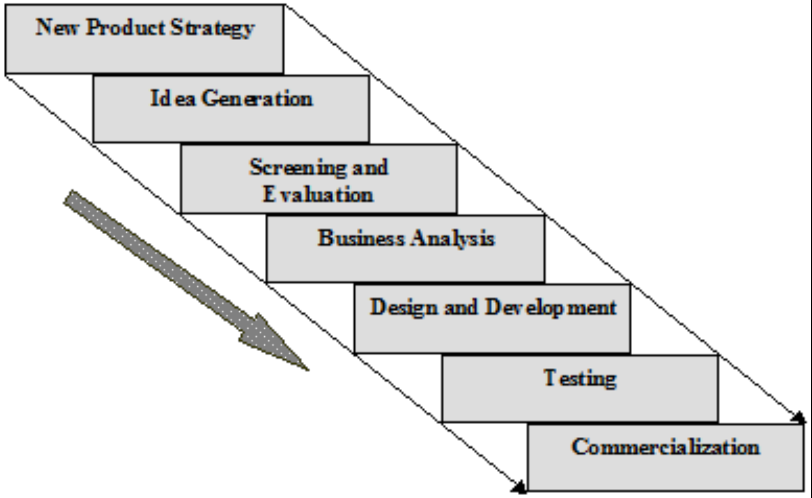
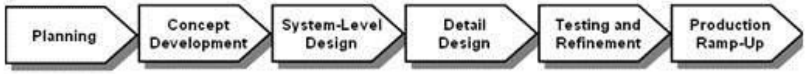
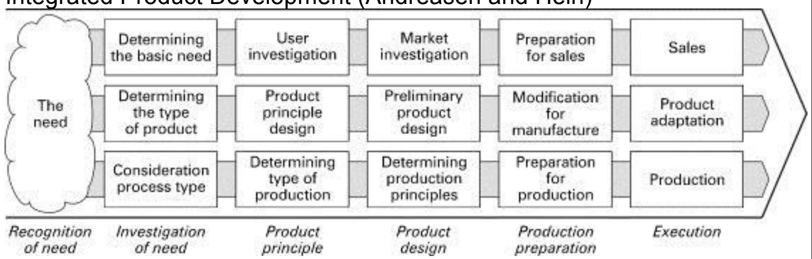
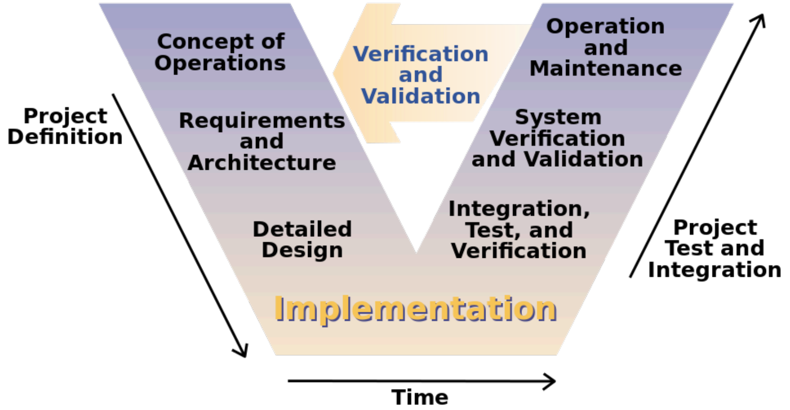
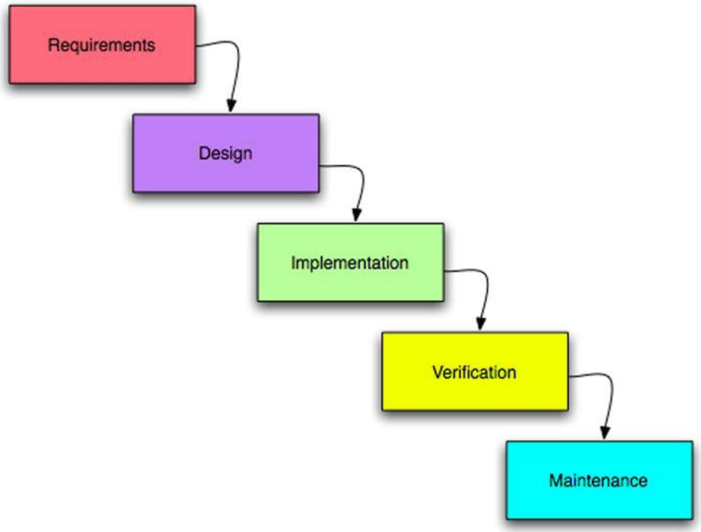
14	New Product Development (Booz, Allen & Hamilton)  	(Bhuiyan, 2011)	NPD (Booz, Allen & Hamilton) Bhuiyan (2011) describes a model for new product development that takes a development team through the stages of new product strategy, idea generation, screening and evaluation, business analysis, design and development, testing and finally commercialisation.
15	New Product Development (Ulrich and Eppinger)  	(Ulrich & Eppinger, 2004)	NPD (Ulrich and Eppinger) Another methodology in the new product development genre, which follows a very similar series of steps, starting with planning, concept development, system-level design, detailed design, testing and refinement and ending with production ramp-up.
16	Integrated Product Development (Andreasen and Hein)  	(Andreasen & Hein, 1987)	Integrated Product Development (Andreasen and Hein) This is a new product development that follows three parallel streams, starting at a single point of the need; but one with a focus on sales, another with a focus on product adaptation and the last on production. Each of the streams follows the same process of recognising the need, investigating the need, product principles, product design, production preparation and finally execution.

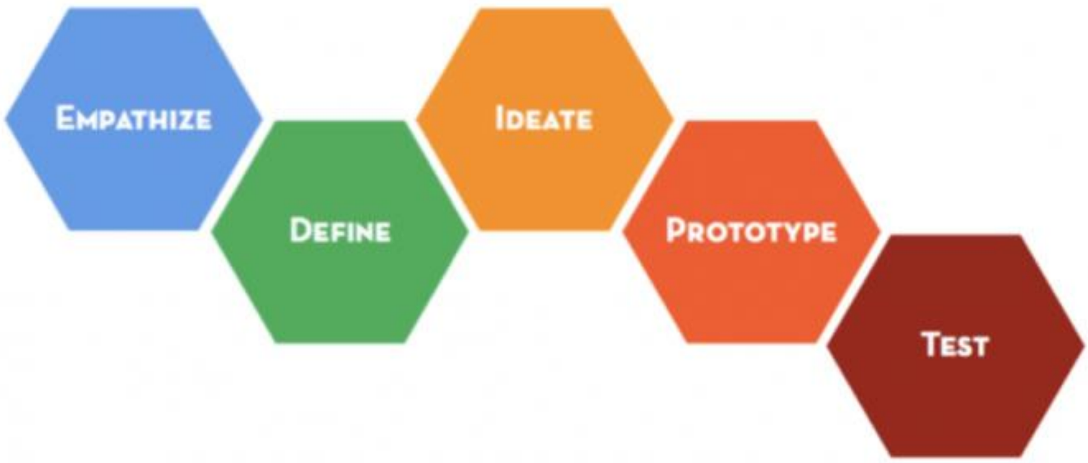
17	V 	(Forsberg & Mooz, 1994)	V The V model is a software development methodology that builds on the waterfall and the spiral methods.
18	Waterfall 		Waterfall The waterfall model is similar to the new product development models, but applied to software development. The process starts with requirements, followed by design, implementation, verification, and maintenance.

2.5.4.2 An introduction to the Stanford design thinking process

The bootcamp process (Figure 20) is described as consisting of five “modes”. These modes are empathise, define, ideate, prototype and test. Multiple interations of activities within a mode or across modes is encouraged. While a linear progression is suggested, users are encouraged to undertake a process that is appropriate for their problem and use the modes as guidelines for the generation and treatment of ideas.

Figure 20: Stanford design thinking process

(Hasso Plattner Institute of Design at Stanford, 2010)



Empathising is the work designers do to understand the users of their designs in the context of the problem for which a solution is sought. Empathy comes from immersing oneself in the user’s world and observing, paying particular attention to the dissonance between what people say they do and what they actually do. Engaging, as well as watching and listening, forms a vital part of the process of empathising. Empathising is an effort to “step into the shoes” of the target users and understand what their lives are about and why they do what they do. Empathising typically leads to a define mode. A necessary part of the transition to the define mode is the documentation and synthesis of the findings of the empathise mode, the output of which will be useful in the definition mode.

The define mode is focused on bringing clarity to the problem at hand, taking into account the situation of the user as understood while in the empathise mode. The define mode results in a point of view that frames the problem in a way that allows teams to be creative, while understanding the parameters within which competing alternatives will be selected. A well-defined point of view will motivate team members while allowing them to make decisions independently that will result in acceptable outputs. The define mode will transition into an ideate mode.

In the ideate mode team members focus their efforts on generating ideas that can be used in finding solutions in the later modes. Ideation represents the divergent thinking mode that is typically associated with design thinking projects. Team members are encouraged to develop as many solutions to the problem as possible, as opposed to offering only the “best” solution. Obvious solutions are dispensed with first, then members are challenged to think beyond everyday solutions. Critical to this mode is abstaining from making judgements on solutions, but focusing on producing potential solutions for later evaluation. Transitioning from ideate to prototype mode involves the selection of potential candidates’ solutions for further development. This process of selection is associated with convergent thinking, in contrast with the earlier stages of the ideate mode.

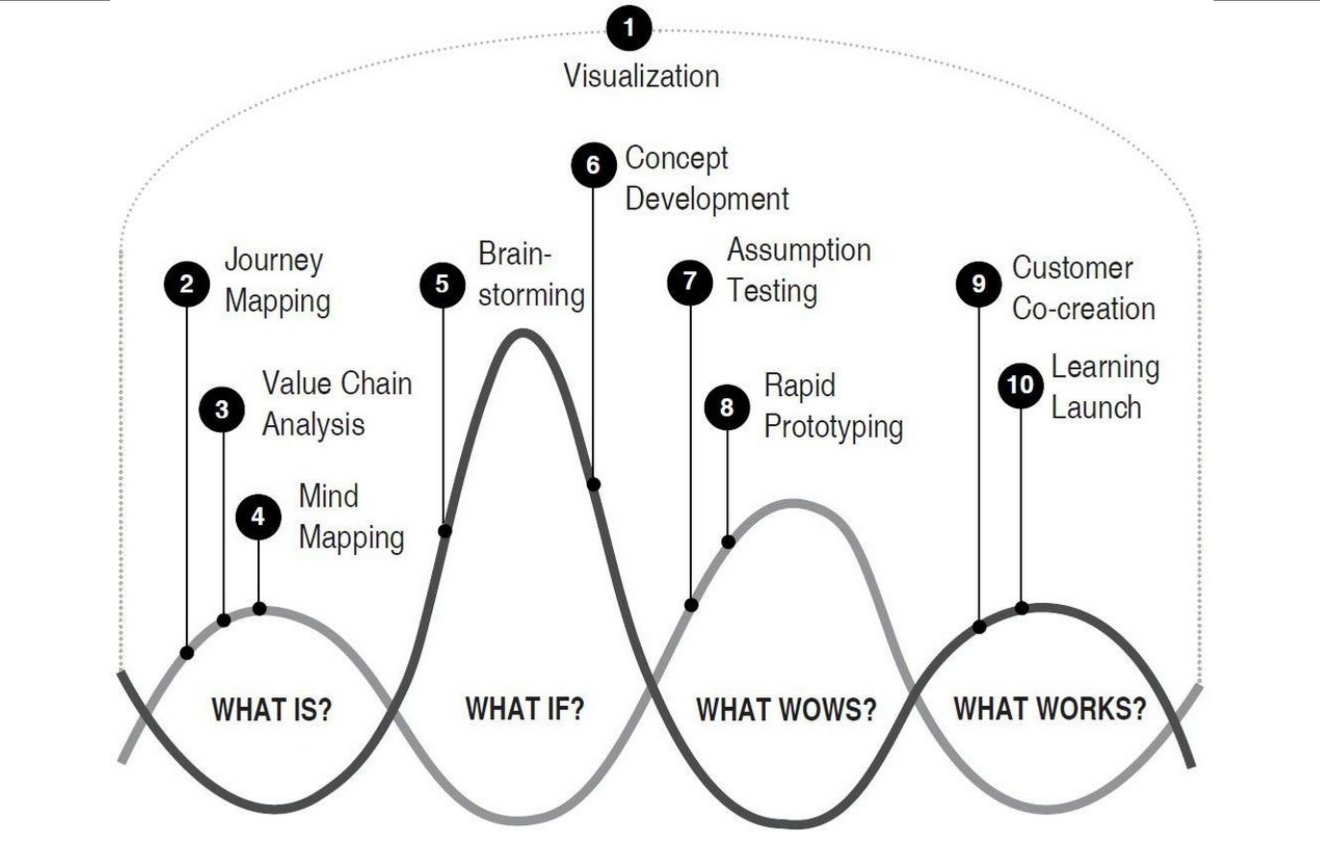
In prototyping, teams build rough artefacts that attempt to illustrate a potential solution. Prototypes should be inexpensive and quick to make, but should prompt team members to think more about the solution and start refining it. Prototypes could be a paper gadget, post-it notes, wire model, string and cardboard or even a storyboard. Prototypes should help answer questions that designers have about a potential solution. Prototyping presents an opportunity to think through building, to build a tool for communicating with the end user, while testing multiple possible solutions without investing in building complete solutions.

The testing mode is focused on getting the user to experience a potential solution. The iterative nature of design thinking is highlighted in the process where the team repeatedly goes through prototyping and testing until a workable solution is achieved. Testing provides an opportunty to learn more, not just about the solution, but also about the POV that has been adopted and about the end user. Showing users prototypes, as opposed to telling them about a solution, allows them to start experiencing what they will receive, while at the same time presenting them will an opportunity to compare and contract different solutions at little cost to the design team.

2.5.4.3 An introduction to the designing for rowth design thinking process

Figure 21: Designing for growth process

(Liedtka & Tim, 2011)



The designing for growth (Figure 21) approach to design thinking is broken down into four key stages that answer specific questions. "What is" addresses the current reality, whereas "what if" envisions a future state. "What wows" is about making choices, while "what works" is about taking products to market. The uneven waves in the model mirror the convergent and divergent nature of design thinking. The model is equipped with a number of tools that help users manage the innovation process (Table 11).

The "what is" stage looks at what is going on today and what people are up to. It is focused on uncovering the disatisfaction with today that may become an opportunity for tomorrow. This phase therefore tries to uncover the frustrations, dissatisfaction and the opportunity that lies in the current reality of the user community. Liedtka and Tim's model employs four tools from their toolkit to assist in this phase. The visualisation tool is applicable throughout the model, with the emphasis on transforming information into images. In this phase, the tool is used to document and make sense of observations about people and their circumstances. The journey mapping tool is used to document users' current experience from observations and interviews while documenting unmet needs. The value chain tool assesses the things that have meaning in a user's journey, while the mind-mapping tool is used to organise and obtain insights from the information collected about users and their journeys.

Table 11: Tools for "designing for growth" design thinking process

(Liedtka & Tim, 2011)

Phase	Tool	Usage
Entire project	Visualisation	Transforming information into images for use in bringing clarity to ideas.
What is?	Journey mapping	Determining and describing a user's current reality.
	Value chain analysis	Establishing the things that have meaning in a user's journey
	Mind mapping	Organising and obtaining insights from information collected about a user's journey
What if?	Brainstorming	Imagining the future through ideas
	Concept development	Bringing together ideas into coherent possible solutions
What wows?	Assumption testing	Questioning the assumptions that are associated with selected possible solutions and the impact they will have on the success or failure of the solutions.
	Rapid prototyping	Building artefacts that help illustrate the working of a selected solution.
What works?	Customer co-creation	Working together with customers to come up with solutions that are most appropriate for their circumstances.
	Learning launch	Allowing customers the ability to experience the solution with a view to testing the assumptions made in the design.

The "what if" stage tries to envisage a potential future taking into account possibilities, trends and uncertainties. While the "what is" stage is focused on collecting data and understanding the current reality, "what if" is more creative and is focused on a desirable future. Divergent thinking is necessary to expose all the possibilities while trying to ignore all possible constraints. Brainstorming is positioned as a tool for this purpose, with the author arguing for discipline in its use to avoid the pitfalls typically associated with its use, some of which are dealth with by Seidel and Fixson (2013) in their paper. The second tool employed in this phase is concept development, which focuses on assembling output from the brainstorming session into coherent concepts for possible future development.

Unlike the “what if?” stage, which depends on divergent thinking to generate many possibilities, “what wows?” requires some choices to be made, forcing the team to question assumptions associated with the various options using the assumption testing tool. As with the other models described here, prototyping is used to explore selected concepts for testing and refining further.

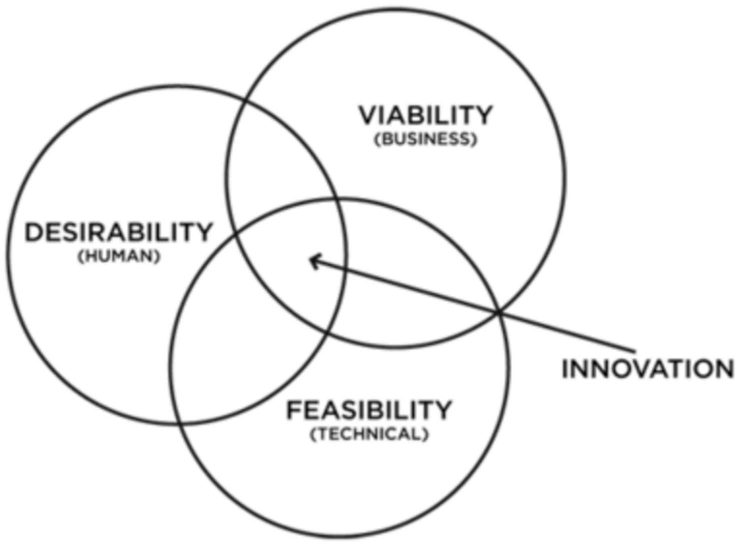
“What works?” is focused on ensuring that the solutions crafted are feasible and viable (Brown, 2014). Establishing what works is only feasible where the end users are involved in the creation of the solution that they will use, hence the need for customer co-creation. The final tool in the toolkit under “what works?” is the learning launch, through which end users are allowed to use the proposed solution and provide feedback about the solution.

2.5.4.4 An introduction to the IDEO design thinking process

IDEO describes the design thinking process as a system of overlapping spaces (Figure 23) as opposed to sequential steps. These spaces begin with inspiration, which gives impetus to the design thinking initiative. Inspiration leads into ideation, in which ideas are put forth and tested before implementation. Central to this process is the belief that innovation lies at the intersection of desirability, viability and feasibility (Figure 22).

Figure 22: Innovation lies at the intersection of desirability, viability and feasibility

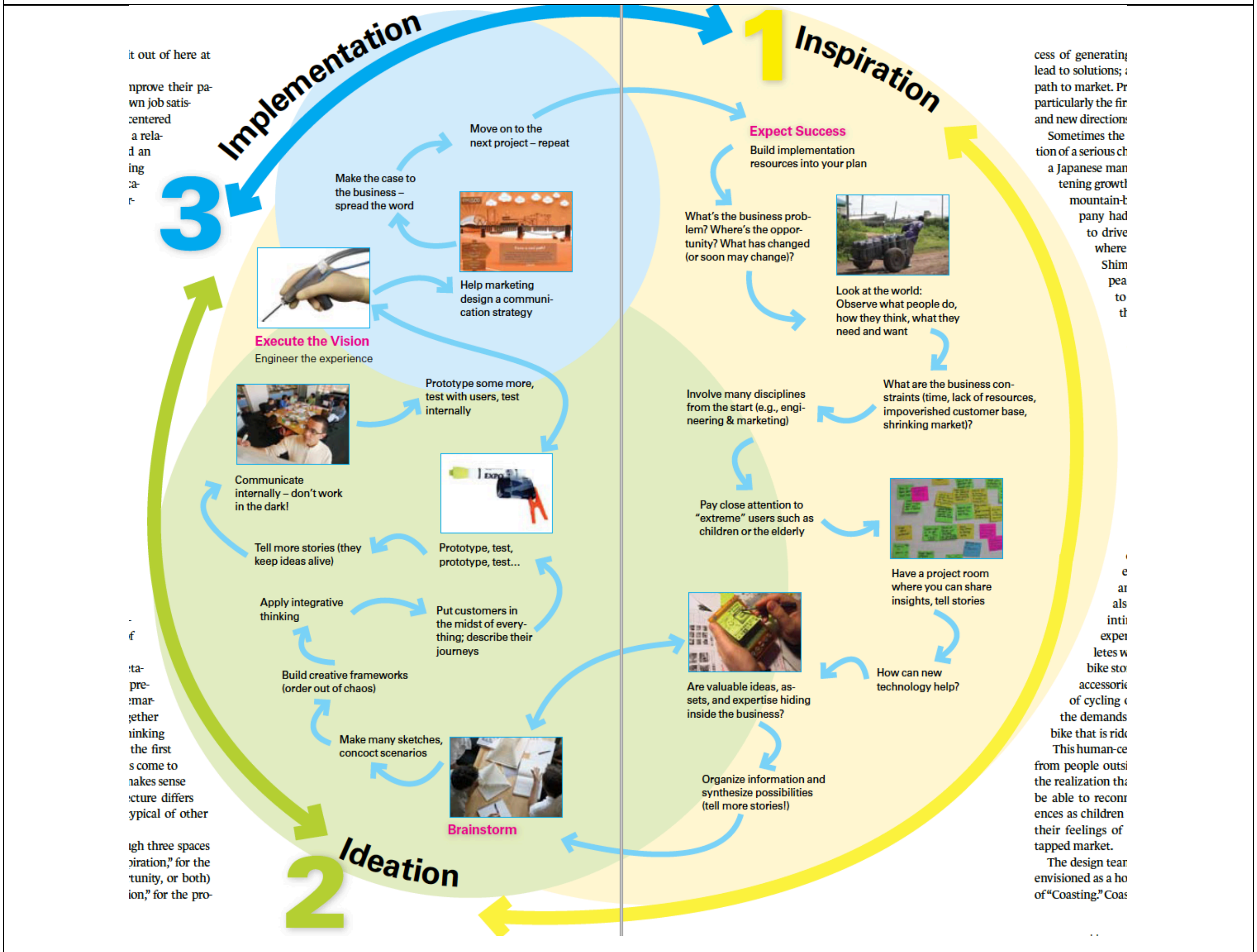
(Brown, 2008)



Inspiration starts with a brief that will guide the team through the design thinking project. The brief should be broad enough to allow the team latitude to explore while narrow enough to guide the efforts of the team. A key part of the inspiration phase is the process of establishing users’ needs, rather than the traditional way of finding out what people want. Establishing users’ needs involves observing them in their daily lives and establishing what their unmet needs are, often involving embedding team members with the user base. The team composition must be broad enough to encompass all the skills that will be required to carry the project to completion. Team members must look for hidden assets in the environment that can be exploited in finding and building solutions. Similarly the team must have enough knowledge to understand the constraints that are likely to be faced. In transitioning to the ideate phase, the team must sythesise their findings in prepration for the solution-finding inherent in the next phase.

Figure 23: The IDEO design thinking process

(Brown & Wyatt, 2010)

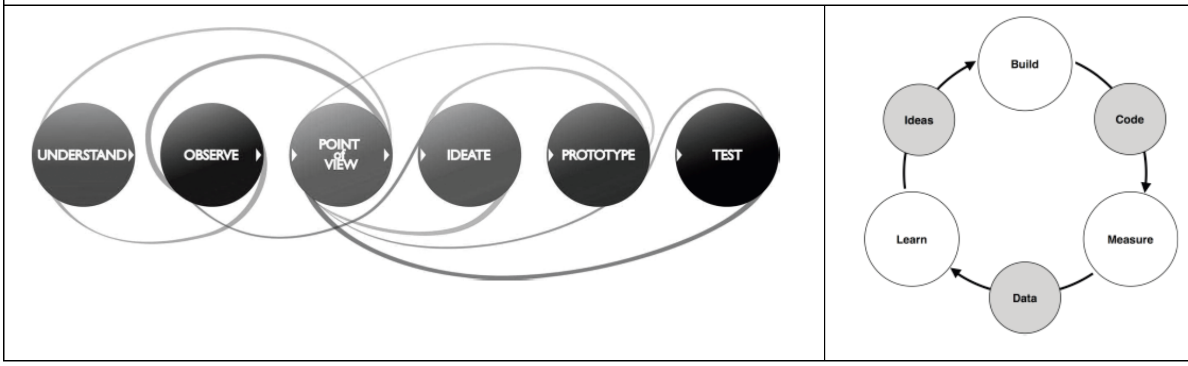


During ideation, teams generate and test a number of ideas that could lead to potential solutions. Brainstorming is used to come up with a large number of potential solutions that put the user at the heart of their design. Promising solutions are prototyped and tested both internally and with users. Successful ideas are moved forward for implementation, a process through which solutions are offered to the end users. At all times during the design thinking process, the team may jump back and forth between different thinking spaces and repeat individual steps to ensure that the best possible solution is obtained.

2.5.4.5 Introduction to the lean design thinking process

In a study that compares design thinking and lean startup as approaches to innovation, Mueller and Thoring (2012) suggest a hybrid model that combines the two approaches (Figure 24). The lean design thinking approach overlays a version of the Stanford design thinking model with the lean startup model and based on an analysis of the two, proposes a new model.

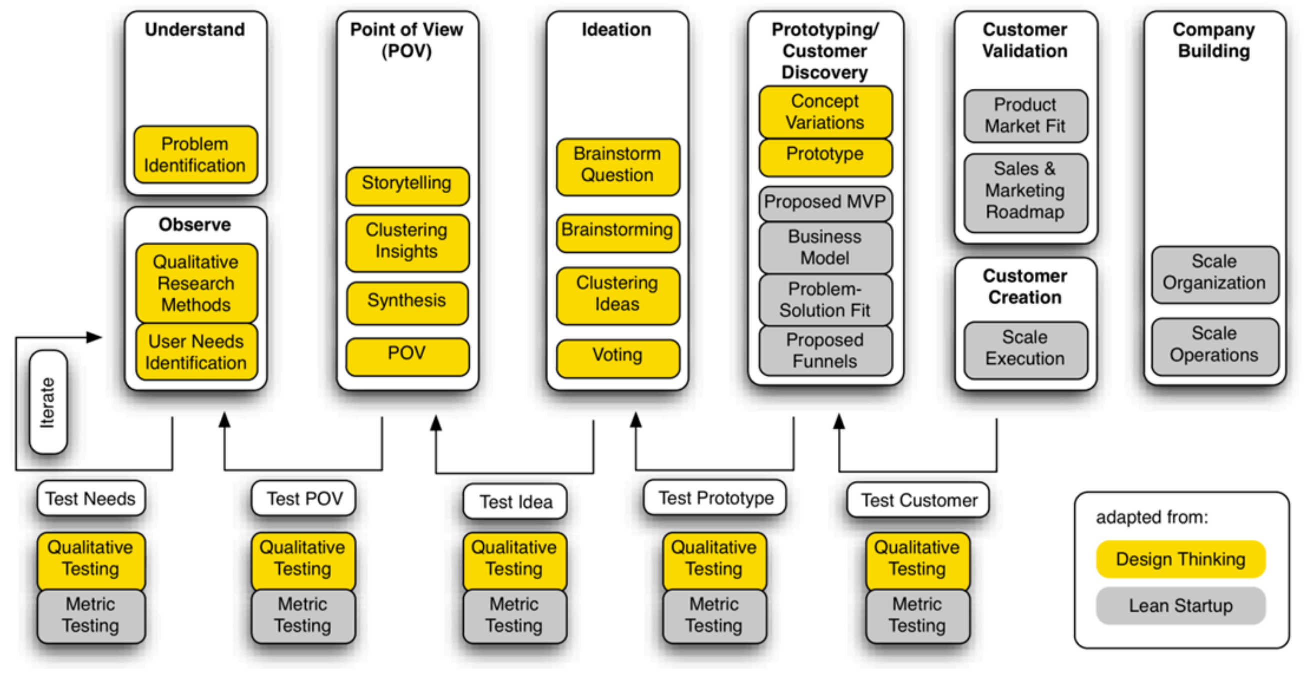
Figure 24: Input to the lean design thinking model
(Mueller & Thoring, 2012)
The lean design thinking approach overlays the Stanford design thinking model (left) with the lean start-up model (right).



While adopting the traditional approach to understanding, observing, creation of a POV and ideating from design thinking, Mueller and Thoring (2012) propose the incorporation of additional activities in the prototyping stage adopted from the lean startup approach focused on building a business model, identifying customers and planning execution. While design thinking is largely dependent on qualitative approaches to collecting and analysing data, lean startup is based on quantitative methods and the combined approach advocates a combination of the two. The iterative nature of design thinking is retained in the proposed model (Figure 25).

Figure 25: The lean design thinking model

(Mueller & Thoring, 2012)



2.5.4.6 Summary of design thinking processes

A number of processes have been put forward as design thinking processes. Although some of these can more accurately be described as new product development methodologies or software engineering methodologies, those that have been identified as design thinking processes seem to follow a very similar thread. All of the design thinking processes have human-centredness as a core attribute. A combination of divergent and convergent thinking occurs at some point in the design thinking processes. The four methodologies that were considered in more detail, Stanford d-school, designing for growth, the IDEO methodology and the lean design thinking model, all start with a focus on understanding what people actually do and what their unmet needs are. All four methodologies move on to define problems to address, then generate large numbers of potential solutions. Prototyping and testing are employed in each of the approaches and user involvement prior to deployment of solutions in the general population appears to be a common thread.

2.5.5 Examples of studies in design thinking: Methodology used

Empirical studies in design thinking have increased with the growing popularity of design thinking. In “Natural Intelligence in Design”, while acknowledging the paucity of research in design thinking at the time, Cross (1999) discusses five different types of research (Table 12). The first type of research focuses on those acknowledged as having a well-developed design ability. The researcher uses interviews to understand how they work. The second type tries to observe designers at work and build case studies around specific design projects. Protocol type studies use set tasks to understand the thought process that designers go through. The last two methods are not empirical in nature and are based on reflections and theorising on the one hand and simulation trials in the other. Recent work appears to continue to follow the same trend of research.

Table 12: Types of research in design thinking **Cross** (1999)		
1	Interviews with designers	Interviews with experienced designers aimed at understanding how they work
2	Observations and case studies	Obseravtion of all types of designers at work
3	Protocol studies	Studies of designers undertaking set work
4	Reflection and theorising	Theoretical analysis and reflection based on prior design research
5	Simulation trials	Attempts at simulating human thinking through artificial intelligence

In an example of the first type of research work, Carlgren, Elmquist and Rauth (2014) interview experienced designers in large organisations in an effort to understand how design thinking is approached and applied in their organisations. Stevens (2012) uses interviews with experienced designers to investigate the use of design artefacts such as sketches, models, graphics and prototypes for sense-making and the role such artefacts play in shaping and implementing strategy.

Seidel and Fixson (2013) observe designers at work in a study of how novice multi-disciplinary teams address design problems. The study uses a combination of interviews, observations, and questionnaires; mixing both qualitative and quantitative methods in collecting and analysing the data. Brereton and McGarry (2000) also follow the "observation/case study" genre, looking at how engineers use physical objects to prototype and how these objects support their thinking and communication processes. Participants are videotaped for observation and artefacts are collected from the exercises. Schneider and Moser (2012) investigate the impact of a design thinking exercise on the participants by observing the conduct of a design thinking workshop. Windahl, Brodie, and Storbacka (2013) explore the use of co-creation in an organisation that employs design thinking techniques. In a study over a four-year period into service innovation initiatives at Air New Zealand, the authors use a combination of interviews, participant observations and collection of company documents to build a case study on the design experience within the airline's "design house".

The study by Robbins, Devitt, Millar and King (2014) is a case study of a design thinking project based on the work of a group of collaborators who come together to create an integrated tourism hub in an Irish town. Over a series of sessions, designers are observed as they go through the design process. The study takes an ethnographic approach, following the design process as it evolves. While the resultant paper does not indicate how data was collected, the style of writing appears to indicate a participatory action research approach, with one or more of the authors having been part of the design team. The study by Carroll, Goldman, Britos, Koh, Royalty, and Hornstein (2010) follows a simlar ethnographic approach, looking at the introduction of a design curriculum. Participant observers collect data through notes, audio and video recordings as well as artefacts produced during the project. Zupan and Nabergoj (2012) report on a study aimed at introducing design thinking into entrepreneurship education. The study documents the process undertaken by a university trying to introduce design thinking into the curriculum of the university, collecting data through interviews with educators and students, and evaluating student projects as well as course syllabuses. Patel, Moore, Blayney, and Milstein (2014) document a design thinking challenge aimed at improving cancer care delivery by using design thinking approaches. In a participatory action research project, the authors document the insights of participants as they address various challenges presented to the team.

The work by Buur and Gudiksen (2012) follows the protocol studies mould. In an action research project, two sets of managers are given the task of designing a new media service in one case and an amusement park in the other. Participants are recorded through videos and conversations that are transcribed, while their actions are analysed through interaction analysis.

Mueller and Thoring (2012) take a reflection and theorising approach in their comparison of design thinking to lean startup as approaches to driving innovation, basing their input on previously published works on design thinking and lean startup models. The work by King, Parmar and Liedtka (2012) follows a similar reflection and theorising approach, looking at the mindset of designers and comparing this with approaches in management and psychology. Lee (2012) reflects on the development of a design thinking culture as opposed to the culture of the traditional sciences and that of the humanities.

2.5.6 Findings from selected studies in design thinking

Studies in design thinking continue to build on knowledge about the field, with many of them buttressing already held views about design thinking.

Seidel and Fixson, in a study comparing mixed teams of designers, found that high-performing teams had better common understanding of user needs, used prototyping regularly and regulated the use of brainstorming better than lower-performing teams. The use of prototyping and physical artefacts in design is reinforced by a study by Brereton and McGarry (2000) on the use of such physical objects in design.

Robbins, Devitt, Millar and King (2014) find that design thinking works better where participants work in close collaboration, even if they come from diverse backgrounds and affiliations. The study also advocates the use of independent external facilitators for successful projects. The need for collaboration builds on an earlier finding by Carroll, Goldman, Britos, Koh, Royalty and Hornstein (2010), who maintain that collaboration and design thinking are in fact intricately linked. Carroll, Goldman, Britos, Koh, Royalty and Hornstein (2010) also highlight the improvement in metacognitive ability associated with the use of design thinking, through helping participants to think more about their thinking, while encouraging active participation in activities.

The work by Stevens (2012) finds that the use of symbolic objects in design helps executives conceptualise and build consensus on new business models and product offerings. Similarly, symbolic objects assist managers in communicating ideas about future business directions and energise their teams around the strategy adopted by the business. Schneider and Moser (2012) argue that design thinking should not replace the current ways of thinking about business or technology, for example, but should be used to complement these approaches in developing better solutions. Patel, Moore, Blayney, and Milstein (2014) find that the use of design thinking allows healthcare professionals to go beyond the traditional approaches to solving problems and focus instead on the unmet needs of stakeholders, while incorporating the input of professionals that may be outside the normal reach of the medical profession.

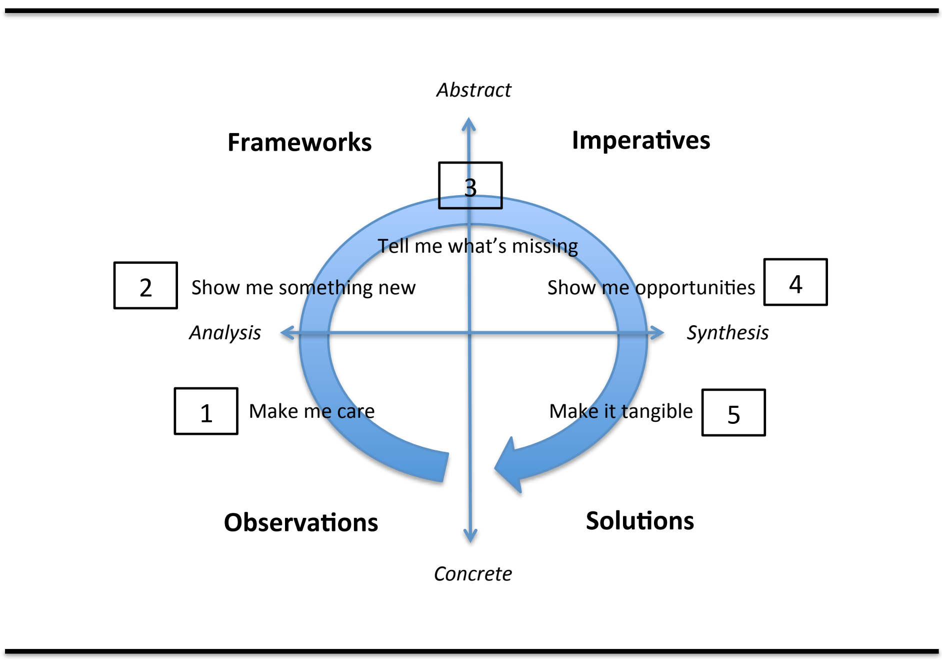
2.5.7 Summary

Design thinking is an approach to innovation that is human-centred and takes into account the unspoken needs of those for whom the innovation is intended. Growing in popularity over the years since the turn of the century, the approach has increasingly been used to solve bigger and more complex problems. Despite attempts to incorporate quantitative approaches, as in the description of lean design thinking above, the approach is still based on qualitative approaches, with practitioners taking an ethnographic interest in the lives of those for whom they design.

While there are many approaches to design thinking, most seem to follow the process described by Beckman and Barry (2007), reproduced in Figure 26. Starting in the real world, design teams observe the world at work sufficiently to identify a problem about which someone cares. Any analysis of these observations should result in something new. Using frameworks that have abstracted the real world and imperatives for change, design teams suggest opportunities for change, which are synthesised into tangible offerings that become solutions for application in the real world.

Figure 26: The innovation process

(Beckman & Barry, 2007)



Design thinking appears to suffer from the same challenges that bedevil any other form of innovation process. Preparation for design exercises can be challenging and there is no universal agreement on how to conduct design thinking projects. Resistance to change can derail progress, while the inclusion of technology can distract attention from the problem whose solution is being sought.

2.6 Synthesis and Summary

2.6.1 Reconsidering ICT in healthcare

The need for ICT in healthcare is driven by the need to manage the large amounts of data that the sector generates and has to refer to regularly to be able to continue offering a service. Information about patients and their interaction with practitioners is essential to allow the provision of further services. Historical records of patients' health are as critical as details of their current ailments that can be used to paint a broader picture of the health of a community. Equally important is information about prescriptions given to patients and the drugs issued. As healthcare has become more formalised through clinics and hospitals, the need for systems to help manage these institutions has grown.

The use of ICT in healthcare has grown at a pace that has closely mirrored the development of the ICT industry itself, albeit with a time lag. Current uses of ICT in healthcare include electronic patient records for maintaining patient data and histories of prior interaction with healthcare providers. Picture archiving and communications systems have been used to capture, store and communicate images such as X-rays. Scheduling systems have been used to plan staff duties, allocate rooms for surgeries and operations, as well as allocate beds to patients. Also relevant have been enterprise resource planning systems that have been used to manage the operation of hospitals, from their financial systems, to human resources and logistical functions such as managing stock, plant, equipment and vehicles. As the communications infrastructure around the world has grown, driven by the growth of the internet, increasing interest has been shown in systems that exploit the ability to offer services remotely, including tele-health and supported home care.

Opportunities to grow the service offering in healthcare seem to revolve around improvements in communication. Healthcare providers are interested in exploiting better integration of data and processes, so that services offered by different players are as seamless as possible. Interoperability of systems that may not be integrated presents an alternative that will allow smoother interfacing between different participants. The ability to interchange data through commonly agreed standards and protocols is also essential. The advent of the internet and the web have made patients the experts in their own health by virtue of the large amount of reference information available to them. The opportunity for healthcare providers to remain relevant is in regulating the self-diagnosis that comes with this new phenomenon and play a role in ensuring that this diagnosis is indeed correct and that the right medication is prescribed.

Several challenges are faced in trying to implement ICT in healthcare. Institutions that offer healthcare services are typically large and complex. A multitude of stakeholders exist that range from the patients, nurses, doctors, specialists, pharmacists, caregivers and families of the patients, to those behind the scenes such as administrators, medical insurers and funders, as well as regulators. A whole range of service providers exist, from primary healthcare providers, secondary and tertiary providers, all of whom have unique needs that must be addressed. Those implementing systems must take into account the divide between private and public-funded healthcare. The biggest challenge, and possibly the biggest opportunity for innovation, comes from the highly collaborative nature of healthcare, that demands that the ambulance crew feed into the admission clerk, who feeds into the nurse who will feed into the doctor, to the specialist, to the radiology team, to the anaesthetist, to the surgeon, to the pharmacist, to the funder and a whole lot of other service providers that make this service possible.

2.6.2 Innovation using ICT in healthcare

Innovation is about change, doing things differently, introducing new products, new processes and new services, not just for the sake of innovation itself but also in an effort to improve, to make life easier, to do things faster, more efficiently, or to create wealth. Innovation can be incremental or it can be radical. Innovation can be evolutionary or it can come from R&D or from changes in the supply chain. Innovation involves a change in the scope of an offering, the method by which a service is offered, its contents or the participants in the offering. Innovation could also be a change in the service concept, interface, delivery mechanism or technology employed.

In spite of all the arguments for innovation, research shows, particularly in healthcare, that innovations are rarely adopted by those for whom they are intended (Fitzgerald et al., 2003). Among medical practitioners, the decision to adopt an innovation usually follows long periods of debate. Innovations are unlikely to be adopted unless there is solid scientific evidence to back any claims being made. Innovations that have not been shown to apply to many patients, or alternatively where the innovation is the only way to avoid severe suffering, are unlikely to be adopted. Issues of cost and simplicity of operation also affect decisions about adoption. Patient satisfaction plays a part as well in determining whether an innovation is adopted or not.

ICT is increasingly seen as being at the heart of what has become a “network society” and having a profound impact on how innovation occurs (Glott, 2016). Lewis, Synowiec, Lagomar and Schweitzer (2012) identify six areas in which ICT can be used to innovate in healthcare. ICTs can be used to extend the geographic reach of medical services, through the use of telephones, cell phones, the internet and other communication media. ICT-based platforms can also be used to facilitate communication with patients, allowing the flow of information that will encourage health education, ensuing patient compliance with recommendations by healthcare practitioners and enabling emergency care. The use of decision-making platforms can assist field workers to improve decision-making and diagnosis. ICT platforms allow healthcare workers to improve management of data through electronic collection and storage. ICT-based systems are able to streamline the financial aspects of healthcare provision through online links between providers and funders.

ICT innovations in healthcare require considerable commitment not only by the implementers but also by those affected. The number of people affected by large-scale ICT implementations in healthcare is typically huge and those affected come from a variety of backgrounds. ICT implementations will have multiple effects on the value chain, while challenging power relationships between stakeholders (Constantinides & Barrett, 2006). Any attempts at innovation must therefore take into account the views of those at whom that the innovation is aimed.

2.6.3 Design thinking as an approach to Innovation

Design thinking has been described as a human-centred approach to solving complex interdisciplinary problems that affect many stakeholders. Allowing for the participation of many team members with varying backgrounds, design thinking allows participants to delve into the lives of those that are likely to be touched by a problem and any solution that may be proposed. The use of a combination of divergent and convergent thinking at various stages of the process allows for the exploration of solutions that are beyond what may otherwise be thought of by teams of experts with an external view of the problem and its environment. Through the use of abductive thinking, participants in design thinking initiatives are encouraged to go beyond analysis of available data or synthesis of potential solutions to imagining potential solutions that may not be related to the present circumstances. The use of prototyping allows for the creation of rapid and occasionally low-fidelity artefacts that can be used to represent future solutions and assist participants in the design process to understand better what can be delivered.

The design thinking approach focuses on offering solutions at the intersection of what is desirable for the target market, technically feasible to implement and financially viable to finance. While different models exist for implementing design thinking projects, all seem to follow a similar development process. This process begins with understanding a problem and through observation, its context. This stage, which is also referred to as empathising, is followed by an imagination or ideation phase, where the future is envisaged and potential solutions explored. Following a selection of most practicable solutions, prototyping is undertaken to help the design team to understand the potential solution better and to communicate its potential to future users. While appearing sequential, these stages are considered and re-considered multiple times in an attempt to improve and perfect solutions. Finally, tested solutions can be implemented.

The use of design thinking in a healthcare setting allows the incorporation of a large number of diverse skills and capabilities that can be brought together to work on potential solutions. Design thinking, by its nature, is designed to deal with large and complex problems, such as those encountered in the healthcare sector. The use of prototyping allows the design team to build understanding of a proposed solution quickly by communicating ideas through physical artefacts, thereby building up user commitment prior to the final implementation of solutions. The cyclic nature of design thinking-based designs allows for solutions to be refined, such that the final solution that will be implemented will have been seen and critiqued by some of those for whom the solutions are intended.

2.6.4 Co-creation and design thinking

According to Prahalad and Ramaswamy (2004), co-creation is about getting the customer or end user of a service to participate in the creation of value, allowing them to participate in the construction of the service experience to suit their context. Each user/customer's experience is constructed to suit his or her desired experience. Customers are able to participate in the innovation that is aimed at them, allowing them to experience variety and the experience of one. Co-creation is only possible through continuous dialogue that allows for joint problem definition and problem-solving. Vargo, Maglio and Akaka (2008) argue that organisations propose value through their market offerings, while customers continue the value creation process through utilisation. Co-creation fosters adaptability, survivability and the general well-being of the system delivering the service.

Design thinking sets the stage for experts from different disciplines to come together to solve complex problems. This approach allows them to place themselves in the shoes of those for whom services are designed, allowing them through interviews and observations to experience what it is that they need, as opposed to what it is they want. Through an interactive process, problems are defined and refined, potential solutions are explored and narrowed down to those that are viable, feasible and desirable. Prototyping allows these solutions to be tested and any lessons learnt are fed back into a finer definition of the problem, or better solution design, or more accurate narrowing down of solutions before further prototyping and testing can result in implementable solutions.

Healthcare presents a unique opportunity for the use of co-creation, in particular co-creation in design thinking. Patients are the ultimate experts in the circumstances of their health. Combining the approaches of co-creation and design thinking allows selected patients to participate in the design experience and in so doing enrich the empathy experience of the design team. All 10 FPs of SDL as espoused by Vargo and Lusch (2004) that underpin the ideas of co-creation retain relevance in the application of co-creation in design thinking-based innovation for healthcare. Of particular interest in a healthcare setting though are FP6, which denotes the customer as a co-producer of service, and FP10, which looks at the entire network of players that come together to provide a service as being core to the successful delivery of that service.

2.6.5 A design thinking approach to co-creation for innovation using ICT

This study is an exploration of innovation in healthcare. It takes the view that the patient is at the centre of all the activities in which the health delivery system involves itself. The ideas behind SDL, and co-creation in particular, are viewed as a desirable starting point for engaging patients in any innovation. Design thinking as an approach to innovation has been used to solve complex problems by engaging experts in all disciplines that relate to the problem at hand. This study takes the view that patients, together with the caregivers and their families, who are not part of the formal healthcare system, are the experts in the circumstances of their lives and should therefore be integrated into the design of any solutions that are aimed at them.

The nature of design thinking work is to go through a series of divergent and convergent thinking processing alternately. During the divergent stages, large amounts of data are generated, either through research such as observing people, interviewing them, or analysing their lives, as in the empathy stage. In the convergent stages, these data are brought together, such as in the definition phase where all the empathy observations are reduced to a POV or a number of POVs. More divergence occurs during ideation, where designers are encouraged to give free rein to their thoughts. It is not surprising then that design thinking projects are often described as chaotic.

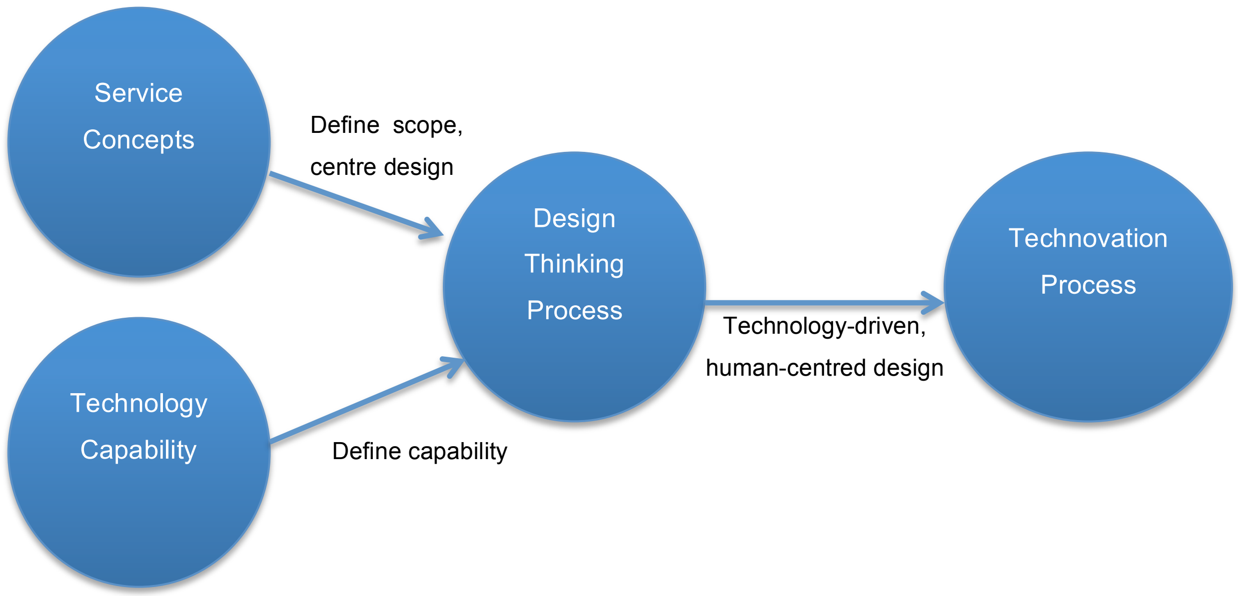
The handling of large amounts of data itself is problematic (Beckman & Barry, 2007), with information collected at early points of the study being discarded with little justification. Critics and often case proponents of design thinking alike point out the lack of rigour that is associated with design thinking projects. Scholars such as Kimbell (2009) note the confusion that arises from lack of an authoritative description of design thinking.

Design thinking projects can, if not properly controlled, be time-consuming and costly, given the large array of resources that are typically aligned to make such project a reality. Design thinking projects bring together people from many diverse backgrounds and persuasions (Collins, 2013). During a relatively short time, these people are expected to work together and collaborate. This process is never as seamless as expected, because each of the participants introduces his or her own methodologies and ways of thinking into what is literally a blank canvas process.

Another major criticism is that designers struggle with technology in design thinking projects. Non-technologists retreat when the issue of technology is raised, leaving the task to those who are technology-aligned. Technologists, on the other hand, appear to retreat to areas of technology with which they are familiar, limiting the potential solutions that could be exploited.

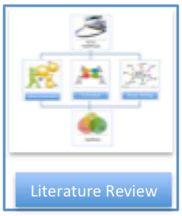
This study builds on the ideas explored in this chapter and proposes the Technovation Framework. The Technovation Framework combines the ideas of service as defined in SDL theory, technology capabilities and design thinking to come up with a process that enables teams consisting of designers, service providers and the beneficiaries of services to come together to map out ways to improve service delivery by using technology. Figure 27 outlines the conceptual basis for the Technovation Framework.

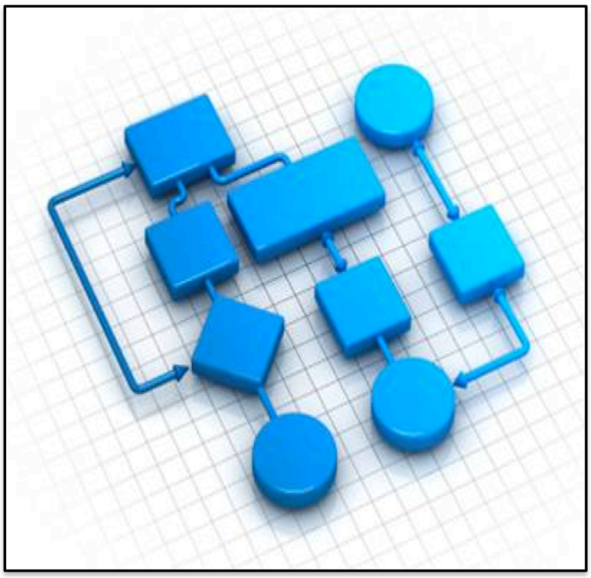
Figure 27: Conceptual basis of the Technovation Framework (CF_0)

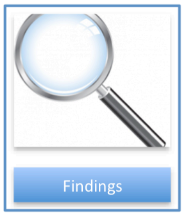


The Technovation Framework and the accompanying process are designed to address the issues related to project structure as well as the use of technology in design thinking. SDL is used to define the scope and centre designs on beneficiaries, while technology capabilities open up technology exploration to non-technical participants, leaving the technologists to work out the detailed technical designs towards the end of the engagement.

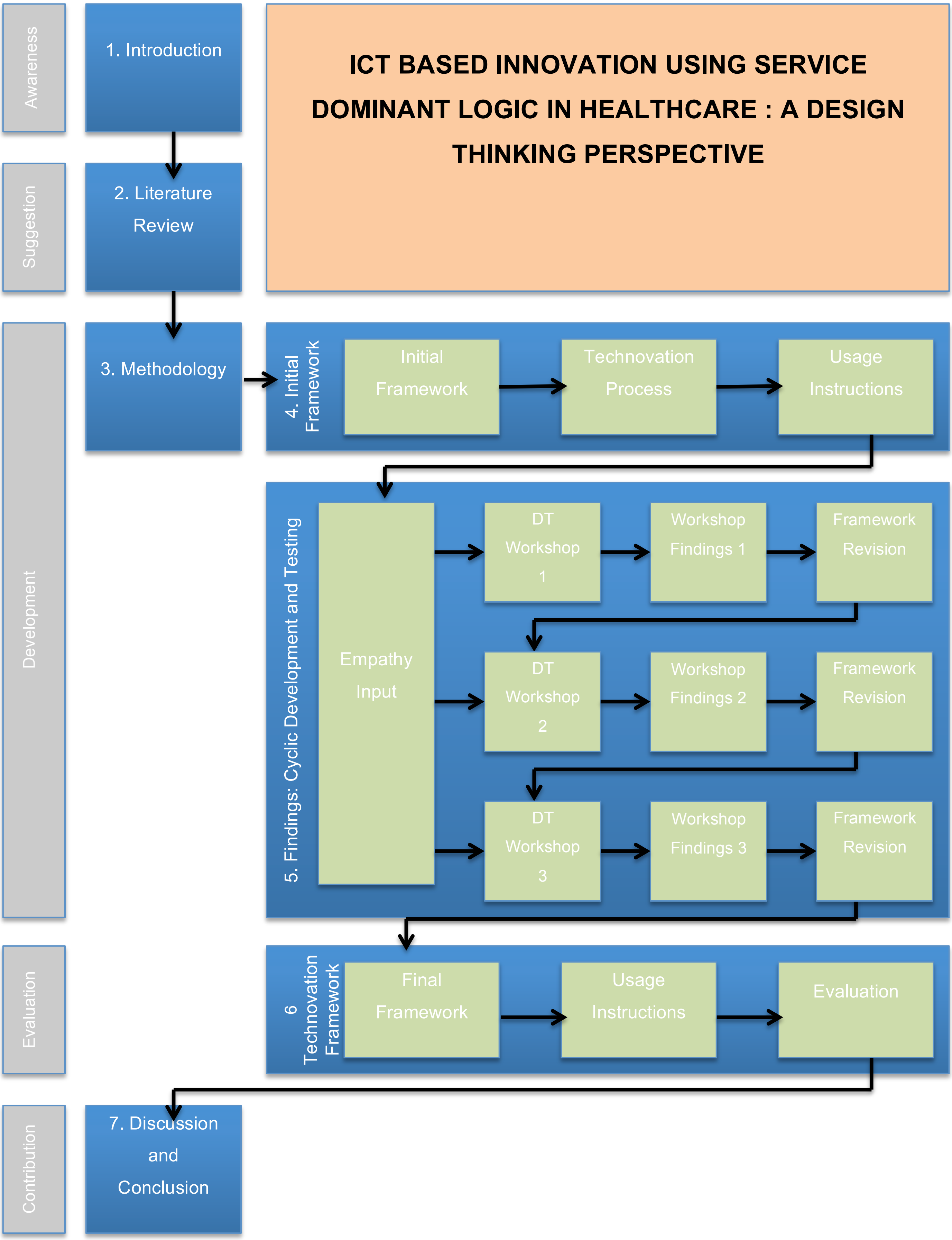
Chapter 3 of this study begins the formal process of constructing the framework, outlining the philosophical stance taken, the strategy and theories explored. The chapter also describes the process of building the framework, as well as establishing the basis for the evaluation of the framework. A formal description of the framework is provided in Chapter 4, while Chapter 5 focuses on the various iterations of testing that contribute to the development of the framework. A revised framework, that takes into account the observations from the testing cycles, is presented in Chapter 6. The final chapter of this study presents a discussion and conclusion.







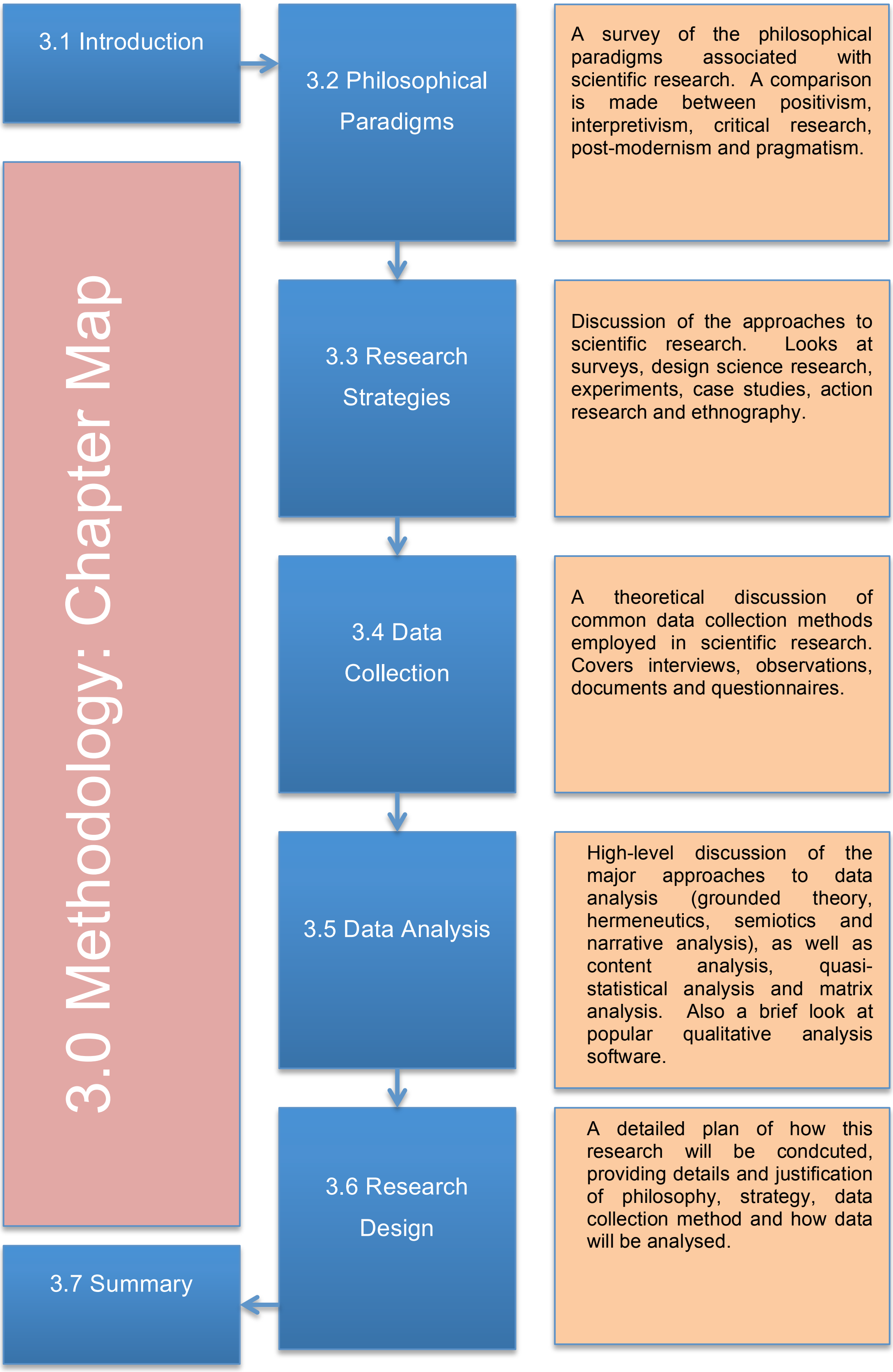
3. Methodology


Awareness
Suggestion
Development
Evaluation
Contribution
1. Introduction
2. Literature Review
3. Methodology
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings: Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
7. Discussion and Conclusion

Deep knowledge of principle knows without seeing, strong practice of the Way accomplishes without striving. Deep knowledge is to ‘know without going to the door, to see heaven without looking out of the window’

The Book of Balance and Harmony

Chung-ho chi.


3.0 Methodology: Chapter Map
3.1 Introduction
3.2 Philosophical Paradigms
A survey of the philosophical paradigms associated with scientific research. A comparison is made between positivism, interpretivism, critical research, post-modernism and pragmatism.
3.3 Research Strategies
Discussion of the approaches to scientific research. Looks at surveys, design science research, experiments, case studies, action research and ethnography.
3.4 Data Collection
A theoretical discussion of common data collection methods employed in scientific research. Covers interviews, observations, documents and questionnaires.
3.5 Data Analysis
High-level discussion of the major approaches to data analysis (grounded theory, hermeneutics, semiotics and narrative analysis), as well as content analysis, quasi-statistical analysis and matrix analysis. Also a brief look at popular qualitative analysis software.
3.6 Research Design
A detailed plan of how this research will be condcuted, providing details and justification of philosophy, strategy, data collection method and how data will be analysed.
3.7 Summary

3. RESEARCH METHODOLOGY

3.1. Introduction

This goal of this study was to develop a framework for ICT-based service innovation using design thinking techniques. This framework was tested and enhanced in a healthcare setting. Chapter 1 of this work considered the reasons for undertaking this work and the expected benefits, serving to bring awareness to the problem space. Chapter 2 started exploring the theoretical tools that could be employed to achieve this through an extensive search of the literature on innovation, co-creation, design thinking, as well as the use of ICT in healthcare. The current chapter focuses on the development of a tool that can be used to achieve the goal of healthcare innovation using ICT, beginning with an exploration of research methods leading to a plan for the development of the tool and how it was tested. Figure 28 summarises the journey to this point.

Figure 28: Journey to Chapter 3

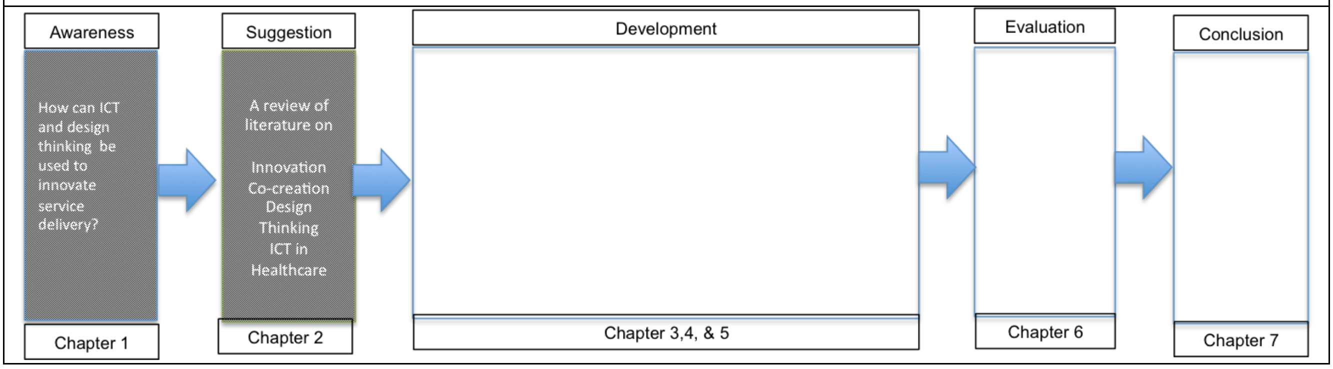
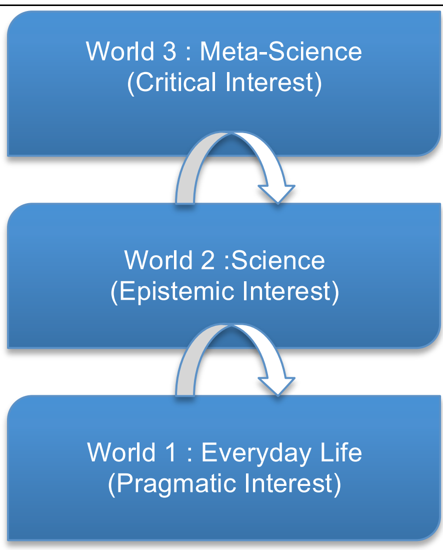


Figure 29: The three-world framework Adapted from Mouton (2001)

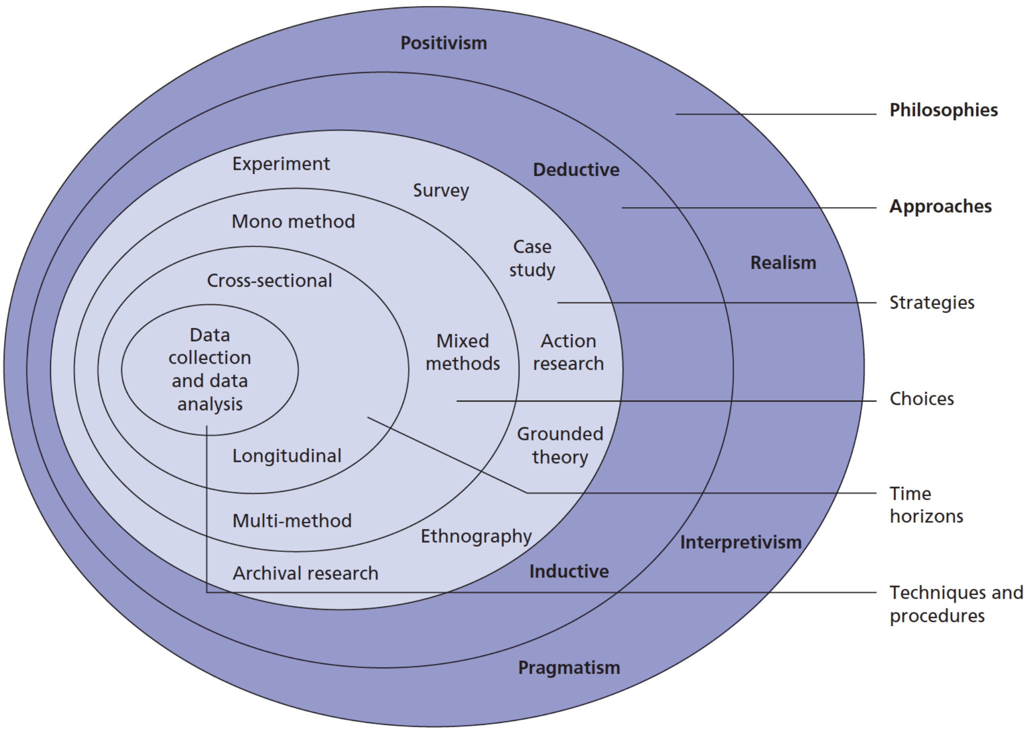


Mouton (2001) describes a framework (Figure 29) developed for helping researchers understand research especially in the social sciences, distinguishing between three worlds: The world of everyday life, characterised by pragmatic interest; the world of science and scientific research, characterised by epistemic interest or interest in truthful knowledge; and the world of meta-science, characterised by critical interest. While the everyday world concerns itself with the ordinary social and physical realities of the world in which people exist, the scientific world concerns itself with building up knowledge about the everyday life in a systematic and rigorous manner. The world of meta-science concerns itself with the philosophies and methodologies adopted in building up knowledge in the world of science.

Oates (2006) notes that the philosophy underlying a research question and the process of answering it can depend on an individual's own views about the nature of the world and therefore how to investigate it, identifying three distinct philosophical paradigms: positivism, interpretivism and critical research. Mouton (2001) identifies various paradigms in the philosophy of science, such as positivism, realism, interpretivism, phenomenology and critical theory. The research onion (Saunders et al., 2009) identifies positivism, interpretivism and realism and pragmatism as philosophies that guide researchers in their work. The discussion in the following sections of this study describe key components of the research onion (Figure 30).

Figure 30: The research onion

(Saunders et al., 2009)



The first section deals with research philosophies and these are discussed in some detail. Research approaches include deductive and inductive approaches. Deductive approaches, typically associated with positivism, assume that research starts off with a theory and goes out to prove its efficacy. An inductive approach, on the other hand, aims to generate theory from research. Researchers make choices about qualitative or quantitative methods to use in their research. Every study must adopt a unique research strategy, choosing from potential strategies that include experiments, surveys, case studies, action research, grounded theory, ethnography or archival research. A researcher could use one, mono-method; a combination, mixed methods; or multiple methods. Finally, a researcher can conduct longitudinal research, in which a phenomenon could be observed over a period of time, or could investigate a phenomenon over multiple settings, thus cross-sectional research.

3.2. Philosophical Paradigms

The reason for undertaking research varies between different philosophies. Positivists undertake research so that they accurately describe how the world works, while attempting to reduce the workings of the world into laws that operate in social life. The work of positivists therefore sets out to explain, control and predict reality (Guba & Lincoln, 1994). Mel-Gray and Webb (2009) add that positivists aim to undertake research that then directs practice. While interpretivists simply want to gain better understanding of reality (Guba & Lincoln, 1994), critical researchers want to change the status quo, agitating for change to create a better society (Orlikowski & Baroudi, 1991). In their work, they want to empower others; they strive to expose exploitation, repression, fear, unfairness and unbalanced power due to gender, race, sexual affiliation and any other excuse for repression. Mehra and Kilduff (1997) describe post-modernists as challenging the way in which people view knowledge, wanting to produce new forms of knowledge through breaking down barriers of discipline and bringing into discussions those who are typically left out of the dominant discourses. Pragmatists aim to find practical solutions to problems, basing their work on an iterative process of action and investigating leads until doubt is eliminated (Johnson & Onwuegbuzie, 2004). Almeder (2008) argues that the primary purpose of inquiry for a pragmatist is to establish knowledge that allows people to adapt successfully to their environment.

Researchers' view of social reality affects the methods they adopt in designing their work, collecting and analysing data, and the conclusions they reach. Positivists view social reality as stable and unchanging, external to those who experience it and objective, appearing the same to all (Wahyuni, 2012). Interpretivists, on the other hand, view social reality as socially constructed, arising out of the very interactions of those who experience it (Orlikowski & Baroudi, 1991). Such reality is therefore subjective and subject to change. While agreeing on this nature of reality, critical researchers argue that power and influence matter, and the construction of such reality cannot be viewed out of the context of the instruments with which discrimination is practised: sex, race, age or sexual orientation. Critical researchers also argue that the history within which a reality has been created cannot be ignored, and that any analysis of the nature of the current experience cannot be viewed in isolation of what has taken place before (Orlikowski & Baroudi, 1991). Post-modernists argue that reality is constructed by the environment in which people live, with the media playing a central role in deciding how people view the world around them. Given that thinking, post-modernists further argue that reality is relative, and in fact plural in that several correct versions of reality can exist concurrently. Pragmatists argue that reality is external and multiple realities can exist, advocating the adoption of the most appropriate reality that allows problems to be resolved

(Almeder, 2008). These views of reality held by researchers are generally referred to as the ontology of the researcher.

Researchers make assumptions about the objects and subjects of their research, one of the most important of which is human beings. On the nature of human beings, positivists assume that human beings are regular and predictable, while critical researchers argue that human behaviour is situational, contextual, social, personal and unpredictable (Johnson & Christensen, 2012). Gorton (2010) argues that post-modernists deny the existence of a fixed human nature, viewing human nature as relative and depending on time and space. Pragmatists refute the idea of human beings being responsible to a higher power (Cherryholmes, 1992), viewing them as dynamic, complex but partially predictable (Johnson & Christensen, 2012). According to Johnson and Christensen (2012), pragmatists believe that human beings respond to multiple influences, including the environment (which nurtures them), biology and nature, freewill and agency, just as much as chance and fortuity.

A researcher's approach to knowledge and how it can by acquired, also known as the epistemology of the researcher, is another important determinant of the philosophy of the researcher. Positivists believe that people build knowledge so that they are able to facilitate social control and in turn direct innovation and change (Hassard, 1994), in the process building up an ever increasing pool of knowledge (Guba & Lincoln, 1994). The view of an accumulating knowledge pool is shared by interpretivists, but disputed by critical researchers who argue that knowledge does not accumulate in the absolute sense, but is revised over time to reflect historical changes. Post-modernists, according to Hassard (1994), argue that all prior knowledge should be dismissed, or at best treated with caution. In keeping with the contempt that post-modernists hold for dominant discourses, local knowledge, which is seen as refining sensitivities, is treated as prestigious. Cherryholmes (1992) notes that pragmatists view knowledge as a social and historical product, with facts being theory laden. Pragmatists tend to cherry-pick explanations and theories and dismiss others to arrive at solutions whose efficacy fits their goals.

The generation and use of theory in research varies among the different paradigms. Theory, according to positivists, is deductive and propositional and derived from analytical knowledge. Hypotheses are verified as facts or laws (Guba & Lincoln, 1994). For interpretivists, theory is inductive and comes from metaphorical and reflective thinking. Critical researchers agree with this basis for getting to theory, but argue that such theory is only valid if it is accepted by the intended audience (Gorton, 2010). Post-modernists argue against grand narratives and broad theories such as Marxism, while rejecting causality. Pragmatists treat all beliefs and theories as working hypotheses, which have the potential to be modified, refined, revised or rejected as newer information becomes available (McDermid, 2014). The truth, according to positivists, can only come from scientific enquiry and there can only be one version of the truth. Both interpretivists and critical researchers agree that the truth depends on one's position and no single version of the truth exists.

Post-modernists dismiss the idea of a single truth, arguing for the upholding of multiple truths. Similarly, pragmatists deny that true meaning and truth can be determining once and for all time (Cherryholmes, 1992).

Positivists view good evidence as coming from observation, control and manipulation, or from sensory experience (Ponterotto, 2005). Interpretivists argue that good evidence comes from interaction, rejecting empiricism and arguing for interpretations of social action as leading to understanding. Critical researchers argue that only observable phenomena can provide accurate data and any facts are best explained in context (Gorton, 2010). Post-modernists view meaning as being created through language, discourse and symbolism, while pragmatists take an open view of evidence, choosing to focus on applied research (Cherryholmes, 1992).

The role of values, or the axiology adopted by researchers, is an important part of the paradigm they adopt. Positivists argue that research should be value-free, that researchers should remain independent of the data and should maintain an objective stance (Ponterotto, 2005). Interpretivists argue that research should be value-bound and emic, arguing that the researcher cannot be separated from the researched, and thus the values of the researcher affect the results of the research. Critical researchers argue that research is value-laden and etic, and that researchers bring their worldviews, cultural experiences and upbringing into their work. Post-modernists argue that morality and values are personal and these belong to the individual. Pragmatists argue that researchers can be both objective and subjective, but they need to adopt what is appropriate for the work at hand at any time.

3.3. Research Strategies

3.3.1. Introduction to research strategies

Myers (2009) defines a research strategy as a way of finding empirical data about the world. Remenyi, Williams, Money and Swartz (1998) describe a research strategy as the basic philosophical orientation of the research. The strategy adopted by researchers is influenced by their philosophy as described above, as well as their approach to research. A clearly articulated research strategy allows for easier communication between researchers, provides logical structure to the approach being adopted, and provides a framework for reasoning, working, and verification (Remenyi et al., 1998). Research strategies also provide a context in which researchers can evaluate the work of others (Peffers et al., 2006). This section describes some of the common research strategies employed in the social sciences and in information systems in particular. Two of these, DSR (not covered in the research onion) and action research, receive more robust treatment below, as these present the best possible approaches for undertaking a study of this nature.

3.3.2. Survey research

Survey research involves the use of standardised questionnaires or interviews to investigate the circumstances of a group of people systematically, focusing on their thoughts, preferences or behaviours (Bhattacherjee, 2012). Routed in the quantitative domain, surveys can be used for descriptive, exploratory or explanatory research. Surveys are typically based on individuals as their unit of analysis, although individuals have been used as proxies for organisations or groups. Surveys are generally used for exploratory and descriptive research, focusing on providing answers to questions about who, what, where, how much and how many (Saunders et al., 2009)

Bhattacherjee (2012) notes that the strength of surveys comes from their ability to extract from people things that can otherwise not be obtained from observation, such as preferences, traits, attitudes, beliefs, behaviours or factual information, such as age or marital status. The use of e-mail, telephonic interviews or postal questionnaires allows a researcher to collect information using a survey methodology from a large number of people dispersed over a large geographic area. Questionnaire surveys allow interviewees to respond at their own convenience, allowing them time to reflect and provide information that may not otherwise be provided in person. Survey research is economical, allowing a researcher to quickly reach a large number of people who may be geographically dispersed. Surveys allow the researcher to collect, from a sample of people, information that can be generalised to a greater population (Saunders et al., 2009). Surveys suffer from several disadvantages, including bias from non-responses, sampling, social desirability and recall bias, associated with a respondent's ability to recall prior events accurately (Bhattacherjee, 2012). Table 13 summarises some of the common forms of bias in survey research.

Table 13: Bias in Survey Research

(Bhattacherjee, 2012)

1	Non-response bias	The response rate to surveys is typically low, as respondents do not feel oblidged to respond.
2	Sampling bias	A bias that arises out of the manner in which the sample is chosen. A sample drawn from listed telephone numbers is biased against those that do not have a telephone or whose numbers are unlisted.
3	Social desirability bias	Respondents provide what they believe are the correct answers so that they can be more acceptable.
4	Common method bias	A bias that arises out of measuring the dependent and independent variables at the same time such that a corelation is inadvently created between the two.
5	Recall bias	Respondents selectively recall past events based on their current circumstances

The method of collecting data in surveys limits the amount of data that can be collected, resulting in a shallower view of the subjects of research than would be obtained in other richer forms of data collection (Saunders et al., 2009; Mouton, 2001).

3.3.3. Design science research

Design science is research that results in the creation and evaluation of artefacts that solve identified organisational problems (Hevner et al., 2004). These artefacts include among others software, formal logic, rigorous mathematics and informal natural language descriptions. Other characteristics of design science include solving relevant problems, rigorous evaluation of research output, production of clear and verifiable output from a rigourous search process (Table 14). Vaishnavi and Kuechler (2015) distinguish between design science and DSR, arguing that the former is knowledge in the form of constructs, techniques and methods, models and theory. DSR, on the other hand, is research that leads to the development of this knowledge. Peffers, Tuunanen, Rothenberger and Chatterjee (2008) argue that DSR must, out of necessity, follow a rigorous process in observing problems, asking research contributions, evaluating designs and communicating results.

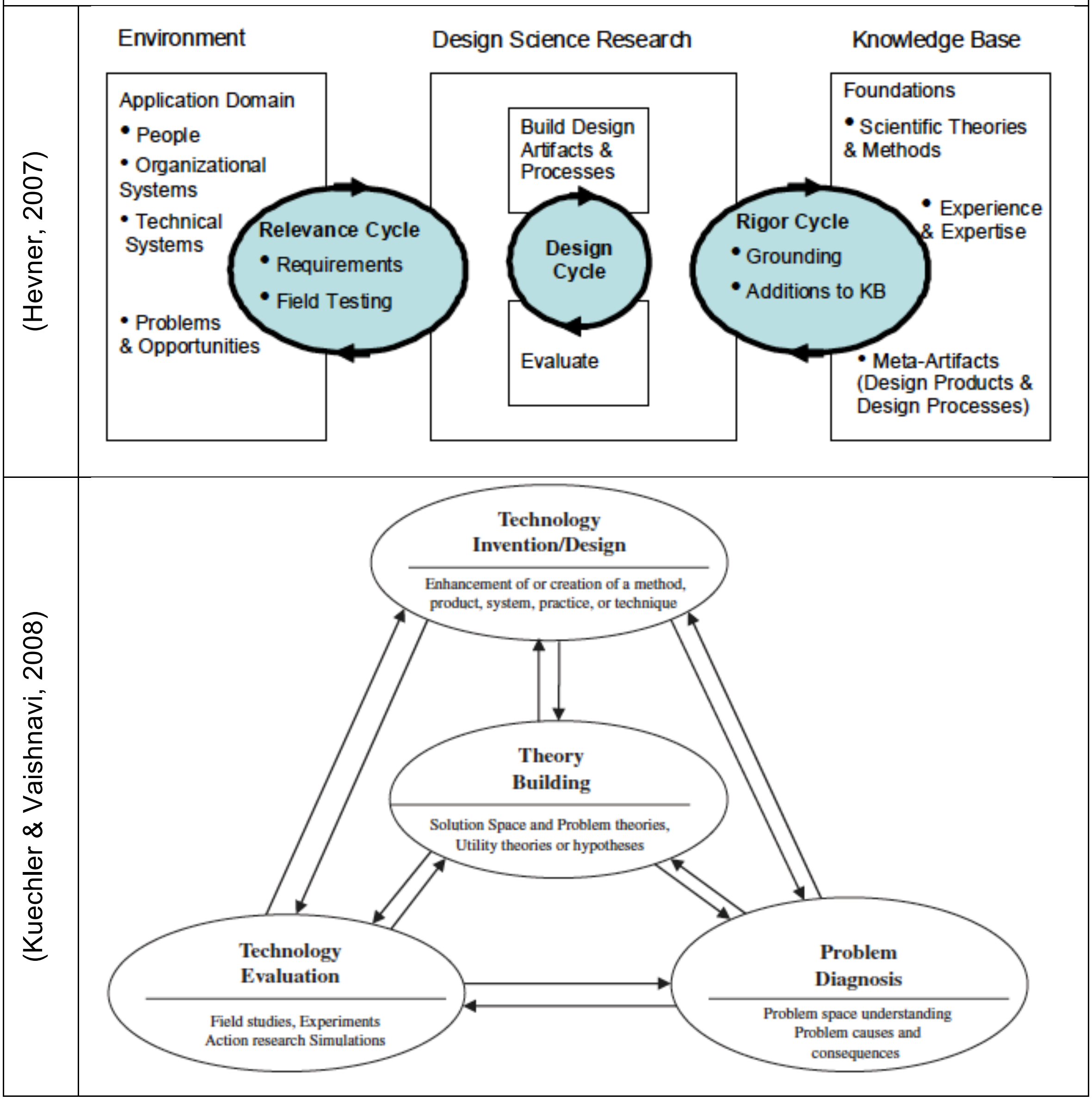
Table 14: Design Science Research Guidelines

(Hevner et al., 2004)

	Guideline	Description
1	Design as an artefact	Must produce a viable artefact.
2	Problem relavance	Must produce technology-based solutions that solve important and relevant problems.
3	Design evaluation	Utility, quality and efficacy of the artefact must be rigorously evaluated.
4	Research contribution	Must produce clear and verifiable contribution in the area of the design artefact, design foundation and/or design methodology.
5	Research rigour	Application of rigorous methods in both construction and evaluation of artefacts.
6	Design as a search process	Use of available means to reach desired ends while satisfying the laws in the problem environment.
7	Communication of research	Must be communicated effectively to both technology-oriented and management-oriented audiences.

Two frameworks have been used to improve understanding of DSR (Figure 31). Hevner (2007) introduces a three-cycle view of DSR while Kuechler and Vaishnavi (2008) employ a four-‘space’ model. In Hevner’s (2007) model, in the relevance cycle, DSR feeds from and into an environment domain that consists of people, organisational systems and technical systems, as well as problems and opportunity. It is through this cycle that requirements are obtained and field-testing is conducted. In the design cycle, a domain in which artefacts are designed, built and processed feeds from and into an evaluation domain. The rigour cycle interacts with a knowledge base, from and into which theories and methods, experience and expertise, as well as meta-artefacts are extracted and deposited. In Kuechler and Vaishnavi's (2008) model, the problem diagnosis space appears to coincide with the environment domain in Hevner's (2007) model, while the technology invention/design space corresponds with the design/build artefacts domain. The two models both have an evaluation domain/space, while the knowledge base in Hevner's (2007) model corresponds to a theory building space in Kuechler and Vaishnavi's (2008) model.

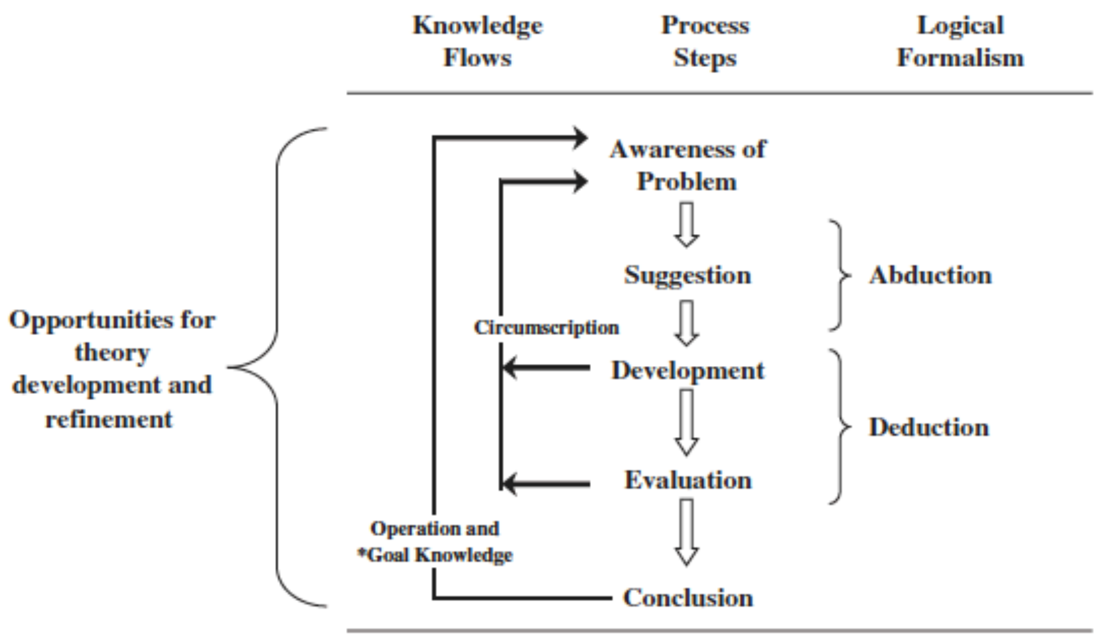
Figure 31: Two perspectives of design science research



The DSR process (Figure 32) consists of a number of iterative steps, which include understanding of the problem, suggestion of solutions, development, evaluation and conclusions, which feed into knowledge (Kuechler & Vaishnavi, 2008).

Figure 32: The design science research process

(Kuechler & Vaishnavi, 2008)



Peffers, Tuunanen, Rothenberger and Chatterjee (2008) propose a six-step process that begins with problem identification and motivation. Problem identification and motivation lead to a definition of the objectives of a solution, focusing on addressing the benefits of a better artefact, similar to the suggestion step proposed by Kuechler and Vaishnavi (2008). While Kuechler and Vaishnavi (2008) propose a single development step, Peffers, Tuunanen, Rothenberger and Chatterjee (2008) propose a design and a development step, resulting in the development of an artefact, followed by a demonstration step. The demonstration step in turn leads to an evaluation step and ultimately a communication step in which scholarly information is published.

Naidoo, Gerber, and Van der Merwe (2012) note that DSR not only contributes to bridging the gap between research and practice, but also the development of relevant artefacts that arise out of more rigourously developed practices. DSR leads to the development of artefacts that satisfy real needs, but are also evaluated against the identified needs, using knowledge based on existing theory, while feeding back into the knowledge pool.

3.3.4. Experimental research

Experimental research is a type of research in which a researcher manipulates one or more independent variables and the result of this manipulation on dependent variables is observed (Bhattacherjee, 2012). With a background in the natural sciences, experiments are typically used to answer questions of how and why. Experiments therefore tend to be used in explanatory studies (Saunders et al., 2009). Experiments are an example of fixed research designs, where a great deal of preparation is required prior to the conduct of the research (Robson, 2002). Robson (2002) distinguishes between field experiments and laboratory experiments, noting that laboratory experiments have higher internal validity while field experience has higher external validity and is therefore more generalisable to a wider population. Despite this desirability of higher external validity, field experiments are rare and more difficult to set up and conduct owing to the difficulties of controlling variables in a real-life setting (Bhattacherjee, 2012). Mouton (2001) associates field experiments with weak causality due to lower ability to control extraneous variables.

Experimental research is typically used in quantitative studies and is therefore not explored in great detail in this work.

3.3.5. Case study research

Case studies typically investigate a single social unit, located in one place with people in the unit being differentiated from outsiders, providing a clear boundary of the unit (Myers, 2009). Yin (2003) defines a case study as investigating a phenomenon in a real-life setting where the boundary between the phenomenon and context is blurred, where there are more variables of interest than data points. Multiple sources of evidence exist, giving an opportunity to triangulate findings, and prior theory is useful in data collection and analysis. While other forms of qualitative research, such as ethnography, typically involve field work or participant observation, case study research typically involves only interviews and document analysis (Myers, 2009, p.77). In critiquing Yin's (2003)'s definition of case study research, Myers (2013) finds the definition positivistic in nature, since it advocates the use of theory to guide data collection and is therefore restrictive. This observation narrows the definition to exclude studies that take a critical or interpretive approach, as these do not use an initial hypothesis to guide data collection. Myers (2013) also notes that Yin's (2003) definition is too broad in that it does not restrict the scope of a study to an organisation or organisations.

One of the main advantages of case studies is the ability to generate interesting contemporary stories that readers are likely to relate to and learn from (Myers, 2009). Case studies allow researchers to test theories in the messiness of real life. Disadvantages of case studies include difficulties in gaining access to willing organisations, since case studies may take too much time and result in unexpected and possibly unflattering reports, as well as lack of control of the process by the researcher. Case research may be difficult to conduct and may thus take a long time, especially for inexperienced researchers. According to Bhattacherjee (2012, p.93), the internal validity of inferences made in case studies is weak because of the lack of experimental control. The findings and inferences that arise from a case study are dependent on the integrative powers of the researcher to the extent that a novice may miss or dismiss interesting patterns that a more experienced researcher would have observed. Bhattacherjee (2012) highlights the difficulties of generalising from a case study, a weakness that is disputed by both Yin (2003) and (Myers, 2009).

The quality of a case study is judged by its ability to interest the reader by providing new perspectives (Myers, 2009). The case study should provide sufficient information for the reader to understand the context of the phenomenon being investigated, thus a case study must be 'complete'. A good case study will provide multiple perspectives and not focus on a single view of the phenomenon. The case study should be written in an engaging manner and should contribute to knowledge. In the case of positivist research, Yin (2003) suggests further criteria for evaluating the quality of the study. These include the study's questions, any propositions made, the unit of analysis, logic linking the data to propositions and the way in which the findings will be interpreted.

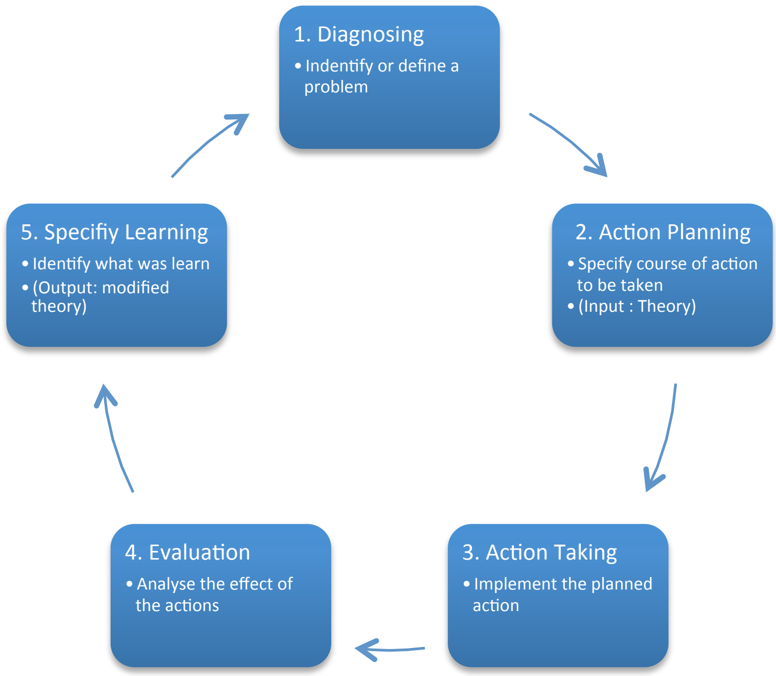
3.3.6. Action research

Action research aims to solve real-life problems while generating knowledge (Myers, 2009). Action research allows researchers through systematic investigation to create a communicative environment through which people may increase the effectiveness and meaningfulness of their work (Bloomberg & Volpe, 2012). Remenyi, Williams, Money and Swartz (1998) provide a formal definition, describing action research as a process of collecting data about a system relative to a goal, objective or need, then feeding that data back into the system, altering selected variables based on the data and hypotheses and evaluating the results by collecting further data. According to Bhattacherjee (2012), a researcher using action research initiates action in response to a real problem. The action must be based on theory, which should explain how and why the action would work. Observation of the effects of the action and any subsequent modifications produces knowledge, which enables the validation of, or the production of better theory about the phenomenon being observed. Action research is unique in that it allows problem-solving and knowledge generation to occur simultaneously.

Myers (2009) describes the process of action research as consisting of five phases arranged cyclically (Figure 33). In the diagnosing phase, the researcher identifies or defines a problem to be addressed in an organisation. The second phase, action planning, takes as its input the problem specification on the one hand and a theoretical framework on the other and generates a plan of action. The third phase involves the implementation of the planned activities that lead to an evaluation phase. The fourth stage is the evaluation phase, in which the effects of the action taken are analysed. The final and fifth stage is a learning stage, out of which the knowledge generated from the entire exercise is published for the scientific community and in the case of the host organisation, generates input into other cycle of action research. Remenyi, Williams, Money and Swartz (1998) sum up the process as being made up of four essential steps: understanding the current situation, formulating a hypothesis about the status, manipulation of variables under the control of the researcher and ending up with understanding of the final state. Implied in this process is the use of theory as an input and the production of improved theory from the process.

Figure 33: The action research process

Adapted from Myers (2009)



The advantages, and indeed the disadvantages, of action research arise from its being rooted in a real-life situation. Action research studies therefore tend to be practically relevant Myers (2009). Myers (2009) also notes that because the aim of such studies is to improve business operations, action research inevitably leads to improvements, if not in the operations themselves, in the impact and image of the business. Mouton (2001) notes that because of the active participation of the subjects, where successful, action research studies lead to high construct validity, low refusal rates and "ownership" of results. A disadvantage of action research arises from what Myers (2009) points out as a difficulty in combining action and research. Mouton (2001) notes that the emotional or subjective involvement of the researcher can lead to manipulation of results. Myers (2009) observes that researchers are prone to exaggerate the importance of their intervention and their contribution to scientific knowledge. Remenyi, Williams, Money and Swartz (1998) throw doubts on the ability of researchers conducting action research to remain intellectually independent. A final disadvantage of action research is that articles that arise from this body of work are generally shunned by the more respected academic journals and end up being published in practitioner-oriented journals and magazines (Myers, 2009)

3.3.7. Ethnography research

Ethnography research employs fieldwork and participant observation to obtain a deep understanding of people in the context of their lives (Myers, 2009). Robson (2002) defines ethnographic studies as wanting to “capture, interpret and explain” the lives and experiences of people, groups or communities and how they make sense of their lives and their world. Ethnography describes and explains the world in which subjects live, in the way that they themselves would describe and explain it (Saunders et al., 2009).

Ethnography allows for a deep understanding of subjects and their context (Saunders et al., 2009). It is useful for exploratory and descriptive studies, as it provides deep insights into the lives of those being investigated (Mouton, 2001). Ethnographic studies often present an opportunity to question widely held assumptions about a phenomenon being observed (Myers, 2009). Limitations of ethnography include lack of generalisability of results, non-standardisation of measurement and the heavy time demands of the data collection and analysis methods employed (Mouton, 2001). Writing up ethnographic studies tends to be just as time-consuming and is seen to work against this type of study (Myers, 2009). Writing up the different facets of a community may be impossible, forcing the researcher to tell only part of the story, especially when writing for scientific journals.

3.4. Data Collection

A number of methods of collecting data are available to qualitative researchers. This section deals with the most common ones and focuses primarily on the ones that were considered potential means of collecting data for this study, even if they were not employed in the end. The choice of a data collection instrument or combination of data collection instruments is an integral part of the research design that brings together the research paradigm, approach and strategy for the study.

3.4.1. Interviews

Interviews can be used to gather detailed information from people, allowing researchers to focus on and gain a perspective on the subject’s world (Myers, 2009). Interviews are a personalised form of data collection and are best conducted by trained interviewers (Bhattacherjee, 2012). Bhattacherjee (2012) highlights that the interviewer is an essential part of the research instrument because of the potential influence he or she can have on the interview. Interview scripts may contain special instructions for the interviewer, which the subject may not be aware of, to help guide them through the process. Interview scripts may also provide room for interviewers to record personal observations and comments. During the interview, the interviewer listens, prompts, encourages and directs the interview (Myers, 2009).

There are a number of different criteria for classifying interviews. Interviews may be conducted on a one-to-one basis or in group format (Saunders et al., 2009). One-to-one interviews may be conducted face-to-face or over the telephone. Interviews can also be conducted over the internet or an intranet and use any one of a wide range of communication applications. Group interviews allow an interviewer to face a number of subjects at the same time in a format referred to as a focus group. Focus groups may also be mediated via electronic means. Interviews can be classified as structured, semi-structured or unstructured (Myers, 2009). Structured interviews follow a pre-defined format in terms of questions, the order in which the questions are asked and at times the amount of time available. Semi-structured interviews start with some guiding questions and allow the interviewer the latitude to explore any emerging themes. Unstructured interviews have a broad objective but allow the discussion to evolve, often with no time limit set. Less structured interviews tend to feature more commonly in exploratory studies, while explanatory studies tend to utilise structured interviews (Saunders et al., 2009).

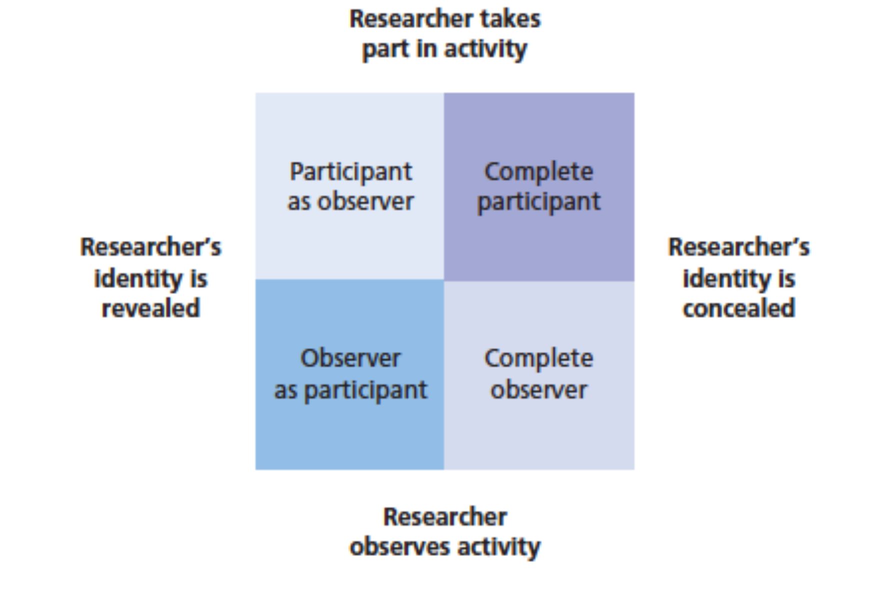
Good interviews must gather information that is valid, reliable, and relevant to the researcher's research questions (Saunders et al., 2009). Unbiased interviews lack or minimise interview bias that arises from the tone or non-verbal signals given by the interviewer in response to answers being provided by the subject. Bias in interviews may also result from sample selection. Good interviewers devote time to preparing for the actual interview, focusing their efforts on being knowledgeable about the subject and context of the interview. Equally important is the need to prepare interviewees by providing them with information about interview themes, their rights and obligations, the conduct of the interview itself and relevant events after the interview. Good interviewers choose appropriate locations, free of noise and distractions, where the interviewee is likely to be at ease to share information. Equally important is the appearance of the interviewer, who must blend into the environment in which the interview is being conducted.

3.4.2. Observations

Formally, observation is the process of systematic observation, recording, analysis, and interpretation of people's behaviour (Saunders et al., 2009). Observation generally refers to the act of observing people from the outside for purposes of research. This is distinct from participant observation (Figure 34), in which researchers are involved in the activities of their subjects (Myers, 2009). Saunders, Lewis, and Thornhill (2009) describe a four-role categorisation of observer roles starting with a complete observer, who does not participate and whose identity is concealed from the subjects of the study, through to a complete participant, who appears to other subjects to be just another participant with no other role. In between the two lies a known observer, who participates in the activities and a participant who is known to be observing the activities of the group.

Figure 34: Participant observation roles

(Saunders et al., 2009)



The role adopted by a researcher in an observation scenario depends on a number of factors. The purpose of the research and the probable impact of a researcher being known or being a participant are likely to influence the behaviour of other participants. The researcher must keep these in mind when choosing which role to adopt. The amount of time available to a researcher also affects the decision on which role to play, as being both a participant and an observer is likely to slow down the research process. The researcher may not be competent to participate or may not be given permission to participate, especially in sensitive environments, and may be forced to become an observer only. Ethical considerations may also make it inappropriate for a researcher to participate (Saunders et al., 2009).

3.4.3. Documents

Documents are written materials that people produce and typically reflect their thoughts, ideas, and actions. Documents may be in the form of books, newspapers, meeting minutes, diaries, emails, contracts, pictures, diagrams, photographs or hand-written materials (Myers, 2009). Increasingly the definition of documents is being used to refer to electronic media such as recordings, films and television programmes (Robson, 2002). Documents may be classified as personal, private, or public. Personal documents include letters, diaries, notes, drafts or books. Private documents are generally produced for use within a group or organisation and will include meeting minutes, memoranda, budgets and personnel files. Public documents are generally produced for public consumption and will include financial statements, media statements and newspaper articles (Myers, 2009).

A distinction is sometimes made between written documents and records, which are produced to confirm a particular transaction. Historical documents are a form of document that will be of interest to historians and researchers and will include contemporary records, confidential reports, expressions of interest, government notices and questionnaires that may have been used to solicit opinions. Documents stored in electronic form, such as computer files, software-generated reports, hyper-texted documents and email are also of interest to researchers.

Documents and other "trace" (Robson, 2002) elements, articles that leave a record of an activity, are easier to collect data from for a number of reasons. Documents are unobtrusive and non-reactive and will therefore not be influenced by the researcher. They provide a means to triangulate information provided by other sources and encourage ingenuity and creativity on the part of the researcher. Documents are generally cheaper and easier to access and process than other forms of data collection. In some cases, documents may be the only source of information that is available (Myers, 2009). On the down side, verification of the source of the document may be difficult, and where more than one subject is involved, the level of their participation in the production may be difficult to quantify. Ethical issues may arise, as documents by themselves are unable to give consent (Robson, 2002).

Myers (2009) discusses ways in which the quality of documents can be measured. The authenticity and credibility of documents contribute to the believability of their content. Equally important is the representativeness and clarity of evidence presented by the document. Poor documentary evidence will make little sense and may contain errors. Documents with internal inconsistencies are poor evidence; so are documents that have been transmitted through several people, some of whom may have vested interests. Documents that demonstrate inconsistencies in style and quality with other documents of their class are to be treated with suspicion.

3.4.4. Questionnaires

Questionnaires are typically associated with the survey research strategy (Robson, 2002; Saunders et al., 2009) although they can also be used as case studies or experiments. Questionnaires typically request respondents to answer a pre-set set of questions. The broad definition will include those used in structured interviews conducted in person, telephonically or online. Questionnaires are a useful way of collecting responses to standardised questions, which make for ease of analysis, especially in quantitative studies. Production of questionnaires is difficult because researchers have to ensure upfront that their questionnaires solicit all the information required to answer their research questions.

In order to improve the response rates, validity and reliability of their study, researchers need to pay careful attention to the manner in which questions are presented to the respondent. Equally important is the need to ensure that the entire questionnaire is clear and laid out in a pleasing manner. Questionnaires must be designed in such a way that respondents are able to read, understand and respond in a meaningful way (Bhattacherjee, 2012). A proper explanation of the purpose of the questionnaire is therefore necessary. Planning is necessary, as is efficient execution of the process of delivery and collection of the responses. Pilot testing is likely to help minimise some of the glitches that a researcher is likely to face in execution (Saunders et al., 2009).

One type of questionnaire is the self-administered questionnaire, where questionnaires are sent in bulk to many people and enable them to respond at their convenience within specified time frames. In group-administered questionnaires, respondents are placed in a room and given questionnaires to answer, which they hand in on completion. Increasingly important are online questionnaires, which follow the format of the self-administered questionnaire but are conducted online.

3.5. Data Analysis

Qualitative data analysis is the process of making sense of data that were collected, to aid in understanding and interpretation, in an effort to understand a phenomenon better. Qualitative data analysis is an iterative process that begins with initial understanding of the setting and perspectives of those being studied. This understanding is built up as more data are collected and further analysis is conducted (Bhattacherjee, 2012). The iterative nature of collection and analysis means that these are not two distinct phases of a project but often overlap (Myers, 2009). Data analysis allows researchers to develop theory from their data, using procedures that can be either inductive or deductive in nature (Saunders et al., 2009).

Qualitative data analysis allows large amounts of data to be reduced to manageable information that is easier to consume. The process must not only reduce the volume of data but also transform it into insightful information that the consumers of the information should find interesting. Through this process, the research is able to provide meaning to the piles of data collected, find common themes that run through it and contribute to knowledge (Myers, 2009).

Approaches to data analysis include hermeneutics, semiotics, narrative analysis and grounded theory (Myers, 2009). Hermeneutics is a qualitative analysis approach that focuses on meaning and understanding, within a particular socio-historic context. Semiotics focuses on signs and symbols and their meaning. Narrative analysis tries to extract a story with a plot from within the data being analysed. Grounded theory develops theory from qualitative data by spotting trends within the data.

Robson (2002) describes a different nomenclature, consisting of four approaches to qualitative data analysis, each one increasingly more esoteric and requiring more skill to accomplish. Quasi-statistical analysis involves counting the occurrences of terms and concepts in text and their inter-correlation as a means of establishing their importance. This approach is used in content analysis. Template approaches use pre-determined classes, determined from either theory or a prior reading of the data, to classify data into categories for further analysis. Matrix analysis is an example of this approach. Editing approaches are more flexible in nature, starting with no codes and building these up from the data based on the researcher's interpretation of the data. Grounded theory is an example of this type of approach. Immersion approaches, which are the most challenging and difficult to apply, demand more insight, intuition and creativity on the part of the researcher.

Qualitative analysis using computer software has become more prevalent with the spread of the personal computer. Among the most popular computer-aided qualitative data analysis software (CAQDAS) packages are products such as NVivo™, ATLAS.ti™, N6™, QDA Miner, and HyperSearch (Saunders et al., 2009). Such software can be used to automate and speed up the process of organising large amounts of data collected as part of a qualitative study. Through such software, researchers can organise, search, sort and process data. Despite the power of these tools, the researcher must still be able to specify the rules within which they operate, defining coding schemas, indices and other rules. Such systems are also unable to understand the meaning behind the data they process, with humour, sarcasm, the use of metaphors and other complex human constructs being lost in the processing of large amounts of data.

3.6. Research Design

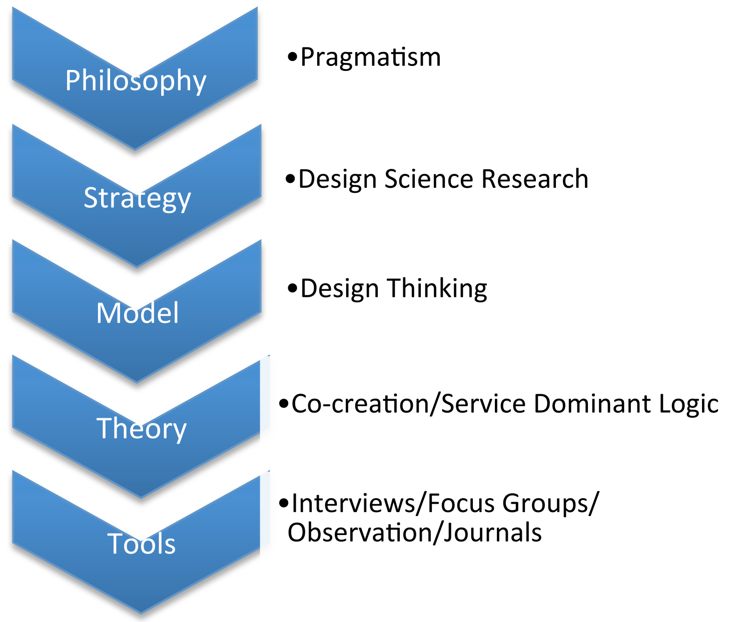
Having established a theoretical background for the conduct of research, this section describes the process followed in conducting this research, providing justification for the decisions made in choosing a research paradigm, strategy and the collection methods employed. A good research design is an architectural blueprint for the process to be followed to answer the research questions posed at the start of the project (Bhattacherjee, 2012).

3.6.1. Design Overview

The main objective of this study was to develop a framework for the implementation of ICT in service innovation. Starting with ideas from literature, an initial conceptual framework was proposed. This section describes the methodical choices made to construct, refine and test this framework.

For this study, the research choices made are summarised in Figure 35. The sections below it summarise the logic behind the choice of pragmatism as a philosophy and the choice of DSR as a research strategy.

Figure 35: An overview of research design for this study



While the hierarchy in Figure 35 appears to indicate a series of decisions being made, each one affecting the next, the reality of the messiness of research is that several decisions were made and discarded as the research evolved. The research design evolved as the literature began to provide more guidance on how the research could be conducted. An interpretive case study turned into a pragmatic DSR project. A participatory action research approach became a design science approach once the realities of wanting to produce an artefact in a limited three-year PhD programme became apparent.

3.6.2. Pragmatism as a philosophical paradigm

The selection of pragmatism as a philosophical paradigm to guide this study is based on the resonance between the key tenets of pragmatism and the objectives of this study. A treatment of the key concepts of pragmatism in the John Dewey tradition by Dalsgaard (2014) examines the paradigm from a perspective of its theory-practice relationship, emergence and interaction, situation, inquiry, transformation, technology and experience.

The relationship between theory and practice in pragmatism dictates that one gives primacy to that which works; that theory, ideas, and assumptions are only relevant if they lead to better practice (Cherryholmes, 1992). The researcher of a study learns from theory to challenge practice in an effort to improve theory. Such an approach can only be workable once one accepts the FP of the primacy of practice in pragmatism. The pragmatic principle that human circumstance can only be understood in the context in which they occur fits in with the aim of this study to take a human-centred approach to innovation. The pragmatic principles of emergence and interaction, which posit that the world is in a state of permanent flux, foster the environment for “action and reflection” (Dalsgaard, 2014). This environment in turn provides a basis for a study such as this one, where theory and practice are reviewed in an effort to reach a better situation.

Dalsgaard (2014) argues that the pragmatic principle of inquiry, a mode of thinking and doing that has learning and transformative action as raison d’être, also lends itself to the conduct of design-inclined studies. In line with this thinking, the principle of transformation converts indeterminate situations into ones of certainty, transforming the situation, the subject, or even the inquirer by providing better clarity or thought. This study pursues such transformation, through the use of technology in healthcare workers, their patients or in the absence of any change being required, in the mind of the researcher. Pragmatism views technology as the use of instruments to reach an intended outcome. Dalsgaard (2014) further argues that “technology frames our understanding of a situation and serves as a means for transforming it.” This study explores solutions aimed at exploiting technology to deliver transformation in healthcare experiences in much the same way that pragmatism holds technology.

3.6.3. Design science research as a strategy

DSR was selected as a research strategy primarily because the study involved the production of a generic artefact that can be used to solve problems in similar settings. Whereas action research is focused on solving problems in specific settings, DSR results in the production of ‘tools’ that can be used in other environments.

Table 15: Conceptual view of output chain

Actor	Primary interest	Tool	Example Output
Researcher	Helping practitioners shape better solutions	Design Science Tools *	Technovation Framework
Consultant	Helping service providers to improve service	Technovation Framework	Healthcare Application
Service Provider	Providing a service to ordinary people	Healthcare Application	Post-natal Care
Mother	Ordinary life	Post-natal Care	Healthier babies

* Tools employed by research scientists include theories, methods, data gathering tools, data analysis and conceptualisation

Researchers employ the tools of research, such as those associated with DSR, to construct tools that practitioners such as consultants can employ in their daily jobs. Such tools in turn help practitioners to shape tools, which can be used by those that provide service to ordinary people, to provide better service. This cascading relationship of outputs is illustrated in Table 15.

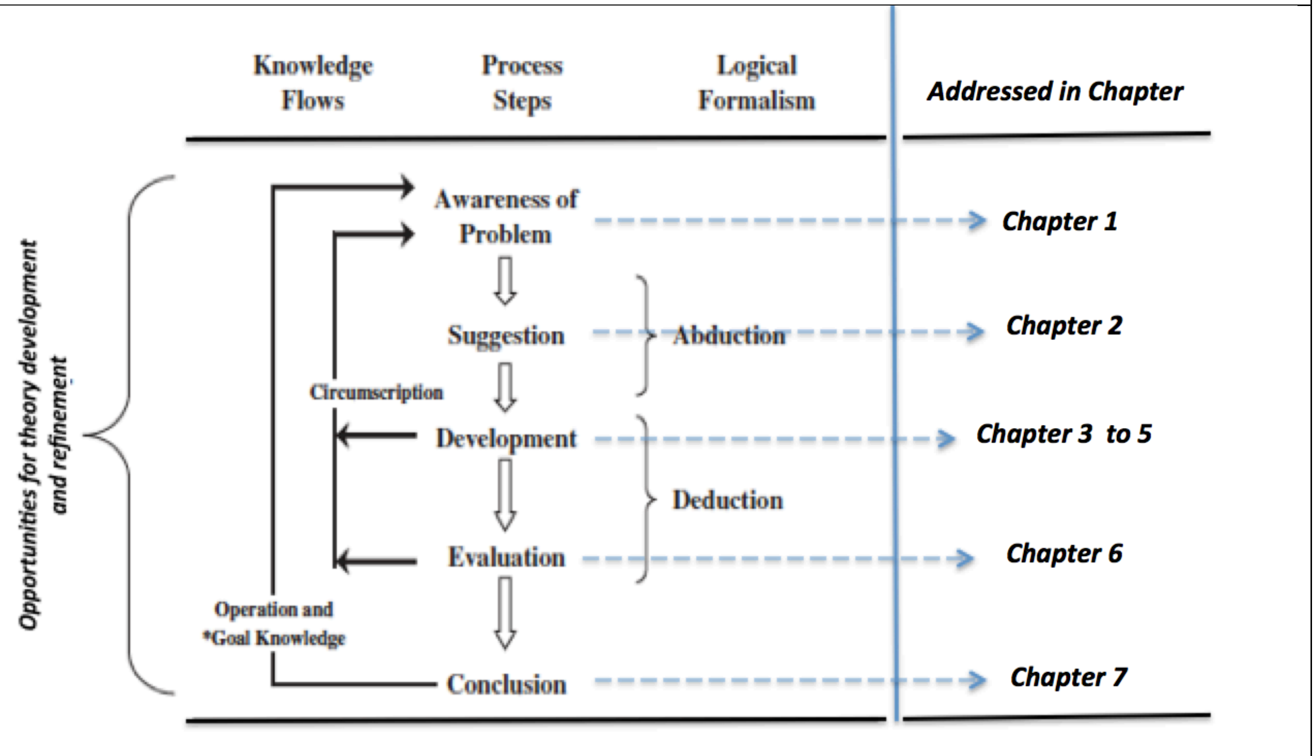
Table 16: Comparison of characteristics of design science and action research
(Baskerville et al., 2009)

Characteristic	Design Science	Action Research
Orientation	Research	Practice and Research
Goal	Problem-solving	Problem-solving and/or Behavioural Understanding
Specificity	Generalised	Situation-specific and Generalised
Design Role	Invention/Generative	Application
Outcome	Design Theory or Artefact with Utility	Situated Organisational Improvement

While the objective of an action research project is to effect some change in an environment and learn from it, the objective of DSR is to produce a way of solving problems. The design science approach is therefore generalised in nature, with the aim to produce theory or an artefact that can be employed in many settings. With an intended objective of developing a framework to help healthcare workers innovate, this study is therefore best approached as a DSR project as opposed to an action research project. Table 16 presents a comparison between DSR and action research.

Figure 36: Design science research process reconsidered

(Kuechler & Vaishnavi, 2008)



This study follows the DSR process proposed by Kuechler and Vaishnavi (2008), as shown in Figure 36. The problem awareness phase is explored in Chapter 1 of this study, identifying the use of technology for innovation in healthcare as a potential opportunity to solve the problem of dwindling resources in the face of increasing demands. The search for solutions and suggestions is undertaken in Chapter 2 where current uses of technology in healthcare are explored, along with an investigation into how innovation is conducted. The use of co-creation and ideas about SDL are researched along with an inquiry into design thinking and how it is used to drive innovation.

Chapter 3 begins the process of developing a potential solution to the challenge presented in Chapter 1, culminating in the development of an artefact in the form of a framework and a process for its application in Chapter 4. The initial conceptual framework and associated process are described in Chapter 4. A series of design thinking workshops is used to validate the efficacy of the framework and the findings of this work are presented in Chapter 5. Chapter 6 presents the final Technovation Framework, which incorporates the findings of three cycles of evaluation. The final chapter of this work presents a discussion as well conclusions from the study.

3.6.4. Building a conceptual framework

Gregor (2006), in her taxonomy of theory in Information Systems (IS), describes five types of theory. Analysis theories aim to analyse and describe, focusing on what is, while explanation theories aim to explain without any aim to predict, focusing on what is, how, why, when and where. Prediction theories focus on what is and what will be in providing predictions, but without necessarily offering causal explanations. Explanatory and prediction theories combine the attributes of the last two types of theory. The last class of theories is termed design and action theories and they aim to explain how to do something. This framework falls in this last class, namely design and action.

"Design and action theory says how to do something. The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artefact".

(Gregor, 2006)

Jabareen (2009) defines a conceptual framework as "a network, or 'a plane', of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena." Meredith (1993) identifies three types of conceptual frameworks. Conceptual induction frameworks are used to infer the nature of a system or the treatment that produces the phenomena associated with that system. Conceptual deduction frameworks are used to predict the outcomes of phenomena. Conceptual system frameworks are characterised by many interactions that occur among different elements of the framework and include process descriptions. The proposed framework follows the characteristics of a conceptual system framework.

A concept is defined as a set of specific objects, symbols or events, which are grouped together on the basis of shared characteristics and which can be referenced by a particular name or symbol (Merrill & Tennyson, 1977). Concepts are defined by their components, both unique and those shared with other concepts, and are related to other concepts. An example of a framework is the information systems research framework (Hevner et al., 2004), based on concepts of a business environment, information systems research and the body of knowledge. In the information systems research framework, the business environment concept is defined by various components, which include people, organisations and technology. The information systems research concept is defined by components that include how to build/develop theories and artefacts, how to evaluate/justify them, how to access and how to refine them. The body of knowledge is defined by methodologies that are used to build foundations (theories / frameworks / models / methods / instantiations).

3.6.5. Data collection and analysis

Data collection for this project was conducted in two distinct work packages. The first set of data collection was used to collect ideas that were used to construct the Technovation Framework. The second aspect of data collection related to data required to test and refine the framework. In both cases, a thematic analysis of the data was used to identify patterns in the data.

3.6.5.1. Components of the Technovation Framework

The first cycle of collecting data for a DSR project, once the problem area has been identified, is in the literature. This was accomplished in the second chapter of this study. The literature search was focused on four concepts as follows:

- ICT in healthcare
- Co-creation and SDL
- Innovation
- Design thinking.

a. The ideas behind the ABCDEFS framework for reviewing literature

The ABCDEFS framework (Table 17), based on the work of Boote and Beile (2005), helped the researcher to gain a comprehensive understanding of each of the four concepts identified. By exploring what the concept was about, the researchers became acquainted with the terms that are generally used, together with the concept of interest. Definitions of the concept as presented by different authors were explored and compared. This section was also used to find the rightful place of the concept under discussion in the broader scholarly literature. The background section was used to place the concept in the broader historical context of the field. By bringing together different voices that have participated in the study of the concept under discussion, the researcher was able to create a new, albeit brief, narrative of the concept.

Table 17: The ABCDEFS framework for reviewing literature (reconsidered) (Adapted from Boote & Beile (2005))

Section	Description	Purpose
About	What is?	Acquire and enhance the subject vocabulary Place the topic/problem in the broader scholarly literature
Background	What is the history behind it?	Place the research in the historical context of the field
Complexity	What are the challenges and complexities?	Articulate important variables and phenomena relevant to the topic
Description	A description of the methodologies associated with this concept	Identify the main methodologies and research techniques that have been used in the field, and their advantages and disadvantages Relate ideas and theories in the field to research methodologies.
Examples	Empirical studies around the concept	Distinguish between what has been done in the field and what needs to be done
Findings	Findings from the example studies	Rationalise the practical significance of the research problem Rationalise the scholarly significance of the problem
Synthesis	Identification of other studies that have linked the concepts in this study together	Synthesise and gain new perspective on the literature Link ideas about this concept to other concepts in the study e.g. keywords for search

The challenges and complexities associated with each concept were identified and documented. The conceptualisation, development, testing, and evaluation of the solution proposed took into account the known challenges associated with each of the concepts that were brought together in the proposed solution to the research question. Using the ABCDEFS framework, the research explored the method and processes behind the concepts of interest. The researcher also sought to understand the methods used to study the concepts of interest and where appropriate identified known theories in the area.

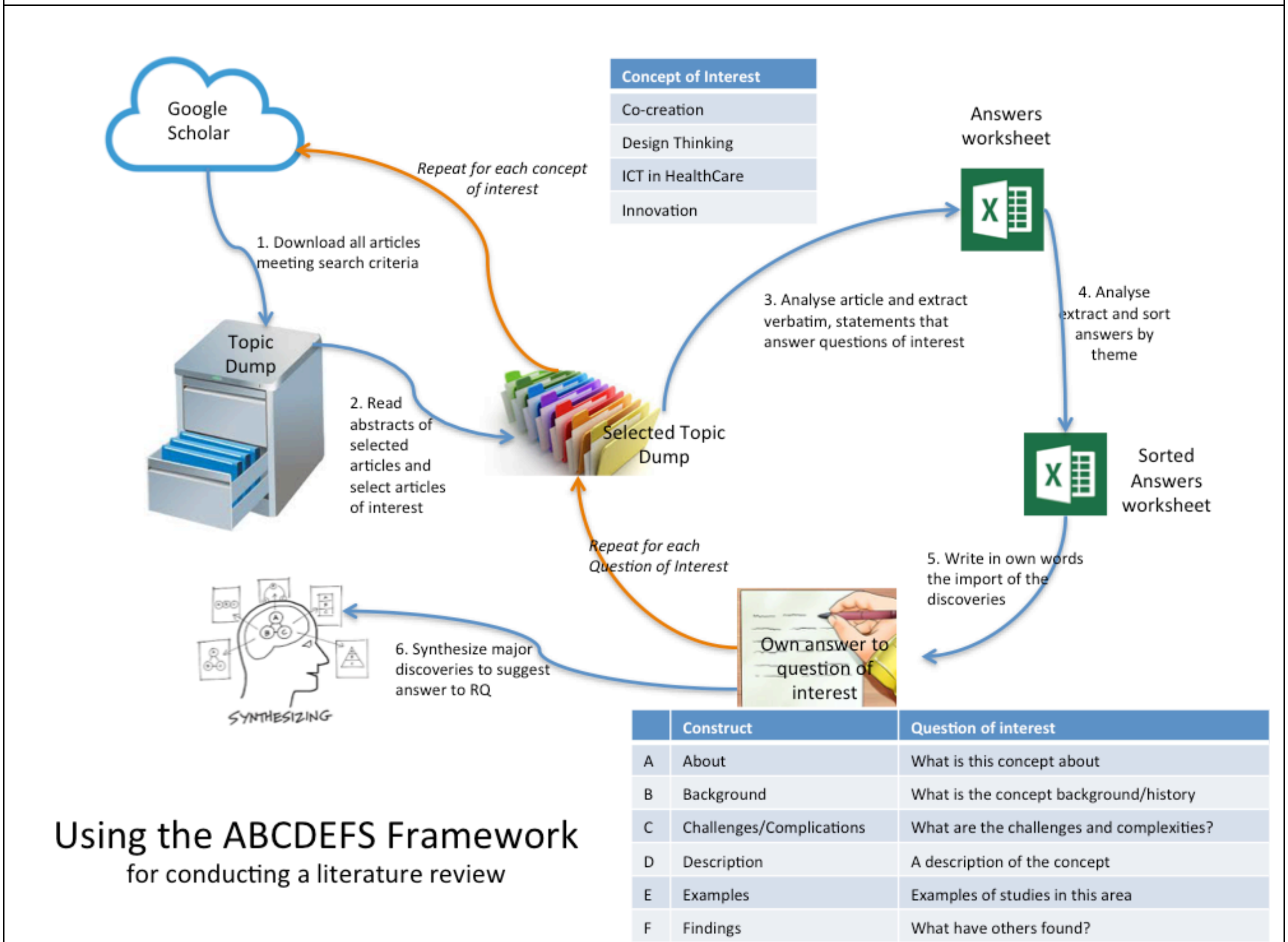
The examples section of the ABCDEFS framework was used to gain understanding of prior studies in the field. This endeavour helped the researcher to understand the gap in the literature, identifying solidifying of evolving ideas as the opportunity for further work. Findings from prior studies were documented to gain full understanding of the state of the knowledge about the concept of interest. The final act of the literature review was a synthesis of the key ideas in an effort to propose an answer to the research question, which initiated the journey into the literature.

This classification of the literature, based on the ABCDEFS framework developed in this study, gave the researcher sufficient data in the form of concepts and constructs to be able to construct the initial Technovation Framework.

b. Using the ABCDEFS framework for reviewing literature

Figure 37 describes the 'mechanical' aspects of how the ABCDEFS framework was used to explore the literature. In discussing and positioning the problem statement and research questions of interest in Chapter 1 of this study, four concepts were presented as pertinent in the development of a potential solution. An understanding of how innovation is conducted was deemed of interest in the pursuit of innovation in healthcare. The problem statement is built around the difficulties in offering services to increasing populations and hints at the engagement of those who use the services as a potential source of solutions. The literature thus looked at co-creation and this led to the ideas espoused in the SDL theory. Design thinking was also proposed as a way of bringing about innovation that is consistent with co-creation and this was investigated as well. An understanding of how ICT is being used in healthcare and how this has evolved was also explored.

Figure 37: Using the ABCDEFS Framework



All the articles included in this review were retrieved through Google Scholar, accessed through the University of Pretoria's library site to take advantage of the university's subscription to the various journals publishing the papers. A brief discussion on the merits and demerits of the use of Google Scholar for academic research is presented in the introduction to the literature review in Chapter 2 of this study.

Table 18: Literature Search terms	
Concept of Interest	Google Scholar Search Terms
ICT in Healthcare	"ICT in Healthcare"; "ICT in Health"; "Health Informatics"; "Healthcare informatics" and "e-Health".
Innovation	"Innovation", "Service Innovation"
Co-creation	"co-creation", "co-production", "service dominant logic"
Design thinking	"design thinking"
NB: The search terms for the last three concepts were also combined with "healthcare" to bring greater focus to the area of interest.	

Using the search terms for each area of interest (Table 18), a search was conducted on Google Scholar for articles of interest. Initial screening was based on the title of the article. Articles that appeared to match the area of interest were saved into a local folder on the researcher's laptop. Articles included were generally based on work undertaken in the last five years, although the search was broadened specifically to answer the question on the background of a concept. From this broad group of articles of probable interest, the article abstracts were reviewed and the list of articles whittled down to articles of interest, which were placed in a "Selected Articles", folder for the concept under consideration.

Each selected article was then read in detail and the researcher extracted, verbatim, any writing that appeared to answer the question of interest about the concept being researched. Table 19 presents a sample of the output of such an extraction. Having studied articles on design thinking, the researcher constructed the answer sheet of challenges consisting of the citation column and the challenge column. These were then analysed and grouped into emerging themes. The section in Chapter 2 on challenges in design thinking was then written, summarising the themes as they emerged from the research. This process was repeated for each of the six constructs in each of the four concepts under study.

Table 19: Sample Analysed Answer Sheet

Citation	Challenge	Theme
(Brown & Wyatt, 2010)	One of the biggest impediments to adopting design thinking is simply fear of failure. The notion that there is nothing wrong with experimentation and failure, as long as they happen early and act as a source of learning, can be difficult to accept. However, a vibrant design thinking culture will encourage prototyping — quick, cheap, and dirty — as part of the creative process and not just as a way of validating finished idea	Culture and Attitudes
(Bjögvinsson, Ehn, & Per-Anders, 2012)	A fundamental challenge for designers and the design community is to move from designing “things” (objects) to designing Things (socio-material assemblies).	Culture and Attitudes
(Bjögvinsson, Ehn, & Per-Anders, 2012)	Designing for, by, and with stakeholders may be challenging enough where common social objectives are already established, institutionalised, or at least seen as within reasonable reach.	Culture and Attitudes
(Bjögvinsson, Ehn, & Per-Anders, 2012)	The really demanding challenge is to design where no such consensus seems to be in view, where no social community exists.	Culture and Attitudes
(Cooper, Junginger, & Lockwood, 2009)	This is not always the case. In fact, it is here that the potential problems and challenges for design thinking lie. Since design thinking and design methods always go hand in hand — that is, in design the thinking is informed by the doing, and vice versa — there is concern among some designers that the emphasis on thinking might overshadow the importance of making.	Culture and Attitudes
(Rylander, 2009)	The literature on knowledge work and knowledge-intensive firms typically addresses organisational issues emerging from the challenges posed by coordinating and managing highly qualified knowledge workers who are expected to act and collaborate based on their own understanding, thus invalidating bureaucratic forms of control.	Culture and Attitudes
(Koria & Karjalainen, 2012)	This implies that the past social and collegial control and tacit knowledge transfer in projects has eroded and that projects need better strategies for both management and learning.	Preparedness

The final act of the study of the literature was synthesis of the key ideas that had been explored. This synthesis led to the suggestion of a conceptual framework that forms the basis of the Technovation Framework.

3.6.5.2. Construction of the Technovation Framework

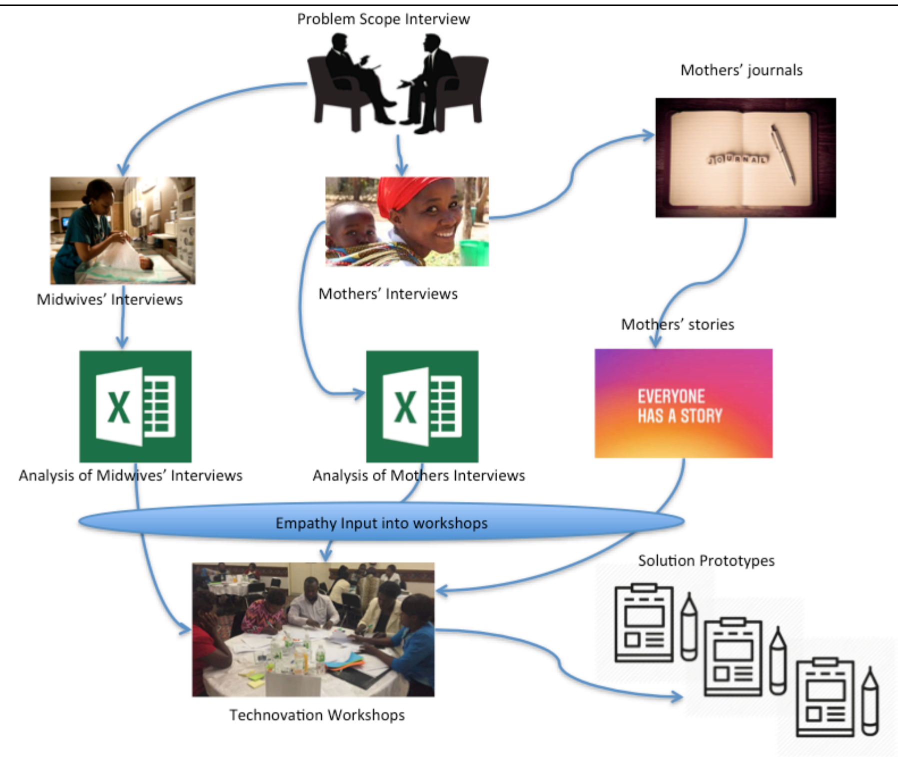
Construction of the Technovation Framework and the resulting Technovation Process is discussed in Chapter 4 of this thesis. The researcher sought to overlay the various concepts extracted from the literature by exploiting commonalities in the ideas investigated. This continued synthesis allowed the researcher, having explored what had been done before, to articulate a new perspective on the problem at hand. The result of this was a conceptual framework, the Technovation Framework, which is described in Chapter 4 of this work. The Technovation Framework advocates combining SDL with technology capabilities to enhance design thinking processes for use in innovation work. The resulting process is referred to as the Technovation pProcess.

3.6.5.3. Testing and refinement of the Technovation Process

The second cycle of data collection was focused on collecting data for the testing of the echnovation process and was in itself split into three areas. The first area related to collection of data to enable the researcher to zero in on a specific problem area to be addressed using the Technovation Process. This was accomplished through interviews with the CEO of Chitungwiza hospital and the chief nursing officer (CNO). The Technovation Framework adopts the five-stage process described in the Stanford d.school (2016) design thinking approach. In this approach, designers embed themselves with those for whom services are being designed in order to gain empathy. In this study, the researcher conducted research into the circumstances concerning service delivery in healthcare and this was analysed and presented as empathy in the design workshops conducted using the Technovation Process.

An overview of the process of collecting and analysing empathy data is presented in Figure 38.

Figure 38: Collection and analysis of empathy input into workshops



a. Scoping the area of interest

The interview with the CEO and CNO was aimed at gaining broad understanding of the institutional perspective of offering post-natal care with the objective of providing a broad scope for the design thinking work. Using a semi-structured interview format, questions were asked about the service that the hospital offers and challenges faced in providing this service. The interview also looked at who the key players in service provision were and the roles they played. The two medical officers were asked questions about their contact with patients after discharge and the tools they used in the discharge of their duties at a central hospital. This meeting also served as an introduction to the hospital environment, with several follow-up meetings being arranged with key personnel as a result of the recommendations from this meeting. The information collected formed a basis for understanding the dynamics of service provision in the hospital and the ecosystem around it.

Table 20: Collecting data for testing

Purpose	Activity	Collection Tools	Instruments*
Define Problem Area	Problem scope interview	Interview	IG 01
Building Empathy Input	Midwife interviews	Interviews	IG 02
	Initial home interviews	Interviews	IG 03
	Mothers' journals	Journals	JG 01
	Follow-up home interviews	Interviews	IG 04
Evaluate Framework	Three cycles of design thinking workshops using the Technovation Process	Observations, Questionnaires	WG 01

* See Appendix A for interview instruments

An overview of the instruments used in collecting data for testing the framework is provided in Table 20. The actual instruments are provided in the appendix to this thesis. The sample sizes for the various data collection and development activities are summarised in Table 21.

Table 21: Field data collection sample sizes

Purpose	Instrument		Number
Define Problem Area	Hospital head interview (CEO + CNO)	Interview	1
Building Empathy Input	Midwife interviews	Interviews	10
	Patient diaries/journals (returned)	Journals	10
	Initial interviews	Interviews	22
	Follow-up interviews	Interviews	17
Refine Framework	Design Thinking Workshop 1	Participants	28*
	Design Thinking Workshop 2	Participants	4**
	Design Thinking Workshop 3	Participants	4
Evaluate Framework	Design Thinking Workshop 4	Participants	6
Prototype Testing	Senior ICT practitioners/design teams	Review	3

* The initial design thinking workshop was made up of four teams, each consisting of a designer/developer, two mothers and two midwives. Also in attendance were a co-facilitator and two senior developers who assisted with the testing of prototypes.

** Subsequent design teams were made up of two developers and two midwives

b. The midwives' perspective of offering post-natal care

The second area of inquiry focused on building empathy input into the design thinking workshops. This was achieved through multiple instruments involving midwives as well as new mothers. An advertisement was placed in local newspapers for midwives to participate in a research study. Twenty midwives responded to the advertisement, of which 13 arrived to be interviewed. After the nature and purpose of the research work had been explained to them, 10 midwives agreed to participate in the study and they signed the consent forms. Midwives who participated in the interviews ranged in experience levels from a few years to over 30 years in the case of one of them. They had a combination of private sector and public sector experience.

Table 22: Sample interview analysis

The role of the midwife in post-natal care			
Mother_ID	Question_ID	Response	Theme
Midwife 10	Role	… and then we take the baby to the post-natal ward.	baby
Midwife 01	Role	Examine the baby, head to toe; the eyes, anything that the labour ward may have missed, the cord is not bleeding and securing it if it's loose, the bladder, and the rectum … a quick examination throughout.	baby
Midwife 06	Role	... we do physical examination of ... the baby.	baby
Midwife 06	Role	Generally we do post-natal examinations from head to toe. Usually what is done some hours after the patient has delivered ... we do physical examination of the mother and the baby.	baby
Midwife 03	Role	… and that the baby is also healthy and breastfeeding well, has been examined that there are no abnormalities that have not been attended to and that there is continuity of care in the community … we are looking at breastfeeding, immunisation, welfare of the baby, nutrition …	baby
Midwife 02	Role	We check on the baby as well, the functioning of the brain, their physical well-being and any disabilities.	baby
Midwife 04	Role	… you explain how to hold the baby, start teaching them how to look after themselves, how to bond with the baby.	education
Midwife 06	Role	We also give them review dates on when they should next come.	education
Midwife 07	Role	… and that there is continuity of care in the community … we are looking at breastfeeding, immunisation, welfare of the baby, nutrition …	education
Midwife 07	Role	We need to go through issue related to mother to child transmission; during the ANC, they may have gone through those issues in training … the mothers get to choose whether they want to breastfeed or not …	education
Midwife 04	Role	… after that you want to make sure the uterus is contracting and the condition of the baby	Physiological

Interviews with the midwives focused on their roles in providing post-natal care. The nurses were encouraged to go into detail regarding the processes they followed, with special focus on how they managed their work and its flow. The weaknesses in service offering and challenges faced were investigated. The researcher questioned the midwives on their interaction with new mothers and their babies, both in the hospital and after discharge. The interview also explored their experience with mothers who returned to the healthcare system for immunisation of their babies. The handling of information was of particular interest and midwives were asked to explain their experience. Midwives were asked to make suggestions on how they could improve their service offering.

The interviews with midwives were recorded and transcribed. The answers to the questions were imported into an Excel spreadsheet with three columns: Mother_ID, Question_ID and Answer. The spreadsheet was then sorted by Question_ID and all answers relating to a Question_ID were moved to a different sheet. The resulting sheet was analysed into emerging themes and ultimately sorted by theme. This process was repeated for each of the questions asked in the interview. A sample of the analysed data is provided in Table 21. Thematic analysis allows not only for the identification, analysis and reporting of patterns in data, but also for interpretation of aspects of the research (Braun & Clarke, 2006).

c. The mothers' perspective of receiving post-natal care

The CNO helped the researcher identify mothers for participation in the study. Thirty mothers were approached, 10 on each of three successive days. Each of the mothers selected had given birth in the 48 hours prior to the selection. In their groups of 10, the researcher explained the reasons for the study and read through the consent forms. This information was conveyed in both English and Shona and the session was conducted in the presence of a qualified midwife at all times.

Selection of patients for further participation in the study was made, based on their ability to maintain journals on a daily basis, keep those journals private and agree to follow-up interviews to the conducted in their homes. Eight mothers declined to participate further in the study and 22 mothers agreed to proceed. These were requested to sign the consent forms. These mothers were issued with journals to complete on a daily basis at home. A week after the journals had been issued, the researcher and an experienced midwife visited the mothers for initial interviews. Interviews with mothers and observations in their home settings allowed the researcher to experience their situations first-hand and understand their perspective of the service offered by the healthcare system. Six weeks later, the researcher and midwife made final visits to mothers to collect the diaries.

Interviews with mothers were recorded and transcribed. The answers to these questions were imported into an Excel spreadsheet. An analytical process similar to that undertaken for the midwives' interviews was followed. This helped the researcher to identify themes related to the use of post-natal care services by new mothers. The journals were studied and three stories were chosen out of the most compelling accounts of the mothers' lives. Each of the stories presented is true, and between them, they convey most of the experiences faced by all the mothers interviewed.

The mothers who took part in the study were all literate, capable of writing and conversing in Shona and English. All the mothers were familiar with cellphone technology, with three quarters of them reporting to have access to a smartphone. Two of the mothers reported having access to a computer at home and another one had access to a computer at work. The level of ICT literacy was basic at best and in the worst cases limited to a general awareness of computers.

d. Testing the Technovation Process

The development of the Technovation Framework resulted in a process that employed the concepts defined in the framework. The process runs along the same lines as a design thinking workshop, albeit with additional guidance for implementing the constructs of the framework. Testing of the process was conducted in three successive design thinking workshops in which the analysis of the midwives' interviews, the mothers' interviews and the mothers' stories were used as empathy input. Observations were made by the researcher as the research teams worked. These observations were used to fine-tune later versions of the framework and the accompanying process.

Although the initial interest was in evaluating the framework using an SAP system as the underlying technology platform, lack of cooperation from the local SAP representative meant that the researcher had to explore other technologies. The researcher then settled on low-cost mobile applications as the technology of choice. The first design workshop was made up of four teams, each one consisting of a designer/developer, two midwives and two mothers. The design output of the first workshop was captured on post-it notes and pasted on team boards. The researcher, along with an independent facilitator, photographed the boards as a record of each team's output.

In the first set of workshops, questionnaires were issued to the teams to help evaluate one another's prototype. In subsequent workshops, the prototype testing was built into the framework as a self-evaluation tool for use by the design team. Output from the second and third workshops was captured in spread sheets in line with the revised format of the Technovation Process.

3.6.6. Limitations

The limitations in this study result from the chosen setting for the study. A township hospital in a developing world is an unlikely candidate for generalisation to a broader population, in spite of any valid lessons learnt. The size of the African continent and the existence of many similar environments do, however, weigh in favour of doing this study. A further limitation is the choice of a healthcare setting, where the workers are all literate, being nurses, doctors and administrators, making generalisation to other settings for ICT projects difficult. Logistically, providing training to members of the public on design thinking techniques is difficult. This thus limits participation of those who are not healthcare workers to the role of less empowered participants, a weakness likely to be faced by any study on co-creation taking a design thinking route.

3.6.7. Ethical considerations

Scientists are expected to be aware of and abide by rules and regulation regarding what is acceptable behaviour in the conduct of science (Bhattacherjee, 2012). In order to conform to ethical requirements for a study of this nature, a number of matters had to be taken into consideration. Of primary concern for a study that touches on the health sector, a commitment was made that no participant would be harmed, placed in the way of harm or placed in a position where service they would otherwise have received became unavailable. Participation in this study was voluntary, and participants were given the opportunity to withdraw at any time, should they wish to do so. Many participants who were approached both from the healthcare side and the patient side declined to participate in the study for various reasons, such as family restrictions, time constraints, religious beliefs or privacy issues.

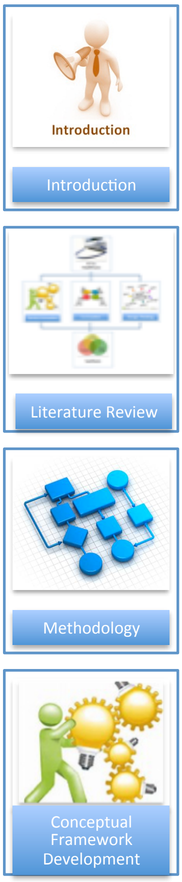
Any responses provided in confidence will remain confident and will not be disclosed, especially where such information was provided in a one-on-one setting. Because of the nature of the study approach, anonymity was not an issue (for those who participated in the workshop), as all the participants faced the researcher or other participants at some point in the study. Background information was provided to participants to ensure that the requirements for full disclosure were met.

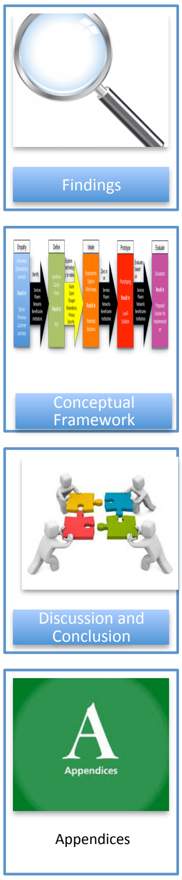
This study is fully compliant with the guidelines provided in the University of Pretoria Code of Ethics (University of Pretoria, 2016). Copies of the ethical approval granted for this study are provided in Appendices F and G.

3.7. Summary

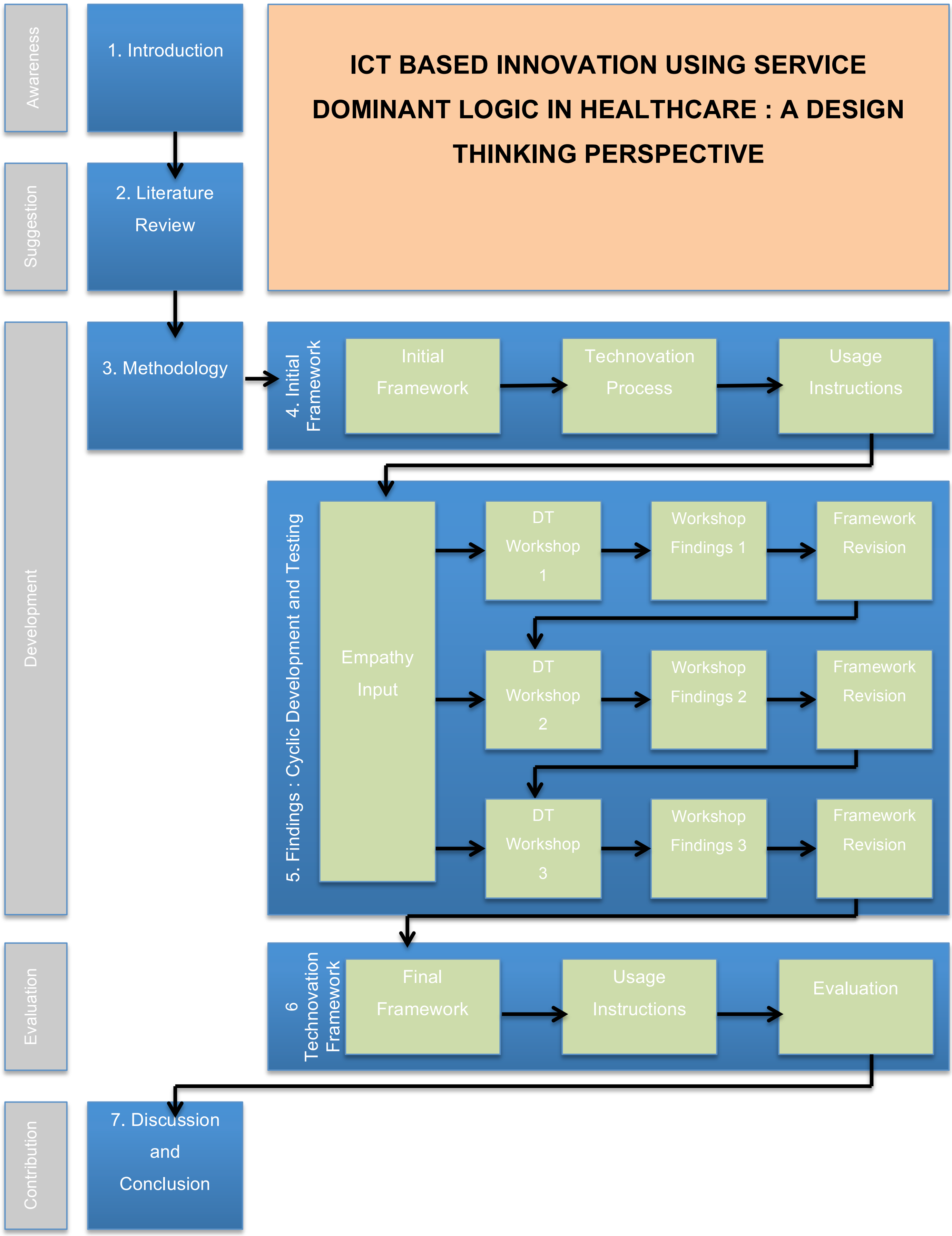
This chapter began with a general survey of the paradigms, approaches/strategies, methods, and instruments used in research as found in the literature. This information was used in consolidating decisions on the manner in which to conduct this research. The later parts of this chapter sought to justify the decisions made in formulating a design for this study. This study is routed in the pragmatic philosophical paradigm and uses a DSR approach. Using this approach, data are collected through interviews, focus groups and observations.

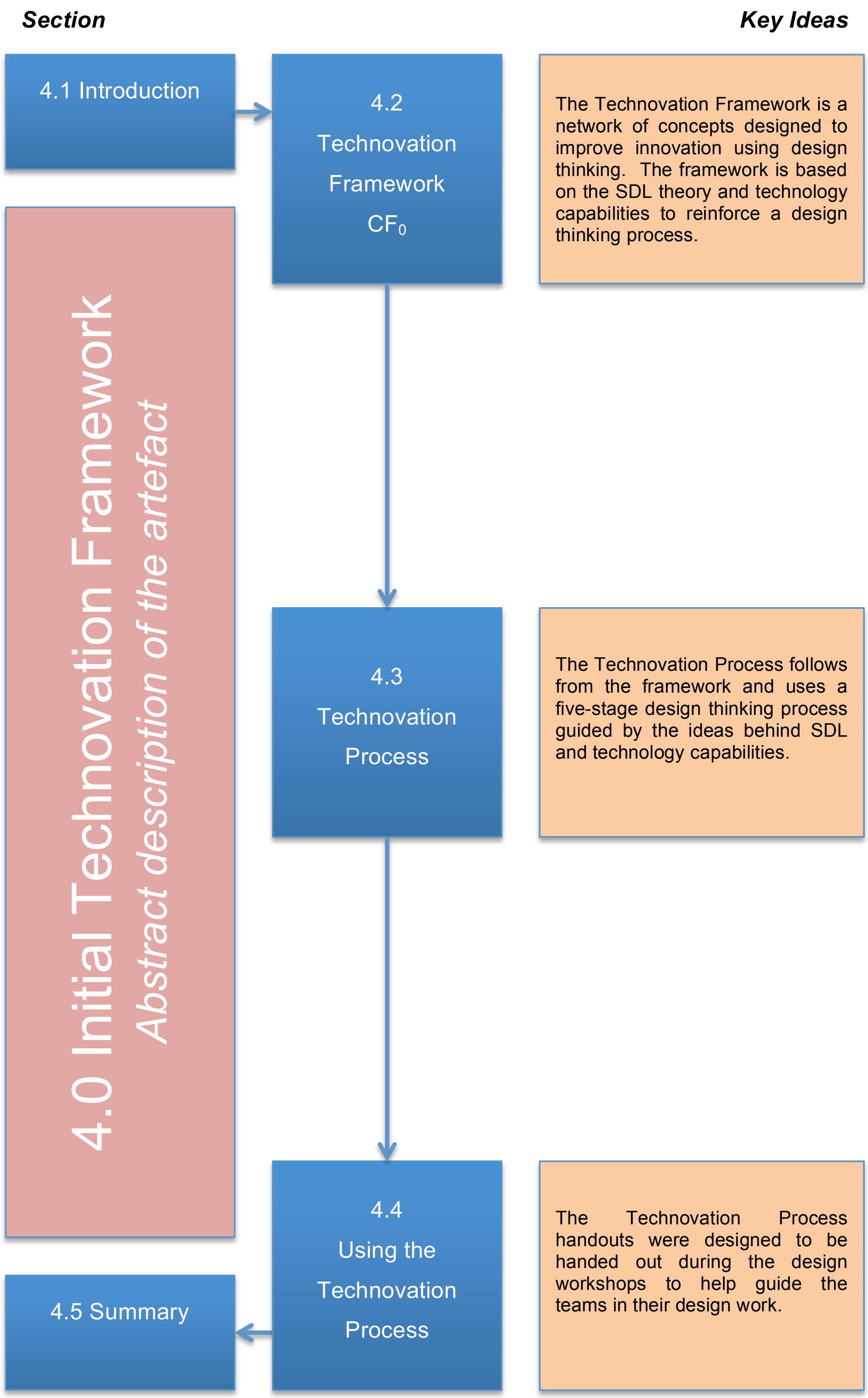
Design thinking workshops were used to validate and further develop the components of the Technovation Framework and the companying process. This chapter also discusses the analysis of data, ethical considerationsand limitations of the study.





4. Conceptual Framework Development


Awareness
1. Introduction
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
Suggestion
2. Literature Review
Development
3. Methodology
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings : Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
Evaluation
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
Contribution
7. Discussion and Conclusion

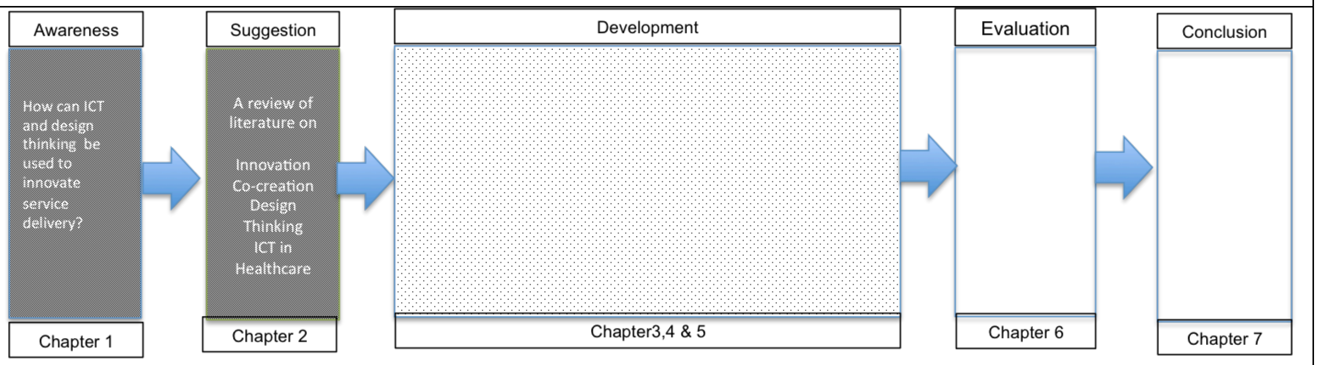

Section
Key Ideas
4.1 Introduction
4.2 Technovation Framework CF_0
The Technovation Framework is a network of concepts designed to improve innovation using design thinking. The framework is based on the SDL theory and technology capabilities to reinforce a design thinking process.
4.0 Initial Technovation Framework
Abstract description of the artefact
4.3 Technovation Process
The Technovation Process follows from the framework and uses a five-stage design thinking process guided by the ideas behind SDL and technology capabilities.
4.4 Using the Technovation Process
The Technovation Process handouts were designed to be handed out during the design workshops to help guide the teams in their design work.
4.5 Summary

4. INITIAL TECHNOVATION FRAMEWORK

4.1. Introduction

This chapter describes the development of a conceptual framework for use in service-based innovation using ICT, built around a design thinking process. The chapter also presents guidelines on how to use the Technovation Process. This study starts on the premise that healthcare is in crisis owing to reduced funding and an increased burden for reasons such as growing populations, people living longer and poverty in the developing world. Healthcare practitioners must look at doing more with less, and this can only come from service innovation. The study argues that technology can and has been shown to assist in the efficient delivery of service. The second chapter of this study searches the literature for suggestions of how technology can be employed to drive the innovation that is required.

Figure 39: Build up to development of the artefact



The literature on the use of technology in health reports a long history of the use of technology, starting with record-keeping, which is as old as medicine itself. In the modern era, technology has been used to maintain records as early as the 1950s when computers were first introduced. Their use has evolved with the evolution of technology and interest continues to grow in how technology can help bringing about continuous change. More recent interest in technology was related to the use of the internet in service provision, and along with it, concerns have arisen about privacy and confidentiality.

The literature review presented in Chapter 2 was focused on service innovation and the different ways in which change can be effected in how things are done. Definitions of innovation describe innovation as change that results in positive benefits for organisations and their stakeholders. Through innovation, ideas are generated that lead to new products, services, structures or processes. Service innovation can result in changes in the scope of an offering, the ways in which a service is offered, the actors that participate in the service or any other attribute that makes up the service.

The study also looks at co-creation and the theory around SDL. Co-creation is defined as the joint creation of value between an organisation that makes a value proposition and a customer that accepts that proposition, generally for the benefit of the customer in return for some payment. This is only possible in an environment where dialogue is possible, allowing customers to experience unique personal experiences. This work on co-creation is encompassed within a broader body of work by Vargo and Lusch (2004), which looks at ideas on how service is offered and used.

A section of Chapter 2 of this thesis delves into the intricacies of design thinking and among other topics, highlights the challenges faced with design thinking. Seidel and Fixson (2013) allude to the chaotic nature of design thinking projects. Badke-Schaub, Roozenburg and Cardoso (2010) argue that because design thinking is not routed in a deep theoretical foundation, it lacks scientific rigour. Bjögvinsson, Ehn, and Per-Anders (2012) discuss the challenges of user participation in design. Many design teams struggle with technology and its role in user-centred design. Lugmayr, Stockleben, Zou, Anzenhofer and Jalonen (2014) argue that many design teams struggle with the way to incorporate technology into their design. Seidel and Fixson (2013) argue that in many design teams, technology is in fact an elephant in the room that is skirted around and not properly addressed. Teixeira, Patricio, Haung, Nobre-ga, Constantine and Fisk (2013) question designers' ability to come up with technology-appropriate designs.

This paper argues that it is possible to develop designs that are user-centric and relevant, that are built from the ground up with technology capabilities in mind. The artefact proposed in this chapter describes a framework, which can be used to bring rigour and relevance to design thinking projects while still allowing the abductive thinking that makes design thinking unique. This framework, which focuses on service innovation, is built on the work of Vargo and Lusch (2017), whose work on on SDL provides a structured way to view how service is offered and used. The framework proposed in this study also takes into account technology capabilities, so that designers work on initiatives that consider technology feasibility upfront.

The work of Frow, Nenonen, Payne and Storbacka (2015) describes a co-design framework on which work such as this work can be built. This work seeks to enhance customer experience **[co-creation motive**], through co-design **[co-creation form],** while engaging various actors that form a part of the service ecosystem **[engaging actors].** The engaging platform is any of the technology capabilities that may be proposed during the design process. The **level of engagement** is largely emotional, as the design team gathers empathy, but could well be cognitive and behavioural. The **duration of engagement** is once-off during the design, although the design itself may last several months stretching from empathy gathering to prototyping.

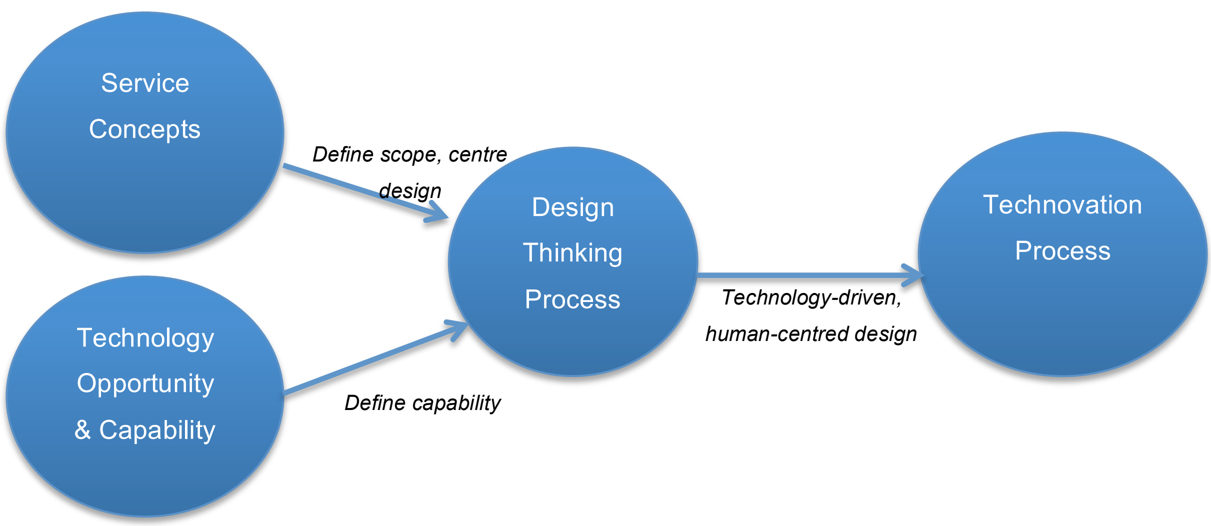
This chapter describes the work done to build the Technovation Framework, a conceptual framework for use in service-based innovation using ICT, built around a design thinking process.

Also discussed is the Technovation Process, a structured design thinking process that exploits the ideas described in the framework. The chapter starts by justifying why an artefact is required, then describes the process of building a conceptual framework (Section 4.1). Section 4.2 describes the concepts used to build up the Technovation Framework and the theory around these concepts. Section 4.3 describes the Technovation Process that supports the framework. Section 4.4 presents workshop guides that can be used to support the use of the Technovation Framework.

4.2. Technovation Framework Concepts

The concepts behind the Technovation Framework arise from the literature review in Chapter 2. The constructs that make up the concepts highlighted in Figure 40 are discussed in the following sections. Service concepts, as employed in the framework, are used to define the scope of a service offering while centring designs on beneficiaries of service offerings. Technology opportunities and technology capabilities are used to identify potential solutions in line with a POV defined in a design thinking process. The combination of these concepts is consolidated below into a Technovation Process, defined below.

Figure 40: Conceptual basis of the Technovation Framework (CF0)



4.2.1. The concepts behind service-dominant logic

In 2004, Vargo and Lusch, building on earlier work by other scholars such Prahalad and Ramaswamy (2000), set out to explore an emerging logic that put service, as opposed to goods, at the centre of all economic exchange. That work was summed up, initially in eight and ultimately 11 FPs that at their core removed goods and organisations from the centre of the universe of economic activity, placing the tiara on service and the customer or the beneficiary of service. Recently, these FPs have been reduced to five axioms that present a more succinct view of the same principles.

This study is based on those five axioms, which are summarised in Table 23. Each axiom represents a concept that relates to the provision of service.

The issue of resources is a common thread that runs throughout the axioms of SDL. While resources have traditionally been seen as fixed or limited supply items, SDL treats resources as anything that actors can call on for support (Lusch & Nambisan, 2015). SDL distinguishes between two types of resources. Operand resources are those that an actor draws on for support, such as the ability to access a service. These are typically static and tangible, such as natural resources. Operant resources, on the other hand, are used to produce an effect, typically by operating on operand resources. Operant resources are typically dynamic and intangible and will include knowledge, skills and expertise. Operant resources, despite being dynamic, are difficult to transfer and can be a source of competitive advantage for an organisation. The application of technology for service innovation can be viewed as an example of the application of operant resources.

Table 23: The concepts behind service-dominant logic

(Vargo & Lusch, 2016); (Vargo & Lusch, 2017)

Axiom	Concept	Description
Axiom$_1$	Service	Service is the fundamental basis of exchange
Axiom $_2$	Actors	Value is co-created by multiple actors, always including the beneficiary
Axiom $_3$	Networks	All social and economic actors are resource integrators
Axiom $_4$	Beneficiaries	Value is always uniquely and phenomenologically determined by the beneficiary
Axiom $_5$	Institutions	Value co-creation is coordinated through actor-generated institutions and institutional arrangements

The first concept behind SDL defines service as the fundamental basis of all economic exchange and distinguishes service, a process through which value is created, from services, defined as units of output (Vargo & Akaka, 2009). The role of all economic exchange is to allow people to acquire the benefits of specialised skills and knowledge held by operants. This concept further states that goods are nothing more than a mechanism in which operant resources are transmitted. Operant resources are here defined as those resources used by an operant to produce an effect on operand resources. In differentiating SDL from GDL, Vargo and Lusch (2004) compare the views adopted in respect of a transaction between a farmer and a fisherman. Whereas GDL views the transaction as an exchange of wheat for fish, SDL views the transaction as an exchange of farming services for the benefit of getting fishing expertise.

The second concept of SDL focuses on the actors that are involved in the creation of value, which actors include the beneficiary. This axiom not only emphasises the co-creation role of the beneficiary, but also highlights the relational nature of the interaction between the actors. It emphasises the concept that value is created, either directly or indirectly (through goods), not only at the point of exchange but also during use, termed value-in-context. While Vargo and Lusch (2004) may in their initial work have given the impression that value co-creation was a dyadic process that involves the service provider and beneficiary, their later work emphasises the important role that other actors play in the provision of service. Vargo and Lusch (2016) note that although the focus may be on the service provider and beneficiary, each of the actors who participate in the delivery will in the process co-create value with those with whom they interact.

The third concept behind SDL highlights the networked nature of service delivery, bringing into play both economic and social actors that influence the exchange of value. This axiom was built around the foundational principle FP9 (Lusch & Vargo, 2006), which focused on the role of organisations as micro-integrators of specialised skills/competencies into complex services demanded by the marketplace. The range of actors implied in the network of social and economic players includes the operant resources, operand resources and other members of their network that might influence the exchange of value between the parties.

The fourth concept focuses on the experiential nature of value, meaning that it can only be enjoyed through experience and observation by the beneficiary. This therefore means that value is unique to the person enjoying that value, as no two experiences are identical. This axiom sets apart the members of the network of actors that is the focus of the delivery of a particular service. This identification of beneficiaries of a service does not preclude them from being part of a large network of operant resources for which a beneficiary lies further down the line.

The fifth concept behind SDL highlights the role of institutions and institutional arrangements in the exchange of value. Vargo and Lusch (2016) argue that institutions and institutional arrangements are necessary for the efficient exchange of value as they stop actors from "overthinking" about the exchange, as institutional order ensures that a certain level of order is associated with the exchange. Institutions are the central building blocks in the cooperation and coordination required for the complex resource integration and service exchange in the service ecosystem. Institutions are defined as rules, norms and beliefs that allow social interaction to function predictably and meaningfully. Institutional arrangements are higher order constructs that describe interrelated institutions. Although the word institution is commonly equated to organisation, Vargo and Lusch (2016) make the distinction that organisations can be equated to players in a game whose rules are defined in institutions. *In the context of this study, institutions are restricted to organisations, and institutions, in the forms rules in the original sense intended, are dealt with later as industry rules.*

4.2.2. Concepts behind technology opportunities

Technology opportunities are what may be deemed glaring prospects for improvement. Such opportunities manifest themselves through processes that are evidently inefficient or glaringly absent and designers suspect that the use of technology can bring about better results.

Bitner (2001) takes a high-level view of technology opportunities, identifying them as offering

- Potential for the introduction of new services
- New ways of delivering service
- An enabling environment for customers and employees
- Internet as a service
- Extension of the global reach of services.

This paper explores a lower level of opportunity, focusing on self-evident concepts that may serve as a prompt to mark a process or service offering as being due for review.

Table 24 lists some of the common opportunities that technology can offer to business processes.

Table 24: Technology Opportunities

Concept	How can technology be employed to
Cheaper	Make it cheaper for the beneficiary to access the service
Choice	Allow the beneficiary more choice
Convenience	Allow more convenience for the beneficiary
Dignity	Enhance the dignity of the beneficiary
Easier	Make a process less cumbersome
Faster	Speed up a process
Flexibility	Make service provision changeable while achieving the same result
Privacy	Ensure that the beneficiary's confidentiality is protected
Redundancy	Reduce repeated storage in the storage of data
Security	Make the storage/transmission of data more secure

A cheaper process allows the service beneficiary to access the same or a similar service at a lower cost. Allowing bank customers to print a statement off their computers as opposed to having to access one in a banking hall at a cost represents a saving for the consumer of the service. Giving a user more choice is an act of opening up multiple possibilities and options. Technology may be used to allow consumers of digital media to access multiple choices, such as watching different movies, as opposed to being forced to watch a predefined offering on a television channel. Dignity refers to the “state or quality of being worthy of honour or respect”. Technology may be used to enhance consumers’ dignity by allowing service providers to customise the service they offer them. A customer service representative who has a full history of the interaction with customers is likely to treat them with more respect, and hence enhance their dignity, than one who assumes that a customer is, for example, ignorant or otherwise uninformed.

An easier process is one that can be achieved with minimal effort. A process that takes telephone calls and bookings in a diary as part of setting up a meeting can be made easier by the use of scheduling application, which automatically checks the availability of participants and suggests entries into their diaries. Making a process faster entails allowing the user to produce the same output in a shorter time. The use of a faster processor to allow a payroll run to take a few minutes as opposed to hours is an intervention that has speeded up the process. While flexibility formally refers to the ability to be bent, flexibility in a service sense is allowing the customer to achieve more than one outcome with the same inputs. Allowing customers who enrol in an online course to use different types of media, or to access course material at times of their choice, or to progress at their own pace, are all indications of flexibility by the course provider.

Privacy relates to the ability to protect oneself from public scrutiny. Systems that allow service beneficiaries to transact without fear of their data being accessed by those who have no right to access it offer privacy. Thus, bank customers demand that information on their transactions be kept out of the public’s eyes. Medical information is highly guarded to ensure that the privacy of patients is not compromised. Reducing redundancy refers to ensuring that there are minimal duplications of the same information. A system that allows an enterprise to share information on a centralised database potentially reduces the redundant storage of multiple copies of the same data in different departments. Data redundancy carries with it the complications of ensuring that all the copies carry consistent versions of the information. Security ensures that privacy is maintained by ensuring that unauthorised access to data is not allowed, either in storage or in transmission.

Technology presents an opportunity to bring many of these benefits to organisational processes and designers must constantly examine their designs for such opportunities.

4.2.3. The concepts behind technology capability

Technology capabilities are constructs that define what technology can do, without attempting to identify any technology or products. Technology capabilities focus on what technology can do rather than how the technology works. Davenport and Short (1990) describe a recursive relationship in which IT capabilities support business processes while at the same time business process re-design looks at IT to transform the processes. Their work identifies nine IT capabilities that can be used to support, or to transform business processes. These capabilities are summed up in Table 25.

Table 25: The concepts behind technology capability (Davenport & Short, 1990)	
Analytical	Apply complex analytics
Automation	Replace human labour
Disintermediation	Allow direct communication of parties
Geographical	Make processes independent of geography
Informational	Bring large amounts of data into a process
Knowledge Management	Facilitate capture, build-up and dissemination of information
Sequential	Reorder task/pararellise tasks
Tracking	Allow detailed tracking of inputs, tasks and outputs
Transactional	Transform unstructured processes into routine transaction

Analytical capability refers to the building up of insights into a problem by applying statistical models, and using these to compare past events and future possibilities (Cooper, 2012). Organisations may use analytical capabilities to improve the way processes are structured and services delivered by comparing past performance, the performance of other organisations that offer similar services or a multitude of other variables that can be analysed. Automation refers to the replacement of human labour with technology capability (Parasuraman & Riley, 1997). Automation can refer to customers facing interaction, such as in a queue management system, or a back office application, such as an online booking system. Each of these replaces a function that would otherwise be performed by a person but is not performed by a piece of technology.

Disintermediation in the general economic sense refers to the removal of intermediaries in an economic process such that those who wish to interact do so directly. In technology, disintermediation capability is a specialised form of automation that removes the need for an intermediary in enabling communication or access to information (Kinghorn, 1996). A company that replaces a telephone operator with a system that allows callers to be routed directly to the person to whom they wish to talk will have implemented this capability. Similarly, allowing a person seeking legal advice to be routed directly to legal information, or a patient seeking medical advice to get medical information, would also be instances of disintermediation. Geographical capabilities allow the conduct of a process to be independent of geography. An organisation that allows, through the use of technology, a service to be offered without the physical bringing together of operant and operand resources would have implemented such a capability. A hospital in India performing surgery on a patient in a rural African hospital can be said to have implemented such a capability.

Informational capabilities bring large amounts of detailed data into a process. Informational capabilities supply the data needed for an analytical process to be able to provide the analytical capability. The information capability gathers information from sources both within and external to the organisation that is relevant to the provision of service. Knowledge management refers to a formal process or processes, which organisations use to collect, organise, analyse, and disseminate information. Knowledge gathering processes include data entry, imaging operations, voice inputs and drawing in data from secondary sources. Processing activities include cataloguing, creating indices, filtering and associating various data sets. Knowledge management processes also including refining activities such as compacting, contextualising and data mining. Smuts (2011, p.131) suggests that knowledge management systems enable organisations to "use what they know, to learn and to add value".

Sequential capability refers to the ability to re-order the sequence of events in such a way that work can be done faster or more efficiently. Re-ordering may involve work being done in parallel or in a different order from that in which work was being done before. Tracking capability allows for the tracking of inputs, tasks and outputs. Workflow management systems are generally used to track the flow of work in organisations, allowing them to keep track of the status of an assignment as it moves through the organisation. Transactional capabilities allow unstructured processes to be turned into routine transactions that are easier to manage.

In their work, Davenport and Short (1990) note that the list is not comprehensive and suggest that other capabilities, including some not considered, may be more relevant in specific circumstances. Other capabilities that have become more relevant in the time since the article was written include those on the list in Table 26.

Table 26: Additional Technology Capability Concepts

Artificial intelligence	Replace human intellect
Cloud computing	Allow storage or processing to be conducted in the cloud
Digital security	Allow the storage and processing of digital identities
Imaging	Allow capture and transmission of high-quality imagery
Location tracking	Allow positioning and tracking of objects
Mobility	Ability to capture, process transmit while on the move
Electronic payments	Facilitate electronic payments
Social mediation	Allow communication amongt multiple parties

Artificial intelligence capability refers to the replacement of human intellect with systems that are able to provide the same type of capability, albeit in a specialised and often limited way (Brooks, 1991). Current implementations of artificial intelligence offer facilities that allow them to recognise objects, such as faces or voices, make or translate text or sounds from one language to another, among other functions. Cloud computing is defined as a model in which computing resources are pooled for sharing on demand via a network. Shared resources can include networks, servers, storage and services (Mell & Grance, 2011). Essential characteristics of a cloud-computing platform include on-demand service, ability to access over a network, pooling of resources, rapid elasticity and a facility to measure utilisation. Business models revolve around offering software, a platform or infrastructure as a service. Deployments of cloud computing are either private, focused on a specific group, or public, offering services to anyone who wants to access the services. Hybrid combinations are also possible.

Digital security capability refers to the protection of one's identity, assets and technology online. This capability includes software, services, biometrics or hardware devices such as security dongles. Digital imaging capability refers to the technology required to acquire, process, store transmit and output images in a digital format. In a medical setting, such imagery includes normal photographs as well as X-rays. The advent of cell phones and other mobile computing devices has created the ability to capture and process information while on the move. Mobile devices allow users to access information that is held elsewhere as well. Typical devices will input data through a keyboard, voice input and image input for both still and moving images. With limited storage capacity, mobile devices are occasionally reliant on remote processing and storage capacity, such as that offered in cloud computing environments.

Electronic payment systems allow for payments to be made with no physical exchange of cash. Electronic payment systems provide facilities where payments can be made via debit or credit cards. Such payment may be made in the presence of the cardholder, termed card-present transactions, or remotely, known as card-not-present transactions. Increasingly other instruments that do not require physical cards, such as electronic wallets, which are more commonly used with remote payments, are replacing cards. Social mediation allows multiple parties to interact online without the need of an intermediary. This capability is typically delivered through social media platforms that allow large numbers of people to share information, in real-time, on an on-going basis.

With rapidly developing technological advances, these capabilities represent a snapshot of the capabilities that are possible, but are not exhaustive.

4.2.4. The concepts behind design thinking

Brown (2008) describes design thinking as a methodology that infuses innovation activities with human-centred thinking. Over the years, researchers and practitioners alike have developed different models of how to conduct design thinking, but the essential components are the same. The human-centredness remains core to design thinking, but so does the use of abductive thinking. The sequence of divergent thinking followed by convergent thinking is repeated throughout the process and remains the key attribute of design thinking. The ability to go back, revise one's thinking and propose better solutions is a key component of the iterative nature of design thinking. For the purposes of the Technovation Framework the design thinking approach used by the Stanford d.school was chosen because of it maturity and the availability of extensive usage documentation that is freely available. The key design 'modes' as employed in the d.school methodology are described in Table 27.

Table 27: Design Concepts

Empathy	Understand people, in the context of design challenge
Definition	Bringing clarity and focus to the design space
Ideation	Idea generation.
Prototyping	Iterative generation of artefacts
Testing	Solicit feedback about the prototypes created

The Stanford d.school (2016) design thinking process is made up of five working spaces or modes through which a design team traverses in its journey to a final solution. The empathy mode allows designers to understand people's needs and wants by talking to them, listening to them and observing their lives in the context of a design challenge. The definition mode tries to bring clarity to the area of interest within the design challenge, with the goal of coming up with a meaningful and actionable problem statement or POV. The idea generation mode looks for possible solutions to problems before zeroing in on the most viable, feasible and desirable solutions for prototyping, testing and possible implementation. The activities within each of these spaces are not necessarily sequential but may be recursive in nature, allowing design team teams to reconsider prior spaces to seek clarification or enhance their understanding.

A number of different terms are used to locate the status of a design thinking project, as shown in the review of design thinking literature in Chapter 2. Writers such as Brown (2008) present design as being undertaken in different spaces where specific issues are addressed and therefore use the term space. The justification for the use of spaces appears to be an attempt to get away from the traditional terms such as phase, used by Leidtka and Tim (2011) and others, which are more traditionally associated with waterfall-style design, in which when once one set of activities is complete the team moves on to the next. The term modes is used to indicate that the team is using a certain mode of thinking as in ideating or prototyping. The Stanford d.school (Hasso Plattner Institute of Design at Stanford, 2010) uses the term mode. As this process is largely based on their work, the term mode will be used to locate the status of the design work.

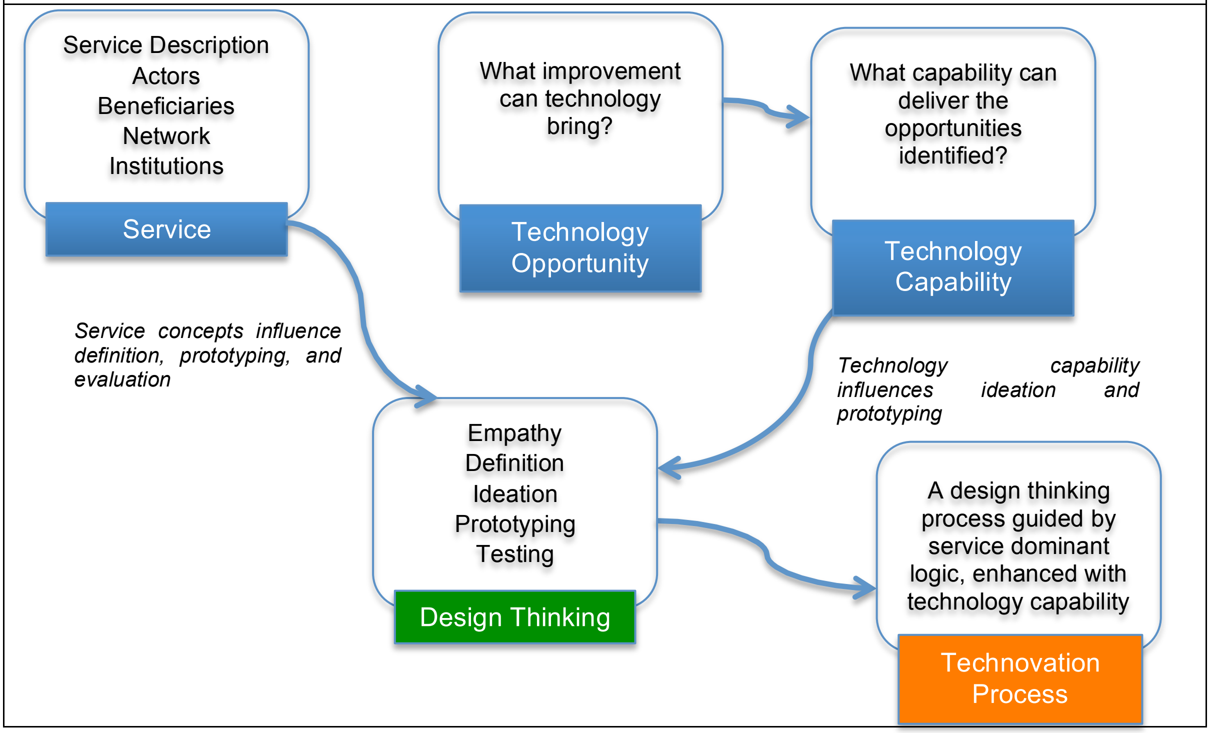
4.2.5. Technovation Framework: CF_0

This section describes the Technovation Framework, a design tool for an SDL approach to technology-based innovation using design thinking. This framework applies the concepts of SDL as well as technology opportunities and capabilities to guide a design thinking process. The logical relationships between these concepts are illustrated in Figure 40. The framework development will follow the naming convention CF_0 for the initial conceptual framework, followed by CF_1 and CF_2 for subsequent revisions.

Service concepts are used to frame the scope of a design thinking exercise. Technology opportunities are used to identify opportunities for improvement in service offerings. Technology capability is used to define what technology can offer to bring about the desired improvement. This results in a technology-driven, yet human-centred innovation process that has been termed Technovation. The process follows the same steps as a normal design thinking process, yet is enhanced by using guidelines that help shape the discussion on the identified problem area.

Figure 41 builds on the conceptual basis presented in Fig 40, illustrates the relationship between the concepts and highlights the constructs within each concept.

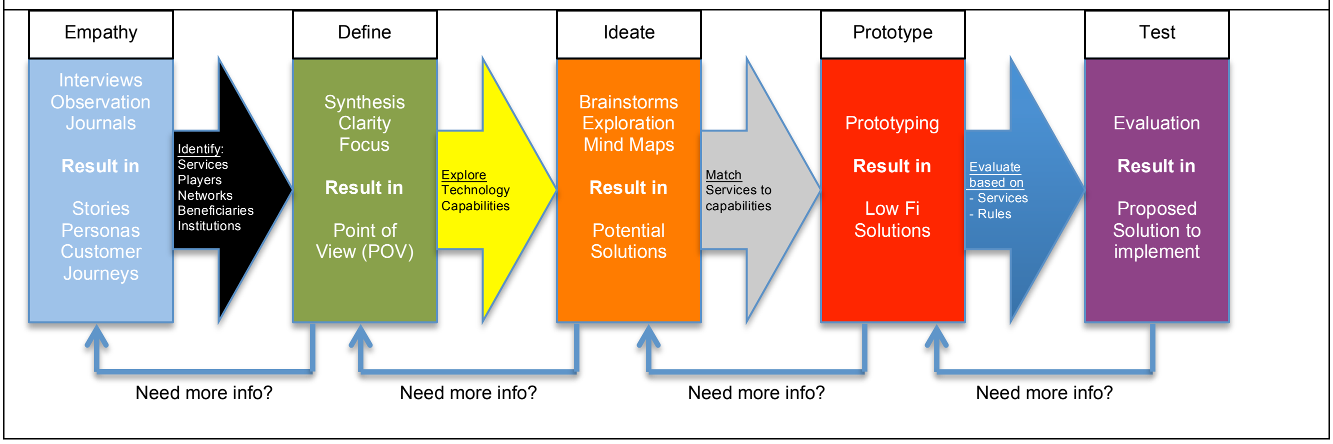
Figure 41: Key constructs within the Technovation Framework



4.3. The Technovation Process

The Technovation Process (Figure 42) brings together the concepts concerning SDL theory, technology opportunities and capabilities, as well as the design thinking process. The Technovation Process is designed for use by multidisciplinary design teams that consist of designers, technologists, as well as subject matter specialists. Potential end users of the service being designed may also be incorporated into the team. The Technovation Process follows the phases/modes/spaces* intrinsic to a design thinking process. These are empathy gathering, problem definition, ideation and prototyping, ending with evaluation/testing. The cyclic nature of a design thinking process is retained in the Technovation Process.

Figure 42: Technovation Process



4.3.1. Empathy in the Technovation Process

In the empathy space, the focus is on understanding the people for whom designers wish to design solutions. Understanding will come out of asking questions and listening to stories about these people's lives. Observing them at home or at work will help designers understand their lives better. Designers must be careful to understand not only what people say they do, but to understand that which they do that contradicts what they say they do. Designers need to understand both those rendering service as well as those who receive service. Designers need to identify and understand the different players that render and receive service. Networks that have an impact on how service is delivered need to be understood, along with their influence . Networks may be formal or informal, and those being investigated may feel that these details do not matter until they are specifically asked. In the same vein designers need to understand the institutions that are part of the service delivery process.

The main output of the empathy mode is an image of those for whom a solution is being designed. This image could be in the form of pictures, journey maps, diaries/journals, video clips, or stories. A summary of the key aspects of the empathy mode is presented in Table 28.

Table 28: Empathy Phase Summary

Key Activity	Immersion into the lives of those for whom solutions are being designed.
Responsible Person	Project manager + Designer team
Actors involved	Service providers and service users.
Process Steps	Following the journeys of the actors of interest
Inputs	Broad definition of the problem area.
Guide	Stanford d.school process guide on empathy
Deliverable	Empathy output in the form of pictures, journey maps, diaries/journals, video clips, or stories.

4.3.2. Problem definition in the tchnovation process

Building empathy, the first task of a design thinking exercise, is typically a divergent thinking exercise, generating large amounts of information about people, their lives, their needs, their wants, and their circumstances. The next design space condenses these ideas into an actionable problem statement. The framework employs the concepts of SDL to help designers analyse the large amounts of information into clusters of information that are easier to use so that a problem statement can be constructed. The premise on which each of the service concepts is utilised in the framework is described in Table 29.

Table 29: Service Concepts Usage Premise	
Concept	The premise on which this concept is employed in the empathy/definition mode.
Service	In order to understand the context and extent of service offering and consumption fully, service offerings and service needs must be catalogued.
Actors	All the actors that participate in the delivery and consumption of service must be identified.
Networks	All networks that influence the delivery and consumption of service must be identified in order to fully empathise with the actors that participate in service exchange.
Beneficiaries	All beneficiaries must be identified, along with an appreciation of how, when and why they use the service they need.
Institutions	Institutions and institutional arrangements enabling or hindering the efficient delivery and consumption of service must be identified.

Starting with the service concept in SDL, designers aim to catalogue and understand the services currently being offered, as well as those that users need, in the problem space. Cataloguing and comprehending the various actors that play a role both in rendering and receiving services is necessary to bring clarity to players in the field. Networks with which the various actors in the problem space align themselves always affect service delivery and these must be catalogued and understood. The human-centredness of design thinking is best brought to the fore in understanding the beneficiaries of the services on offer, along with their needs and wants. Equally important are the institutions and organisations that affect the delivery of services. This exercise allows designers to view a large amount of information that has hitherto been presented in stories, personas, journey maps and pictures into a structured form that is easier input into a process of converging to a problem statement, or POV, the deliverable of the definition space.

Addressing the issues listed below will help designers to define the problem they would like to solve. The input for this will come from the empathy build-up:

- What services are offered, and what services are needed? [Service]
- Who are the key players in providing these services? [Players]
- What networks affect the provision of these services? [Networks]
- Who are the beneficiaries of the services being provided? [Beneficiaries]
- What institutions coordinate the provision of the services identified? [Institutions]

Analysis of the answers to the above will help designers identify a suitable POV to address. A good POV is constructed in relation to a person and identifies not only the benefit the designers wish to bring to this person's life, but also provides a motivation for why it is important to them.

"We would like to help X by providing a service Y that would allow them to be a better Z."

It is unlikely that one POV will capture all the areas of opportunity and propose the building up of multiple points of view. Where resources are limited, designers may then choose to address the most pressing of problems to address.

Some problems are likely to be immediately clear, such as a need that a user has, that an organisation already provides. Some potential problems are more obscure and need closer inspection of the data to understand. An example is a service that is needed by users that the organisation offers but users are unable to access. Another example could be a service that is offered but can be improved on.

It may become clear during this exercise that designers do not have sufficient information to come up with a useful and meaningful POV. In this case, designers are advised to revise the empathy mode until a clear POV is established.

Table 30 summarises the key aspects of the definition mode.

Table 30: Definition Phase Summary

Key Activity	Reducing the empathy input into a POV and preparing the ground for ideation
Responsible Person	Project manager
Actors involved	Design team. Service providers and service consumers may also be included.
Process Steps	Understanding the empathy input and reducing it to a POV and summarising service requirements
Inputs	Empathy mode output
Guide	Stanford d.school process guide on definition + Technovation Process definition hand-out 1
Deliverable	POV + Service requirements

4.3.3. Ideation in the Technovation Process

Ideation is an opportunity for designers to apply their minds to potential problems. While the definition space reduced a large amount of data into one or a few POV in a convergent process, the ideation space tries to get as many ideas as possible related to their selected POV. Ideation is the opportunity to get creative without inhibitions, coming up with potential solutions but without worrying about how these will actually work at this stage. Designers are encouraged to step beyond the obvious and explore unusual and previously unexplored solutions.

For each service, designers need to keep in mind the opportunity that technology provides. Through the application of the capabilities, technology is able to make processes faster or easier, often at a lower cost. Technology provides opportunities to reduce redundancy while making data more secure and providing more privacy for users. People are concerned about their dignity and designers need to think of solutions that provide people with the dignity they deserve. Convenience and choice improve lives and must be considered. Table 31 provides a list of opportunities that technology can provide through the application of the capabilities above.

Table 31 : Technology Opportunities

Concept	How can technology be employed to
Cheaper	Make it cheaper for the beneficiary to access the service
Choice	Allow the beneficiary more choice
Convenience	Allow more convenience for the beneficiary
Dignity	Enhance the dignity of the beneficiary
Easier	Make a process less cumbersome
Faster	Speed up a process
Flexibility	Make service provision changeable while achieving the same result
Privacy	Ensure that the beneficiary's confidentiality is protected
Redundancy	Reduce repeated storage in the storage of data
Security	Make the storage/transmission of data more secure

The Technovation Process provides a set of technology capabilities that can help designers think about what can be done, without focusing on the technology itself. Having defined a POV, the designers must turn to the divergent activity of generating potential solutions to their defined problem. While a POV might consist of a simple statement centred on beneficiaries and their needs and wants, potential solutions are laden with some of the service components identified earlier. For each of these, the opportunity exists to apply technological capability to introduce improvements. The technology capability table (Table 32) provides a catalogue that can be applied to improve the service experience. Technology capabilities offer opportunities to improve the service experience in a number of ways.

Table 32: The Concepts behind Technology Capability (Combined)	
Analytical	Apply complex analytics
Artificial Intelligence	Replace human intellect
Automation	Replace human labour
Cloud Computing	Allow storage or processing to be conducted in the cloud
Digital Security	Capability to store a digital identity
Disintermediation	Allow direct communication of parties
Geographical	Make processes independent of geography
Imaging	Allow capture and transmission of high-quality imagery
Informational	Bring large amounts of data into a process
Knowledge Management	Facilitate capture, build-up and dissemination of information
Location Tracking	Allow positioning
Mobility	Ability to process while on the move?
Electronic Payments	Facilitate electronic payments
Sequential	Reorder task/pararellise tasks
Social Mediation	Allow communication among multiple parties
Tracking	Allow detailed tracking of inputs, tasks and outputs
Transactional	Transform unstructured processes into routine transaction

The key features of the ideation mode are summarised in Table 33.

Table 33: Ideation phase summary	
Key Activity	Identifying technology opportunities and linking them to technology capabilities
Responsible Person	Project manager
Actors Involved	Design team. Service providers and service users may also be included.
Process Steps	Iteratively addressing service requirements and exploring technology opportunities then linking these to technology capabilities
Inputs	Service requirements
Guide	Stanford d.school process guide on ideation + Technovation Process ideation hand-out 2
Deliverable	Service requirements matched with technology capabilities

4.3.4. Prototyping in the Technovation Process

The prototype space represents an opportunity to start concretising the components that make up the design of a potential solution and get feedback from users on how these will be received. Designers are likely to go through many iterations of this process as they apply their minds to what will work and what will not work. Low-fidelity prototypes that allow users to form an idea of what they will get must be produced and used to gain user feedback.

Attention needs to be paid once again to the service concepts, while acknowledging the technology capabilities. The prototype solution must identify the service offering, ensuring that all actors that participate in that offering are accounted for. Networks that influence the delivery of the service must be identified and their potential influence understood and provided for in the solution. Equally important is the explicit identification of the beneficiaries and the institutions that will govern their experience of the service being offered.

For each POV that has been identified and carried forward, designers must match each technical capability with a likely technical solution in an attempt to imagine how this will work. A description of this solution forms an important part of the prototype. Prototypes must be quick and cheap to produce, to allow many options to be pursued. Designers must keep a record of the components of a solution that users like and what they do not like, so each iteration must focus on one or two key features that are being tested.

Table 34 presents a summary of key aspects of the prototyping mode.

Table 34: Prototyping Phase Summary	
Key Activity	Building low-fidelity prototype of proposed solution
Responsible Person	Project manager
Actors Involved	Design team.
Process Steps	Linking proposed technology capabilities to potential technology solutions and building up a definition of a complete end–to-end solution
Inputs	Service requirements matched with technology capabilities
Guide	Stanford d.school process guide on prototyping + Technovation Process ideation hand-out 3
Deliverable	Solution definition or low fidelity prototype

4.3.5. Prototype evaluation/testing in the Technovation Process

Testing of the prototype presents an opportunity to gain further understanding of the beneficiaries of a solution. This is achieved by showing users low-fidelity mock-ups of what their solution will look like as built in the prototype mode. User feedback must focus not just on what users like, but also on why they like that particular portion of the solution. Feedback is fed back into the definition space if the design team feels that they did not understand the problem sufficiently in the first place. If the problem was understood and the users do not like the solution because parts or all of it do not address the problem adequately, then re-entry into the prototype space is required.

The service concepts provide an opportunity to prompt users into ensuring that all aspects of the service being offered to them is complete. An evaluation of the service requirement, service offering and the coverage of the proposed solution should form part of the evaluation. The requirements of all the players involved in the delivery of the service must be provided for in the proposed solution. The delivery of solutions often fails because designers underestimate the role of the networks that influence their user base and these must be accounted for. Often service is provided by many institutions or in some cases external institutions regulate the delivery of service. Solutions that are complete must identify these institutions and provide appropriate interfaces or application programming interfaces (APIs).

The adoption of a solution is ultimately at the mercy of the beneficiary of the service. While designers are at pains to ensure that the solution they propose is technically feasible and is economically viable, the beneficiaries of the service being offered, and primary users of the solution being designed, must desire the system for it to be successful. Solutions that fail the tests of feasibility, viability and desirability must be redesigned either by reconsidering the problem definition, the POV adopted or the ideas prototyped, until a suitable solution is reached.

Table 35 presents a summary of the key aspects of the prototype testing mode.

Table 35: Prototyping Testing Mode Summary

Key Activity	Testing proposed solution with target users
Responsible Person	Project manager
Actors Involved	Design team. Service providers and service consumers are required.
Process Steps	Iteratively testing components of the proposed solution with target users
Inputs	Prototype solution or solution definition
Guide	Stanford d.school process guide on testing + Technovation Process ideation hand-out 4
Deliverable	Tested prototype plus user feedback.

4.4. Workshop Guides for Using the Technovation Process

The following exhibits are hand-outs for use with the Technovation Process. Each hand-out should be handed out to workshop participants at the start of a session, together with the appropriate mode guide from the d-school process guide (d.school, 2016). These guides assume that a comprehensive exercise has been conducted prior to the workshop to understand the circumstances under which services are being offered. The problem definition mode therefore starts by consolidating this information and reducing it into a POV, which guides the rest of the design process.

Table 36: Workshop Guides

Design Mode		Hand-out
1	Empathy	-
2	Problem Definition	Hand-out 1
3	Ideation	Hand-out 2
4	Prototyping	Hand-out 3
5	Evaluation/testing	Hand-out 4

4.4.1. Exhibit 1: Definition guide

Technovation Workshop

Handout 1: Definition

Purpose:

The purpose of this exercise is to define a problem or problems you wish to address. This is known as your point of view [POV].

Task 1: Understanding the landscape

Addressing the following will help you in defining the problem you would like to solve. Use the input provided in the empathy session as well as your own knowledge and experience.

1. What are the key components of the service? [Service]
2. Who are the key players in providing this service? [Players]
3. What networks affect the provision of this service? [Networks]
4. Who are the beneficiaries of the service being provided? [Beneficiaries]
5. What institutions coordinate the provision of the service? [Institutions]

Each of the questions above has multiple answers. Write out each answer on a separate post-it note and post the answers on the board under the heading provided in square brackets at the end of the question. Summarise your output in the form provided.

Spend half of your time on this task

Task 2: Defining your point of view

Spend the rest of the session identifying a problem or a number of problems with the picture painted by the empathy input as well as your own analysis above on which you believe you can have an influence. You will be requested to choose one problem of interest that you will focus on for the rest of the day.

Write out each POV on a large post-it and put this up on your board. You will be required to present this POV to the rest of the group.

4.4.2. Exhibit 2: Ideation guide

Technovation Workshop

Handout 2: Ideation

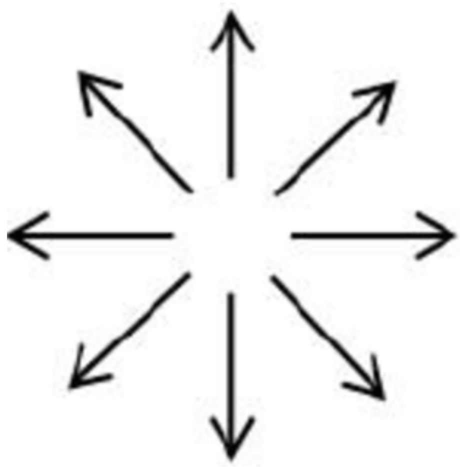
Purpose:

The purpose of this exercise is to develop ideas that could help you solve the problem defined in your POV.

Task:

For this challenge, identify areas that the use of technology can influence. To help you get started, some hints are provided below. Feel free to add other areas as you see fit. Also refer to the technology capabilities table (Table 30) provided and match each proposed improvement with a capability that can bring about that improvement.

- Make things faster
- Make things easier
- Make things more efficient
- Reduce redundancy
- Improve privacy
- Make interaction more dignified
- Provide security
- Introduce flexibility
- Introduce more choice
- Increase availability



Don't worry too much about how each idea will work and write down all suggestions, even ones that may seem impractical at face value. Write out each of your suggested solutions on a post-it and put this up on your board.

4.4.3. Exhibit 3: Prototyping guide

Technovation Workshop

Handout 3: Prototyping

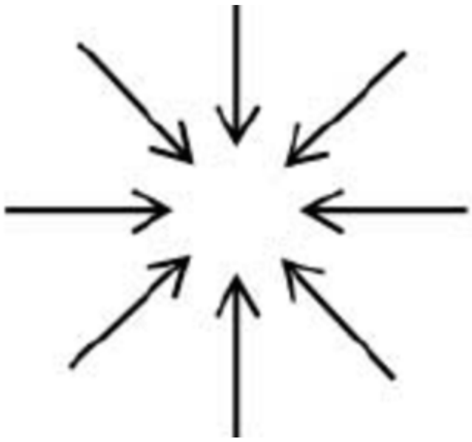
Purpose:

The purpose of this exercise is to help you narrow down your ideas to a single solution or a few possible solutions that can be employed to solve the problem defined in your POV by exploiting the ideas generated in the last session.

Task 1: Identify the boundaries of your solution

The output from the last section will relate to many of the areas that you will have identified during the definition mode. It is necessary at this point to zero in on the specific area for which you want to develop a solution. The following will help you zero in on that area:

- What service are you developing a solution for?
- Who are the players that will be affected by the solution you propose?
- Which networks are likely to influence the adoption of your solution
- Who are the beneficiaries of the solution you propose?
- Which institutions will be affected by your solution?



Spend no more than a quarter of the allocated time on this task.

Task 2: Define your solution

Spend the bulk of your time describing the solution you wish to build. You will need to present this to the rest of the group and will be judged based on this presentation, so you will need to use props that can help explain your solution. These prompts could be role plays to describe a process, physical items, journey maps or simply a series of post-its to describe your solution. If you need to, go back to redefine your boundaries if you think it will help you reach a better solution.

4.4.4. Exhibit 4: Testing guide

Technovation Workshop

Handout 4: Testing

Purpose:

The purpose of this exercise is to evaluate the various prototypes produced.

Task:

Each of the teams is likely to have a different way of presenting its prototype. Solutions must, at a minimum, attempt to satisfy the following:

- Optimise the role of each player in the service delivery process. [Service]
- Identify all the actors that form the service delivery chain. [Players]
- Take into account the networks that are likely to influence the uptake of the solution. [Networks]
- Allow the beneficiary to determine value. [beneficiary]
- Identify all the institutions that participate in the delivery of this service [institutions]

In addition, the solution must meet the following criteria:-

- Desirability: Will the target market want to use it?
- Feasibility: Can it technically be delivered?
- Viability: Is the solution complete and can it be delivered within budget and run sustainably?

Please use the attached form for the self-evaluation of your solution. The same form will be used by the other teams to judge your solution.

4.4.5. Exhibit 5: Evaluation form

Evaluation For for team ___________________________

Does the solution…		Score (0-5)
Service	Optimise the role of each player in the service delivery process?	
Players	Identify all the actors that form the service delivery chain?	
Networks	Take into account the networks that are likely to influence the uptake of the solution	
Beneficiaries	Allow the beneficiary to determine value?	
Institutions	Identify all the institutions that participate in the delivery of this service?	
	A: Total Score (Solution)	

		Score (0-2)
Desirability	Will this solution fill a need?	
(Is it wanted?)	Will it fit into people's lives?	
	Will it appeal to them?	
	Will they actually want it?	
Viability	Is the team's idea complete?	
(Should we do this)	Has the business model been considered?	
	Can it be delivered within budget?	
	Can it be run with no further funding, or	
	Does the team have a viable self-funding mechanism?	
Feasibility	Is the technology available?	
(Can it be done?)	Do the end users have the devices to access it?	
	Can the team deliver the project?	
	Can it be delivered in four weeks?	
	B: Total Score (Desirability/Viability/Feasibility)	

	Grand Total Score (A + B)	

Evaluated by ___________________________

4.5. Summary

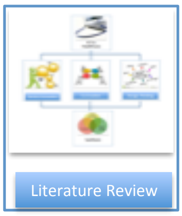
This chapter describes the conceptual framework for use in service-based innovation using ICT, built around a design thinking process. The chapter started by describing the type of artefact, the constructs used to build up the artefact and the theory underlying these constructs and finally described the artefact itself. This chapter also describes the process that derives from the framework and how it can be employed. In anticipation of further development and testing of the framework, an extensive data collection and analysis exercise was carried out. The results of this exercise are presented in Chapter 5 as the empathy data.

Table 37 presents a summary of the features of the proposed framework.

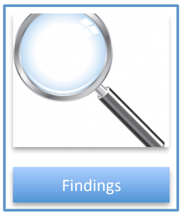
Table 37: Technovation Framework Overview

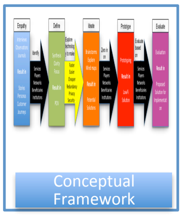
Framework Component	Instantiation
Means of Representation	Words, diagrams, tables
Primary Constructs	Service concepts, technology capabilities, design concepts
Statement of Relationships	Technology-based service innovation using design thinking
Scope	Innovation around human-centred processes that aim to exploit ICT capabilities
Casual Explanations	Design problems that can be addressed by rendering service are best addressed by fully understanding the nature and context of the service. The use of technology in these designs is optimised by examining the applicability of ICT capabilities on each of the service components.
Testable Propositions	This framework will assist design thinking teams in exploring service options and the accompanying technology capabilities for use in a design thinking process.
Prescriptive Statements	Faster design process More predictability in results

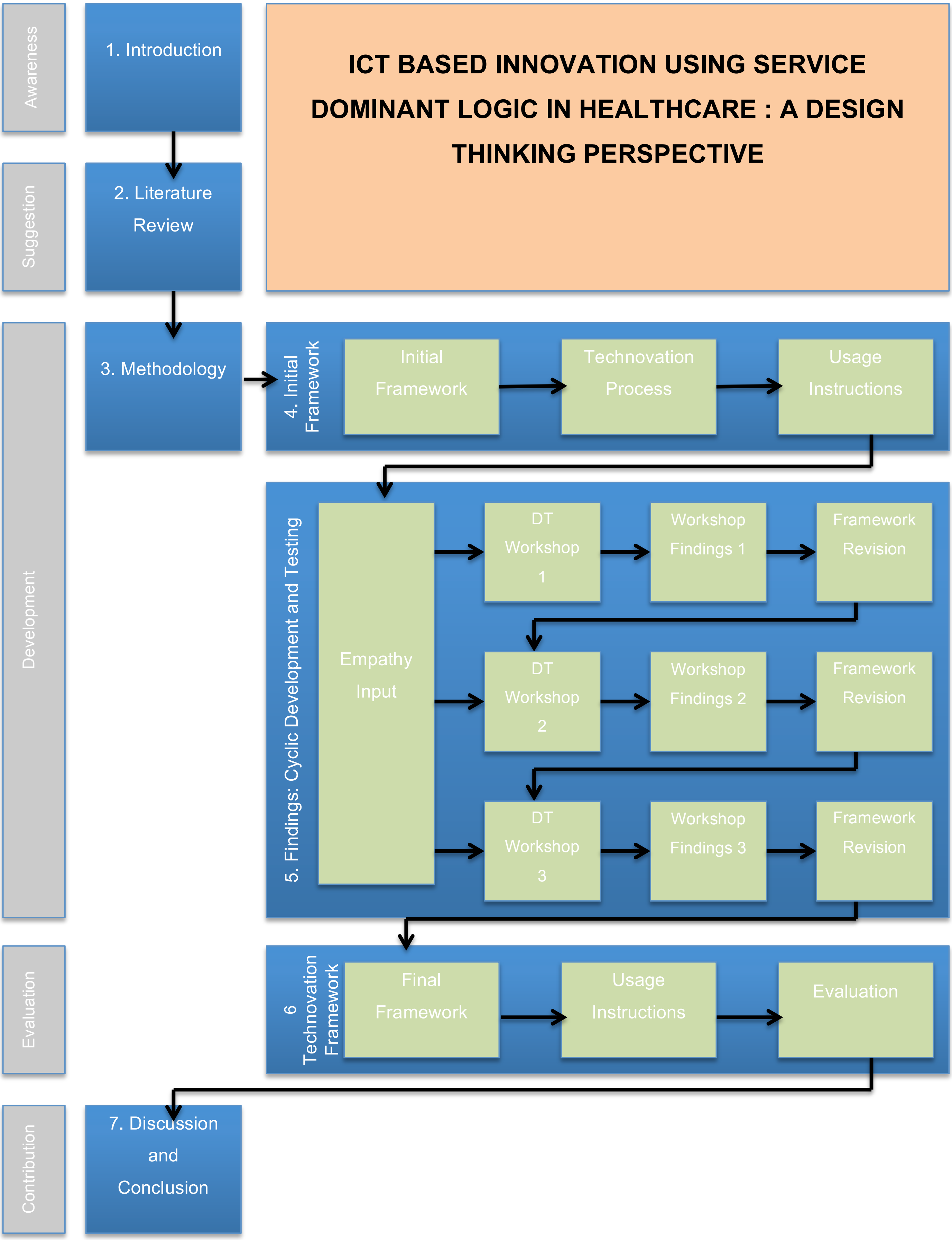
The first version of the conceptual framework (CF_0) and the associated process was based on a study of the literature and how various conceptual tools could be used to address the problem of employing technology in innovation. Designers who sought to identify solutions to a pre-identified real-life problem with pre-collected empathy input tested the framework as part of its development. The findings of these design workshops are presented in Chapter 5. A tested and refined version of the framework is presented in Chapter 6.



5.
Findings : Cyclic Development and Testing






Awareness
1. Introduction
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
Suggestion
2. Literature Review
Development
3. Methodology
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings: Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
Evaluation
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
Contribution
7. Discussion and Conclusion

5.0 Findings: Chapter Map

Cyclic Development and Testing

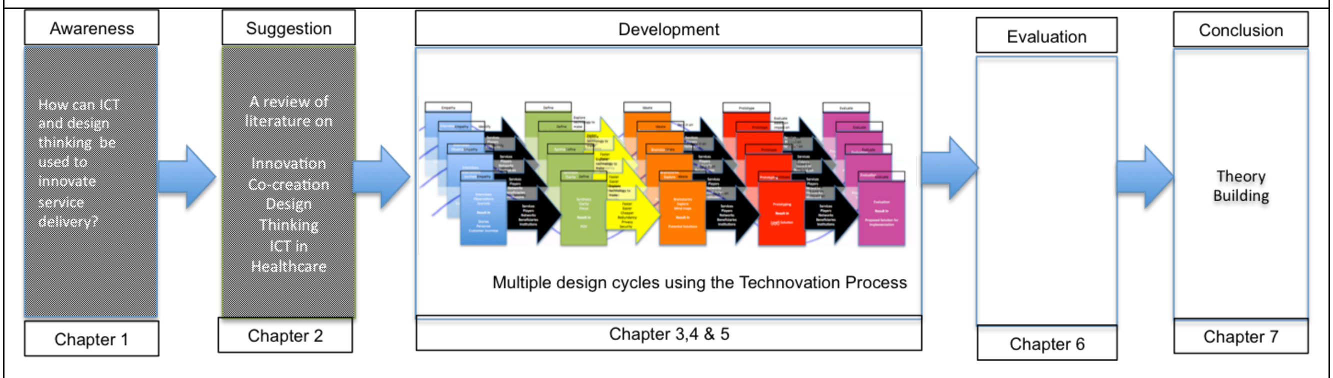
Section		***Key Ideas***
5.1 Introduction	5.2 Empathy	Midwives’ and mothers’ perspectives on service delivery were presented as input into the empathy session of the design process. The views of midwives as well as mothers on their roles, interaction, record-keeping, challenges, and suggestions for improvement are interrogated. Mothers’ interviews are triangulated with self-maintained journals.
	5.3 Design Thinking Workshop 1	Four teams of designers are presented with the empathy input from the midwives’ and mothers’ interviews and challenged to come up with ICT-based solutions to improve service delivery by using the Technovation Process
	5.4 Design Thinking Workshop 2	A different design team was presented with the same empathy input and challenged to come up with an appropriate solution using an updated Technovation Process.
A review	5.5 Design Thinking Workshop 3	A third design group took up the design challenge to test the Technovation Process with the same empathy input to produce their own prototype solution.

5. FINDINGS: CYCLIC DEVELOPMENT AND TESTING

5.1. Introduction

This study explores the intersection of the ideas of innovation based on co-creation and the application of design thinking techniques in human-centred design. The study explores SDL (Vargo & Lusch, 2004; Vargo & Akaka, 2009; Vargo et al., 2014; Vargo & Lusch, 2016; Vargo & Lusch, 2017) as the underlying theory and adopts a pragmatism philosophical stance to underpin a DSR approach. As an area of application, the researcher looks at how these concepts can be applied to improve healthcare service offering using ICT.

Figure 43: The study journey to Chapter 5



According to Kuechler and Vaishnavi (2008), the DSR process consists of a number of iterative steps, which include ***awareness*** of the problem, ***suggestions*** for solutions, ***development***, ***evaluation/testing*** and ***conclusions,*** which feed into knowledge. According to the flow described in Figure 43, Chapter 1 focused on exploring the broad design problem of implementing ICT-based solutions in healthcare, culminating in the research question:

MRQ

How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

Chapter 2 of this work explored potential solutions and looked at literature on innovation, co-creation, design thinking and the use of ICT in healthcare. At the end of Chapter 2 the first version of the Technovation Framework was proposed. Chapter 3 was presented as a roadmap of the rest of the study, describing various approaches to research, including the design science approach taken for this study. Chapter 4 served as the start of the development mode of the project, bringing together the concepts explored in the second chapter and providing details of the Technovation Framework for use in design work. Chapter 4 therefore sought to answer SRQ1:

SRQ1

How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?

Chapter 4 presented the conceptual ideas behind a framework for a SDL approach to ICT-based innovation using design thinking. The framework advocates the use of a design thinking process, guided by the concepts of SDL, coupled with ICT capabilities to build solutions. Chapter 5 is focused on continuing the development of the Technovation Framework and seeks to answer SRQ2:

SRQ2

How can the Technovation Framework be refined in an e-health environment?

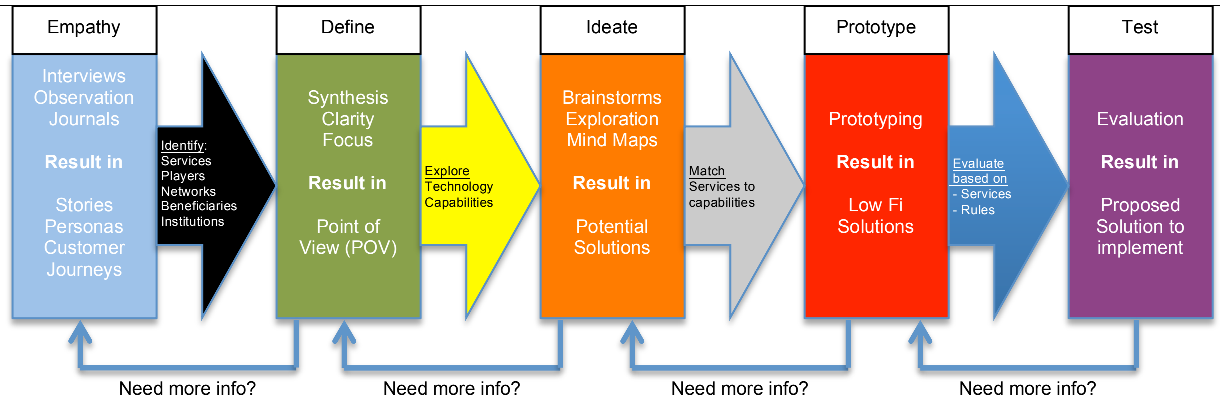
In order to address SRQ2, it is essential to collect test data for use in refining the framework. Collection of this test data relates to the DRQ, which was stated as:

DRQ

What are the challenges faced by hospitals and patients in the delivery of post-natal care?

Answers to the DRQ present the empathy input required to conduct Technovation Process workshops, as shown in Figure 44.

Figure 44: Overview of the Technovation Process



The empathy-building, which sought to answer the DRQ and prepare the ground for the Technovation Process, consisting of an eight-week-long data collection phase. The data collection began in a hospital in a high-density township in Chitungwiza, Zimbabwe with interviews with doctors and midwives. The data collected, which are fully described in this chapter, explore the perspective of healthcare workers, starting with an interview with the hospital head, a highly experienced medical doctor, the CNO, and also engaging with midwives, in an attempt to present their understanding of service delivery around post-natal care. Their roles, the processes they follow, the challenges they face, and their expectations of their patients were investigated through semi-structured interviews. Twenty-two mothers of new-born babies were identified in the same hospital and the researcher, accompanied by a qualified midwife, followed the new mothers into their homes for a six- to eight-week period after giving birth. This chapter also describes the mothers' perspectives, collected in interviews as well as in self-maintained journals, starting with their discharge from hospital up to when their babies were six weeks old.

These findings were presented at the start of a design thinking workshop held in Harare on 5 August 2017 as the main empathy input into the design workshops. A doctor, mothers, nurses and ICT specialists attended the workshop to explore how technology can be employed in improving service delivery using the Technovation Process. The group was split into four teams, each producing a prototype solution for potential use in a healthcare setting. The output of this workshop forms the basis of the third section (5.3) of this chapter, which presents an overview of the process as well as the prototypes that arise from the team activities. Two subsequent smaller workshops were held to test and refine the further development of the framework over a six-week period after the initial workshop. The results of these workshops are presented in Sections 5.4 and 5.5.

The rest of this chapter is structured as presented in Table 38:

Table 38: Workshop Output Presentation

Mode	Workshop 1	Workshop 2	Workshop 3
Empathy	Section 5.2 Presents the empathy input used for all the workshops		
Definition	Section 5.3.1.2	Section 5.4.1.2	Section 5.5.1.2
Ideation	Section 5.3.1.3	Section 5.4.1.3	Section 5.5.1.3
Prototyping	Section 5.3.1.4	Section 5.4.1.4	Section 5.5.1.4
Testing	Section 5.3.1.5	Section 5.4.1.5	Section 5.5.1.5
Prototype overviews	Section 5.3.1.6	Section 5.4.2.6	Section 5.5.2.6

Successful conduct of the design workshops using the Technovation Process allowed for the refinement of the Technovation Framework and process, as well as to answer SRQ3:

SRQ3)

What are the outcomes of using the Technovation Framework in an e-health environment?

5.2. Empathy

5.2.1. Introduction

Building empathy sits at the heart of design thinking work. It is a process in which designers step into the shoes of those for whom they are designing. This work was undertaken by the researcher and a midwife assistant prior to the design workshops. It investigates the experiences of those providing post-natal care, those receiving the services and the ecosystem around them.

5.2.2. The healthcare perspective

5.2.2.1. Doctors' perspectives

Interviews were conducted with the head of Chitungwiza hospital, as well as several doctors who were involved in post-natal care. The initial interview with the head of the hospital was focused on agreeing on the scope of the study.

While the head felt that the study should have involved antenatal care as well, as this in an area in which the hospital had intensive interaction with prospective mothers, it was agreed that the scope would be restricted to post-natal care. The head expressed interest in the potential development of an online application that would assist in improving the communication between the hospital and the newly discharged mothers. Areas of interest in a post-natal setup would include the health of new-born babies and immunisation patterns. The psychological condition of mothers was also an area of interest for the hospital.

The hospital head felt that one of the biggest challenges was that the agreed health practice did not allow for follow-up of patients after discharge, with that task being delegated to clinics and private doctors. The decision to structure the health practice in this way was based purely on a resource allocation basis, and the use of technology could be used to restructure this setup. This potential use of technology was left as a challenge to the design team. Also of concern was the fact that the obligation to continue to look for care was left to the new mothers, many of whom felt there was no need to continue to consult the health system unless there was a palpable problem, by which time it was likely to be too late to take meaningful action. Tracking of mothers with HIV was also an area of interest.

Arranging formal interviews with doctors proved to be particularly difficult, as they indicated they were busy at most hours and even when formal meetings were set up, the doctors devoted very little time and attention to the process. Brief interviews were conducted with doctors, including the resident gynaecologist, who highlighted concerns about the health of mothers after discharge. Mothers with HIV were seen as being at particular risk and to require closer follow-up attention. The issue of resources for drugs, as well as for the provision of basic care within and outside the hospital, was of particular concern to doctors.

5.2.2.2. Midwives' perspectives

Over a period of three days, 13 trained midwives responded to an advertisement placed in a newspaper to take part in interview sessions, with the interview focus being on understanding their experiences as nurses offering post-natal care. After a brief explanation of the purpose of the study, 10 of the 13 nurses agreed to be interviewed and the interviews were recorded. The nurses were all experienced midwives with experience ranging from a few months to close to three decades of practice.

The role of the midwife

Table 39: The Role of the Midwife in Post-natal Care Taking Care of the Baby (Midwives'/Nurses' Responses)	
Midwife 01	Examine the baby, head to toe; the eyes, anything that the labour ward may have missed the cord is not bleeding and securing it if it is loose, the bladder, and the rectum … a quick examination throughout.
Midwife 02	We check on the baby as well, the functioning of the brain, their physical well-being and any disabilities
Midwife 03	… and that the baby is also healthy and breastfeeding well, has been examined that there are no abnormalities that have not been attended to and that there is continuity of care in the community … we are looking at breastfeeding, immunization, welfare of the baby, nutrition…
Midwife 06	... we do physical examination of ... the baby.
Midwife 06	Generally we do post-natal examinations from head to toe. Usually what is done some hours after the patient has delivered ... we do physical examination of the mother and the baby.
Midwife 07	Secondly I look at the outcome of the baby, you may have a deformed baby, some babies may be taken to the neonatal unit, the baby may not have cried at birth, these things concern the mother … I consider all these. Obviously if I did not attend the actual delivery I may take a different take so that I get more information from the mother.
Midwife 10	… and then we take the baby to the post-natal ward.

Table 39 shows an extract of the responses from midwives on their role. The nurses interviewed felt that their role in post-natal care was multi-pronged. Most nurses pointed out that part of their role was to ensure that the new-born baby was healthy and comfortable. Some nurses went into detail to discuss various checks conducted on new babies, including basic functioning of the brain, operation of the eyes, failure to feed, and checking for any potential abnormalities. All the interviewees mentioned taking care of the physiological needs of the mother as being an important component of their work. Nurses pointed out the need to pay attention to any signs of continued bleeding, looking out for sign of post-partum haemorrhage, checking the contraction of the uterus, checking vital signs such as temperature and blood pressure, as well as ensuring the general comfort of the new mother. Where required, administering of painkillers was reported as being part of the role of a midwife.

The psychological state of the mother was highlighted by many of the interviewees as being an issue of major concern, with nurses being highly conscious of the possibility of the development of psychosis. The older and more experienced nurses evidenced greater concern for the psychological state of the mother, indicating an interest not only in the mother's state but also in the bonding of the mother and child, as well as the father. Education of the mother was considered an important role, especially for first-time mothers. Table 40 shows a sample of the nurses' responses in relation to psychological support for new mothers.

Nurses felt that there was a need to reinforce training provided in prenatal classes on how to hold the baby, breastfeeding, bathing the baby and generally how to take care of their new-born. Education on personal hygiene after discharge was also reported as a major role for nurses in post-natal care. Nurses reported on the need to inform mothers of the timetable for further consultations during the first six weeks of the child's life. Nurses also noted that it was their duty to escalate any complications that arose to specialist doctors if this was required.

Table 40: The Role of the Midwife in Post-natal Care Psychological Support (Midwives' responses)	
Midwife 02	We also check on the mental health of the mother to see how they are coping after birth.
Midwife 02	We are concerned about psychosis after birth.
Midwife 07	… so I might get a first-time mother; or a mother who wanted a girl and she gets a boy, someone may want four babies but they have method failure or the husband may not be so supportive.
Midwife 07	There are psychological issues associated with the father as well and these need to be taken into account. The father may have wanted a boy and got a girl ...
Midwife 07	There are lots of issues to consider. As a midwife I try and bring them together (as a family).
Midwife 08	In private hospitals the hospital may allow the father to be present during birth so I allow the three of them to bond.
Midwife 08	So I place emphasis on the psychological aspects, congratulating them on the baby and you will see from the facial expressions if there are any hidden concerns. So someone may start sobbing, or crying, or smiling and I take it from there.
Midwife 10	In the post-natal wards, you also have to access the mental contents of the mother, some can develop people psychosis, and then you should monitor if they are not in that condition.

Patient interaction after birth

Midwives described fairly intensive interaction with mothers soon after birthespecially during the first 24 hours. Nurses agreed that it was desirable to keep mothers in hospital for at least three days after birth, but this rarely the case happened, as resources did not allow it and some mothers were discharged as early as 12 hours after birth. Mothers who had faced complications during birth, or had undergone caesarean section births, generally stayed longer that those who had straightforward deliveries. Despite the differences in discharge dates, all mothers were examined after three days, with follow-up visits to a health centre recommended after a further seven days. The final formal post-natal service was delivered six weeks after the birth of the child.

Midwives reported that in the Zimbabwean healthcare setting, central hospitals were only responsible for delivery and the initial in-hospital post-natal care. Thereafter services were delivered through a variety of channels, including local government clinics, private clinics, private doctors, community healthcare workers and private midwives. Only the most serious of post-delivery complications were referred back to the central hospitals such as Chitungwiza.

Table 41 shows an extract of some of the comments made by mothers in respect of their interaction with the hospital.

Table 41: Interaction of Midwives and Mothers

(Midwife Responses)

Midwife 01	Clinic will call when there is a need to escalate cases.
Midwife 01	… then you (usually after 12-24 hours) check for complications, like post-partum haemorrhage, baby not sucking well, sucking reflex not present or not passing stool.
Midwife 01	You check for this 12-24 hours after birth.
Midwife 02	If one delivers at a central hospital, they are taken over by the local clinics after discharge. So it's the midwives at the local clinic who take over the care of the mothers.
Midwife 04	In the hospital setting it's three days visit, the seven day visit and the six weeks visit. That is how often they are supposed to come.
Midwife 04	But you find some do not come, they only come during at day ten, or do not even come at all.
Midwife 06	(on follow up after discharge) It depends, sometimes we follow up but generally as a central hospital we do not follow up; we hand over such patients to the reproductive health team who focus on this.
Midwife 06	(on interaction after discharge) We don't, unless she has a problem, so we tell them to come after six weeks … but if they have a problem within that period, we ask them to come back.
Midwife 07	(on follow up) Not really, patients are asked to come back after given times.
Midwife 07	After birth, typically we attend to a mother at least once every two hours, but in reality it may not be that often as we move from patient to patient.
Midwife 08	Post-delivery they usually stay in the hospital for three days, … thereafter they are discharged and they come back for the seven day examination, then the six week contact then monthly thereafter.
Midwife 08	We expect them to come back but in the community there are community village health workers who also undertake the follow-up of those mothers, so that any problems are picked up and referred to the hospitals.
Midwife 10	… then at six weeks we also encourage them to come.
Midwife 10	Usually in the post-natal wards, then the following morning we do a post-natal care examination to the baby and to the mother.
Midwife 10	… we do another examination and then at 10 days again, we encourage them to come but here and there, some come and some don't,

Information handling

Although midwives associated with Chitungwiza hospital acknowledged the existence of a patient management system at the hospital, most midwives described a manual system for handling patient information. All births are entered into a register kept in the maternity ward and mothers are presented with a patient card/booklet that summarises their information and that of the child. This card/booklet is used as the main conduit of information between the various service providers with whom the mother interacts. The register is used by the hospital as the reference point for any queries related to childbirths in the hospital.

Challenges

The biggest challenge faced by hospitals in delivering post-natal care was the lack of resources, which manifested itself in a number of ways. Hospitals were generally overwhelmed by the number of patients they had to attend to, implying that mothers were being discharged too soon after giving birth, compromising the quality of post-natal care. The lack of adequate beds in the hospitals meant that any mother who did not have serious complications would be asked to make room for mothers who were more fragile. Drugs were generally in short supply, with some nurses reporting that some mothers who had undergone caesarean births were not receiving sufficient dosages of painkillers to relieve their pain. Midwives also felt that they did not have adequate access to systems that could help them improve service delivery.

Midwives highlighted that mothers themselves faced substantial challenges in respect of resources, which compromised their ability to access and enjoy the services offered by the hospitals. Some mothers from remote areas could not afford to come often to the hospital for antenatal clinics and their lack of preparation became apparent during the provision of post-natal care. This lack of resources also compromised their ability to access post-natal care, as mothers were required to travel to the appropriate centres for assistance. In the most serious of cases, mothers could not afford to feed themselves and their children, leading to early cases of malnutrition in the children.

Table 42: Challenges Faced: Lack of Follow-up (Midwife Responses)	
Midwife 01	Sometimes the mothers come from far, such as Mutoko, and with no follow-up we really do not know what happens to them. All we have is a baby card that has the baby information.
Midwife 01	Usually there is poor follow-up because of the referral system with the clinic.
Midwife 01	We are not aware if there are challenges with the patient.
Midwife 01	We have no way of knowing if the patient really did go to the clinic.
Midwife 01	We have no way of knowing what happens to the patient after discharge.
Midwife 02	If one does not go back for the review, there is no follow up. Midwives do not go into the community to check why the mother does not come back. So we do not have 100% follow-up on the mother.
Midwife 02	Sometimes they (mothers) feel there is no need to go back for the six week review if they have no complication.
Midwife 03	After discharge from a central hospital there is no contact and it is up to the community health system … the clinics ... they are the ones in touch with the mothers for immunisation.
Midwife 03	And there is no follow-up to make sure that the immunisation actually happened.
Midwife 03	There was no way of keeping track of the mothers. Only those with peculiar problems that required follow-ups.

The inability to follow up patients after discharge was almost universally pointed out as a major failing of the healthcare system in Zimbabwe. Table 42 highlights some of the mothers' responses with regard to lack of follow-up. The onus for getting post-natal care was placed on the mother, and even where the hospital felt that a mother who had been discharged needed additional attention, the hospitals were not equipped to provide this follow-up care unless the mother returned to the hospital. Midwives noted cases where mothers did not look for follow-up care because of lack of resources, a belief that they did not need the follow-up care or a decision by the mother to look for assistance elsewhere.

Lack of availability of information to both mothers and midwives was highlighted as a challenge by some of the midwives interviewed. Midwives felt that if mothers had better access to information at home, their care of their babies was likely to be of higher quality. In the hospital nurses bemoaned limited access to the latest information on how to deal with their patients, as well as poor management of patient information generated by the hospital, citing the use of registers as an antiquated way of handling information. Midwives also highlighted the lack of meaningful ICT tools as a challenge, forcing them to spend time updating manual registers at the expense of focusing their attention on improving the well-being of mothers and their new-borns.

The final challenge highlighted by nurses was the lack of coordination of healthcare provision that came about as a result of the fragmented nature of post-natal care. Discharged mothers are requested to look for further assistance from clinics and private doctors. Although the patient card is used to share information between providers, the information on these cards is often abbreviated and much of the patient history is lost. The cards themselves are often lost, compelling patients to narrate their history to overworked medical staff that have little patience to extract complex medical information from, in many cases, semi-literate mothers.

Summary of Midwives Interviews

Table 43 presents a summary of the findings from the midwives interviews.

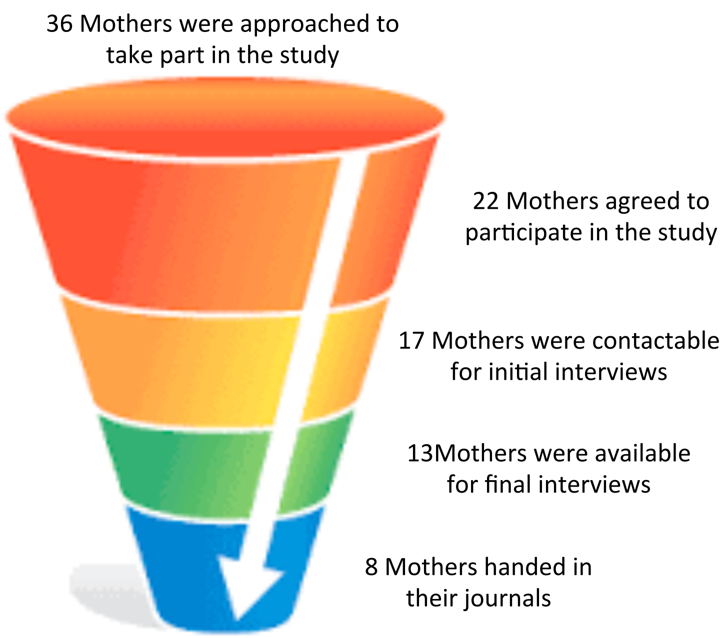
Table 43: Key findings from the midwives

Role of the Midwife	• Baby care • Mothers' physiological support • Mothers' psychological support • Education
Interaction	• Intensive while in hospital • Three-day visit • Ten-day visit (also referred to as seven-day visit after the three-day visit) • Six-week visit • Follow-up visits managed by clinics, except in exceptional cases
Information System	• Manual system built on register and patient cards
Challenges	• Lack of resources • Inability to follow up • Availability of information • Lack of coordination in healthcare

5.2.3. The patient perspective

Twenty-two mothers who had just given birth were identified for participation in this study, as illustrated in Figure 45. The cross-section of mothers included first-time mothers as well as those who had given birth before. The group included mothers who had given birth normally, as well others who had had caesarean sections. The sample of 22 came out of a total population of 36 mothers who were presented to the researcher by the hospital as potential participants, in groups of 12 per day over three days. At a selection session on each of the three mornings, the researcher and a midwife assistant explained the purpose of the study and went through the informed consent considerations in English and Shona. It was explained to the mothers that the interest was in mothers who were able to maintain a journal over a six-week period, had no privacy issues at home and had no religious concerns. On each of the first and second days, seven mothers volunteered to continue with the study while five mothers were released. On the final day, eight mothers came forward to bring the total to 22. Figure 45 illustrates the outcome of the mother selection process.

Figure 45: Participation of mothers in the study



Mothers were asked to write about their experiences on a day-to-day basis, detailing the common things that they went through in their lives, starting from their discharge from hospital. A week later, home follow-ups were conducted to ensure that the mothers were comfortable with the journal experience and to conduct an initial interview. At this stage, 17 mothers were contactable, with five having become untraceable. It became clear from talking to the other mothers that it was common practice to give false contact information to the hospital, as those with outstanding bills did not want to be found. After six weeks, a final interview was conducted and the journals were collected from the mothers. The researcher was able to contact 13 of the 17 mothers who had been contacted in the first round of interviews. Of these 13, eight had faithfully completed their journals and these were collected by the researcher.

The section below presents an analysed view of the initial interviews, highlighting the experiences of the mothers in the first few days after their discharge from hospital. This is followed by several stories, based on the experiences of the mothers as detailed in their journals.

5.2.3.1. Mothers' interviews

The initial interviews with mothers tried to ascertain how they intended to look after their babies and their own health, especially focusing on how they obtained information on doing so, how they interacted with the healthcare system, and the challenges they faced in doing so. The interviews also solicited suggestions on how hospitals could improve service delivery. Follow-up interviews were conducted at the point of collection of journals from the mothers. These follow-up interviews presented little in the way of additional insight over and above what was in the initial interviews.

Sources of information

Mothers felt that communication with the hospital was difficult, with several mothers explaining that it took them hours to physically get to the hospital simply to get information on the health of their babies. Mothers complained that the hospital had no facility for them to request information over the phone, or any other medium. Two mothers mentioned that the hospital contact numbers had never been made available to them and those who had the numbers complained that calls to these numbers were never answered. If one did get through to the hospital, the nurses were unwilling to assist over the phone, even if all one wanted was information, insisting that the mother had to bring the child to the hospital. Responses from mothers on their sources of information are presented in Table 44.

The most reliable source of information was seen to be neighbours, friends and relatives. Mothers and mothers-in-law played a particularly central role in the first few days of after birth in the Shona culture and in many cases, these were seen as the doyens of mothercraft. Because of the challenges of accessing the hospitals and the clinics, fewer than half of the mothers saw the healthcare system as a source of information for their mothering. Pharmacies were also seen as a more accessible means of obtaining professional information on caring for their babies.

Table 44: Sources of Information (Mothers' responses)		
Mother 04	Information source	Sometimes I look up the information on the health card or go to the hospital to seek for the information from nurses.
Mother 05	Information source	We ask around from friends, neighbours and older women in the community, as no nurses or midwives make a follow-up on us after we are discharged. Sometimes we just use intuition to solve the problem which would have arisen
Mother 06	Information source	So far there is nowhere I can access the information as we are required to first settle our bills to get medical attention.
Mother 07	Information source	We have to go to the hospital physically or ask from neighbours.
Mother 08	Information source	Usually from neighbours who have since given birth and my mother in-law for instance when my son once had a fever, my in-law said it was nhova and used traditional methods to solve the situation. I am somehow convinced that not going to the hospital has no effect at all and the child can be fine.
Mother 09	Information source	I physically go to the hospital to get the information (is there somewhere where they document on what you are supposed to do to correct the problem?) They just tell us that the child has lost weight but don't go into much detail about how to feed the baby. Otherwise they don't write anything.
Mother 10	Information source	I keep track of the child's birth card which shows me how my child is progressing. The information entered on the card guides me.
Mother 11	Information source	I ask around from friends, neighbours, relatives or even my parents in the community. (Why not go to the hospital to get the information?) Usually there are long queues at the hospital therefore for some of common ailments we get advice from those close by, another issue is that the hospital is far and going there is time-consuming.
Mother 12	Information source	I ask around from friends, neighbours, relatives in the neighbourhood and even medicine I get from those who would have collected for their children.
Mother 13	Information source	I go to the hospital in person and also look up information on the baby card.
Mother 14	Information source	I just monitor the child myself without going to the hospital and make an assessment.
Mother 15	Information source	From nearby neighbours and friends.
Mother 16	Information source	I just make an assessment based on what I observe on my child and do the best I can to prevent the child from contracting any diseases.
Mother 17	Information source	If I am not sure I ask e.g. the child may develop (yellow) aundice in the eyes or in the hands when you ask they can tell you to get glucose and give to the child. At times when you follow the advice it will work.
Mother 17	Information source	I get it from the hospital. After birth, we always visit the hospital monthly to weigh the children and when we go there that is where we get an indication and are told whether the child is growing well or is lacking and growth is deteriorating.

Interaction with the healthcare system

Interaction with the healthcare system was limited to the pre-agreed baby check-up visits. Mothers who were discharged soon after giving birth went to their local clinics for a three-day check-up following by a visit seven days later. These mothers anticipated a final visit at six weeks. Mothers who had had complications in giving birth were attended to at the central hospital, including those who had had caesarean births and required regular attention. At the time of the initial interviews, seven to 10 days after giving birth, over 50% of the mothers had not returned to the hospital. The reasons given were largely financial and logistical. On the financial front, mothers claimed that they either had no funds to visit the hospital or were afraid of being confronted about past bills that were due. Logistically mothers raised issues such as being too sick to travel or access to transport.

Challenges faced

Mothers faced numerous challenges in accessing healthcare, including the pain they were in, their need to attend to their children, finances as well as transport. Five mothers highlighted that although they had been requested to return to the hospital for further attention, they had not returned because they were in pain. Their physical condition, coupled with the use of public transport, made it impossible for them to return to the hospital even though they felt that they required the hospital's services. Pain played a part in the case of a mother who said that she had missed out on many of the instructions on how to take care of her child because she had been in unbearable pain as she was being instructed on how to take care of her baby.

Finances played a role in women's ability to access healthcare. Those with outstanding bills felt that they could not return to the hospital lest they were detained for having outstanding bills. A few mothers pointed out that they could not travel to the hospital, as they did not have funds for transport and were afraid that if they did travel to the hospital, further funding would be required, which they did not have access to. Mothers complained about the fact that they had no knowledge upfront of all the payments that would be required at the hospital for services and for drugs and this discouraged them from visiting the hospitals and clinics. Some of the responses from mothers on financial challenges are presented in Table 45.

Table 45: Financial Challenges

(Mothers' responses)

Mother 06	Challenges	Financial constraints as we are supposed to settle our bills to access medical assistance	Finance
Mother 11	Challenges	Challenges are mostly financial in nature as hospital visits require that we pay for transportation.	Finance
Mother 13	Challenges	For me to continue going to the hospital it was difficult due to unavailability of money.	Finance
Mother 14	Challenges	I failed to visit the hospital due to financial constraints and I could not borrow money as my husband is does not tolerate and is very particular about borrowing money. I am scared of being beaten so I found it better not to go to the hospital.	Finance
Mother 15	Challenges	I gave birth at the hospital but could not go back for the three-day checkup because I did not have bus fare and the hospital is far.	Finance
Mother 17	Challenges	I got service for delivering the baby but did not have all the money required.	Finance

Families influenced the manner in which the mothers interacted with hospitals. Three mothers indicated that their mothers or mothers-in-law would not allow them to return to the hospital, as they felt that the hospital had no further role to play in the upbringing of their grandchildren. In some cases husbands forbade their wives to visit hospitals. The church played a similar role, with two mothers having been forbidden to return to the hospital on the grounds of their religious beliefs. One mother argued that her family had convinced her that it was not part of her culture to leave the house before the baby's umbilical cord had dropped and so she could not go to the hospital.

The major challenge raised by mothers was the quality of services offered by the healthcare system. Mothers complained about the slow service offered by the nurses at the clinic and the hospital, with several mothers complaining that nurses where seen chatting on cell phones or attending to Whatsapp messages while patients waited. Four mothers commented bitterly about being asked to undress their babies in the cold, while the nurse attending to them turned her attention to something else. In one case a child was reported to have developed a cold as a result. Mothers repeatedly commented that nurses did not treat them with respect and treated them as though they were inferior beings. One mother reported being so petrified of the nurse that she would not give complete information on what she thought had caused her child's stomach ache and that she either lied or withheld information from the nurse to avoid further humiliation. Two mothers reported being asked to go to the hospital, only to leave unattended because the appropriate nurse was not available.

Suggestions for improvements

When asked about how the healthcare system could improve the service offered to new mothers, a number of suggestions were put forward. Responses from mothers on potential improvements are catalogued in Table 46. Mothers felt that neither nurses nor doctors devoted enough attention to understanding their needs and their requirements, paying minimal attention to them before moving on to the next patient. Some mothers felt that at the end of a consultation they were left even more confused, in some cases having received information that they felt was irrelevant. Mothers complained about slow service, inattentive nurses, uncaring nurses and poor work management in the hospital. Overcrowding at the health centres was seen as impeding good service delivery.

Several mothers mentioned the issue of transportation, noting how immobile mothers are generally in the early days after childbirth. Some mothers felt that the hospital should establish systems to undertake home follow-ups so that mothers did not have to return to the hospital for early check-ups. Several mothers referred to the issue of availability of information. Information should be more easily available to new mothers and hospitals should put more emphasis on educating mothers, or alternatively make that information more easily available. One mother suggested the setting up of call centres where mothers can call in to get assistance over the phone.

The issues of fees was raised, with mothers advocating a reduction in fees, and some arguing that childbirth should be subsidised or made completely free.

Table 46: Suggestions for Improvements (Mothers' Responses)	
Mother 01	When we were discharged, nothing was said in terms of likely problems we might face and how to deal with them. There is not even a contact number to call.
Mother 02	It can assist in that if someone feels unwell then they get medical attention. I don't know what else they can do to assist.
Mother 03	They can increase consultation time with the doctor. They should also have a resident doctor in place to assist in cases of emergency because at times emergencies occur which require urgent attention by the doctor.
Mother 04	The hospital could assist with transport and provide a vehicle, especially for those mothers who undergo surgical operations, for their check-ups. Nurses could also be availed to check on us in our homes and make follow-ups.
Mother 05	Nurses should be made available to make follow-ups to see how children are being taken care of, monitor wound healing and cleaning for those who are surgically operated on. Fees charged on giving birth could be removed or slashed to make it easier for mothers to access medical help.
Mother 06	Firstly, hospital bills should be reduced and follow-ups on patients. They also need to establish and consider the way of life of patients and take note of their constraints, particularly financial.
Mother 07	The hospital should establish several service points at the hospital so that we are not overcrowded when being attended to. They can also make follow-ups on individuals who would have given birth. Also, the bills incurred during delivery are a bit on the high side so the hospital could reduce the fees required. Some do not go back for hospital visits due to outstanding bills.
Mother 08	I wish the hospital could do more like conducting road shows even at the nearest shopping centres as outreach.
Mother 09	Hospital charges are high compared to South Africa where people are assisted for free. Some end up giving birth in homes because of the high costs. They can also keep records and circulate information to mothers who would have given birth through phones, flyers etc ... and when we go to the hospital they must also teach and train mothers on health issues. Hospital visits are too frequent. We should only go to hospital if they are issues because we are still in pain.
Mother 10	The hospital should try and attend to us immediately and timeously, they should make an effort and not make us wait for long times. Sometimes we wait for a nurse assigned elsewhere to come and attend to us. (Are you suggesting that there be a nurse specifically for weighing of the babies or what?) Yes at least there should be a nurse assigned to attend to the babies than wait for a nurse assigned to the maternity wards to attend both sections.
Mother 11	Improvement on efficiency in terms of service delivery, they must attend to us timeously. They should also have enough resources to cater for us for instance on drug dispensing. We should not be made to bring our own containers to get medication. If possible they should reduce their hospital bills for they at times restrict other people from going to the hospital.
Mother 12	Nursing services can be decentralised to nearby growth points for easy access to the services. In my case it would be easy to sneak off to the growth point under the pretext of buying other things and access medical services for the child than go to the hospital, as my in-law would be around.
Mother 13	They can establish call centres where we can call and get access to information over the phone. They can have toll-free numbers as well to cater for those in cash crises.
Mother 14	If possible the hospital can assign nurses to pay home visits to discharged mothers and provide us with services and teach us how to deal with our issues.
Mother 15	They can establish call centres where one can call for assistance.
Mother 16	If it were possible they would conduct home visits when they visit we may be in a better position to get assistance from them.
Mother 17	They can advise us on proper use of medication. They can also have nurses dedicated to serving those with children under maybe 5 years and not to be in the same queue with all other patients to be attended at the hospital.

5.2.3.2. Mothers' journals

The mothers' journals presented a detailed look at the day-to-day events in the mothers' lives. The following section presents summarised versions of selected mothers' diaries. These are all true stories.

Table 47: Anna' Story (M4): A Happy Mother
Anna is the mother of four children. She gives birth to her fourth child at Chitungwiza hospital on 11 May 2017. Anna is happy with her child and the nurses treat her with respect. Despite having two other boys, her husband is disappointed that she gave birth to a girl, but he is happy and supportive all the same. He comes to see her in hospital and takes her home when she is discharged, the day after giving birth. Anna lives in a cottage at the back of a large house that she and her husband are building. The husband has a steady job and she runs a profitable mushroom-growing business from home. Anna lives with her husband and children and at the start of the project has no household help. Her cousin comes to visit and gives her hints and tips on looking after the child, even though she has had three other children. Anna's mother-in-law is less pleased with her child and refuses to hold the child, claiming that she has been called a witch in the past. This causes Anna much pain and she is often left in tears after speaking to her mother-in-law. Despite this, Anna spends a week in the rural area with her mother-in-law, to allow her to bond with the new-born, while the husband returns to town to look after the other children. Anna's mother-in-law notices that Anna writes a journal and tries, unsuccessfully, to locate it so that she can see what Anna writes in it. Anna uses public transport to return from the week in Mutoko, as her husband is busy at work. Back home, Anna's days are filled with cooking, cleaning, looking after her children along with tending to her mushroom crop. Having given birth normally, she recovers quickly despite heavy bleeding on the days following her delivery. Anna keeps a copy of the book "Where There Is No Doctor: A Village Health Care Handbook" (Werner et al., 1973) by her bedside to help guide her in looking after her children. She keeps no formal records of her interaction with the hospital other than the health card given to her by the hospital. Other than having had to return to the hospital where her youngest baby was born to collect a birth record, she has no further contact with them. Anna is lucky to live close to a clinic, which she visits for regular check-ups, as advised at the hospital. Anna is generally happy with the health system, her only complaints being that the linen at the hospital was inadequate and not in the cleanest state, and that the clinic keeps no records of the care they give, relying only on evidence produced by the mother when she visits.

Anna's story (Table 47) is an exception rather than the norm.

Table 48: Vimbai's Story (M9): A Struggling Mother

Vimbai gives birth to her only child on 9 May 2017. She is discharged from hospital on the morning of the 10th, but is unable to settle the bill so she is only able to leave the hospital after 17:00. Having been discharged in the morning, she does not get food from the hospital so she is tired and hungry when she finally makes her way home. Frustrated, with a baby in her hands, she boards the wrong public taxi to take her home and is dropped off a long way from the correct route. She then walks to get the correct taxi home, arriving to welcoming neighbours and friends. Her husband cooks her a meal of sadza and fish and she goes to bed happy.

Home is a routine of housework and looking after the baby. The baby hardly sleeps at night, which keeps her and her husband up most nights, and leaves her very tired during the day. Her husband is a faithful provider but occasionally scolds her for sloppiness, which makes her unhappy. She has a small circle of friends who come to visit and she receives presents for her baby, which pleases her. She regularly goes to church for prayers, and when she is unable to go to church she watches church services on TV. Her mother lives close by and she occasionally takes the baby to visit her. She also takes time to visit friends who live in the neighbourhood.

Food is occasionally in short supply in Vimbai's home. Her diet consists of sadza, mainly with fresh or dried fish and occasionally chicken and beef when they can afford it. When there is little money in the house, Vimbai cooks sadza with vegetables or beans. Her breakfast is generally rice and tea. Occasionally her husband or a friend brings her some fruit. On many days, she goes to sleep hungry and she thinks her hunger leads to headaches and the tiredness she frequently feels.

During the early days after giving birth, Vimbai suffers from severe back pain and pain in her stomach. She is frequently tired and suffers from headaches and she attributes this to her poor diet. She takes no medication for her pain; the only medication in the house is the methylated spirit that she uses on her baby's umbilical cord, which falls off after three days. She occasionally feels lonely, and when her husband leaves her to visit his mother in the rural areas one weekend she is left in tears. Despite not being in the best of health, on no medication, she soldiers on to look after her baby and finds time to visit her mother who is also unwell. Although the baby is supposed to go back to the hospital for a check-up after 10 days, Vimbai does not return to the hospital, as she has no funds to do so.

Two weeks after giving birth, she begins to feel better and finds time to attend church services with her baby, carrying her on her back there and back. She resumes her business of making and selling ice-lollies. She is unhappy with her husband one morning when he, fumbling in the dark while preparing to leave for work, kicks over a bucket containing syrup she was preparing to freeze to make ice-lollies. Not only does she have extra cleaning up to do, but the loss of raw material is a setback for her business. Her husband does not apologise for the mistake and this leaves her feeling depressed.

Month end is particularly stressful, as rent is due and there is no money in the house. The landlord threatens to evict the family and when she packs up to go on a visit to her sister, she is stopped by the landlord who promises to have the family's belongings in the street when they return. The stress takes its toll on Vimbai and her headache and back pain become unbearable, yet she cannot afford to visit the hospital. She asks a neighbour to look after her child so that she can get a few hours of much needed sleep.

A month after the birth of her baby, Vimbai goes to the hospital to collect her daughter's birth record. This visit is undertaken with much trepidation, as the thought of the outstanding bill is on Vimbai's mind. She is much relieved when it turns out there is no mention of money and in fact no payment is required for the birth record itself. A few days later, she wakes up early and takes the long walk (she has no money for bus fare) to the local administrator's office to collect a formal birth certificate. She is informed that the birth certificate will be ready by the end of that day. With nothing to do, she walks back home to eat lunch before she goes back to collect the birth certificate. She returns to collect the birth certificate and finds that it has errors on it, so she is asked to come back the next day to collect the corrected certificate.

Forty-four days after her baby's birth, Vimbai wakes up early to walk to the clinic to have her baby attended to as part of the six-week check-up advised by the hospital. She arrives at 7:00 but by mid-morning she has not been attended to so she walks back home to find something to eat. She walks back to the clinic and is finally attended to after lunch, and then she walks back home. The baby cries all the way home because of the immunisation injection she received.

Vimbai's story (Table 48) mirrors the stories of many other women whose diaries we saw. Trina's story, presented in Table 49, represents a powerful outlier, which had a strong impact on the design teams that participated in the first workshop.

Table 49: Trina's Story (M13): A Tragic Story

Trina gives birth to a baby boy on 7 May 2017. She is the mother of two other children, and the birth is a caesarean birth. She is discharged on 10 May at 10:00, but having no money to settle the final bill, she calls her husband to inform him of the $192 bill that has to be paid before discharge. She negotiates to pay the $50 that she has with her and the hospital confiscates her national identification card and allows her to leave. Four hours later the husband comes to find her and the child, restless and tired. The outstanding bill is paid, but as she leaves, she is told that the child must be given a BCG injection, although a nurse expresses reservations about the injection, as the child's temperature is high at 37.8° Celsius. At home, she notices that her child's temperature remains very high but thinks it will eventually normalise.

She struggles to feed the child, as she is not producing enough milk. Her child is continually groaning and has hiccups. A visiting aunt expresses concern at the child's groaning on the 12th. She asks to examine the baby's stool, which she says is not normal. A suggestion is made to purchase Gripe water* for the child, since the child is not sucking. The child continues to groan for a few more days until the aunt insists on taking mother and child to the local clinic on the 14th. At the clinic, they wait for 30 minutes for a nurse to attend to them. When she does arrive, she sends them to the hospital, as the case appears beyond her. They wait in a queue at the hospital until a relative who is a staff member at the hospital comes and attends to them. Mother and child are admitted and the child is placed in a nursery.

The hospital asks for payment for blood testing and medication and she is unable to pay. Eventually the medication is bought and the child is placed on a drip. According to the doctor who attends to her, the child is dehydrated. The drip is discontinued after the first day, but when the doctor returns the next day he is angry with the nurses for having discontinued the drip, noting the child is severely dehydrated. The baby's head has started to sink in from the top, commonly known in Shona as "kudona nhova"; a sunken fontanelle, and a known sign of dehydration. The parents are asked to buy another drip, which is procured. Meanwhile the child's condition continues to decline.

On 23 May 2017, a week after admission to hospital, the child dies. The father chooses that the baby be cremated and the mother returns home. The mother is in pain from the complications of the caesarean birth. The wound on her stomach stubbornly refuses to heal. She consults friends and relatives, and all are surprised that she was only given one set of tablets, all of them thinking that there should have been more. She continues to treat her wound with methylated spirit and taking the medication provided by the hospital. After a few more days she decides to go to the pharmacy and she is offered a painkiller, the first time she has received a painkiller since the birth of her child.

Trina's relationship with her husband becomes strained as the days after the child's death become weeks. The husband and his relatives visit traditional healers to establish the cause of the child's death and they are told that the mother sacrificed the child. This causes tremendous tension in the household. Despite not having fully recovered, Trina decides to go back to work to take her mind off her predicament.

Trina meets with the interviewer during her lunch break from work. What was meant to be a routine interview turns into a counselling session as the young mother bares her soul for over an hour, frequently sobbing, and breaking down at some point. Between the interviewer and the accompanying midwife, they try to console her and provide words of encouragement. At the end, she stands up, wipes away her tears, and thanks them. It is the first time I have told my story to anyone, she says as she departs.

** Gripe water is a non-prescription product sold in many countries around the world to relieve colic and other gastrointestinal ailments and discomforts of infants*

5.2.3.3. Mothers' input summary

A summary of the findings from the interaction with mothers is presented in Table 50.

Table 50: Key findings from the mothers' perspective	
Sources of information	• Hospitals and clinics difficult to access • Friends, neighbours and relatives a major source of information • Churches are influential • Pharmacies play an important role • Books • The internet
Healthcare system interaction	• In-hospital services • Three-day check-up • Seven-day check-up • Six-week check-up • Generally mothers do not engage the healthcare system unless critical

Challenges faced	• Difficulties in accessing healthcare
	• Finances/lack of resources
	  o For transport to get to the hospital
	  o For drugs
	  o For food
	• Family influence
	• Quality of services

Suggestions for improvement	• Healthcare system should understand their circumstances • More effort should go into educating mothers • Home follow-ups are necessary • Healthcare should be easier to access • Timeous service delivery • Make remote service available (by phone/internet) • Better scheduling of visits • Services should be more affordable

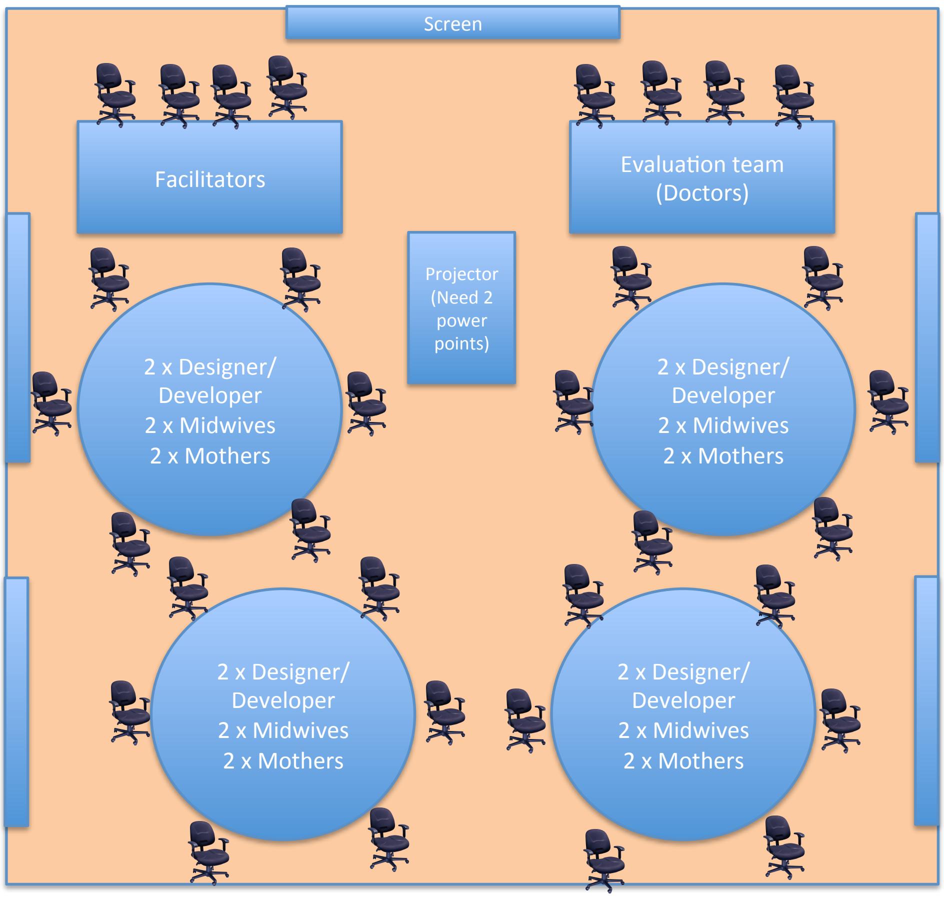
5.3. Design Thinking Workshop 1: The Four-team Challenge

5.3.1. Design workshop 1: Introduction

The purpose of this workshop was to test the efficacy of the Technovation Process and refine the process as necessary. This multi-team workshop was laid out as illustrated in Figure 46. During this workshop, the researcher presented the findings of the doctors', nurses' and mothers' interviews as well as excerpts of the mothers' journals as the empathy input into a design journey.

The CEO of the hospital set the stage for the day with a presentation on the hospital's achievements in the past, including being the first ISO-certified hospital in the country, being a pilot site for an e-government project and having a state-of-the-art renal unit despite being based in a very low-income area. He also highlighted the organisation's design to be a leading innovator so that they can maximise the use of limited resources to service their constituency.

Figure 46: Workshop layout



After an initial presentation outlining design thinking and its use in innovation, a presentation on the empathy findings was made to the group. Four design teams, each consisting of two nurses, a mobile developer and two mothers, were tasked with developing a POV relating to a problem or a number of problems (related to post-natal care) that they would tackle based on the empathy input. Each team was then tasked, after presenting their POVs to the rest of the group, to focus on one problem, unique to the group, that they then ideated before building a prototype. As part of the testing, the prototype was presented to the rest of the group, which by this stage was joined by a doctor and senior developers who helped evaluate the prototypes, with a prize being offered to the winning team to fund the development of a working model.

5.3.1.1. Workshop 1: Empathy feedback

The empathy session was used to set the scene of the study for the design teams. During this session, a presentation was made on the objectives of the study as well as an update of the findings of the study. The researcher took the group through the healthcare perspectives of post-natal care service provision, as well as the mothers' perspectives. The stories constructed from mothers' journals were presented. Through this session, the researcher attempted to get the design teams to understand the experiences of those involved in the healthcare process. The stories attempted to bring to the fore their fears, the beliefs they held, the challenges they faced, the expectations they had and the way they viewed the world around them.

The initial presentation focused on the analysis of the healthcare workers' interviews and the midwives received this presentation with occasional nods and some note-taking. The story of the happy mother was received with a sense of pride and what appeared to be a sense of recognition for the work they do. The story of the struggling mother appeared to make the midwives uncomfortable, with some visibly shrinking at the mention of poor treatment of mothers at the hospital. The tragic story of the mother whose baby died left the room clearly shaken by the young mother's ordeal, with a few of the women, battle-hardened by their work in hospital, dabbing away at their eyes.

5.3.1.2. Workshop 1: Definition feedback

The definition mode was used to allow each of the teams to define potential problems that they wanted to tackle in the problem space of improving post-natal care, given the empathy presentation. Teams were tasked to come up with multiple, own POVs, which they would then present to the rest of the group before selecting one to work on for the rest of the day. In addition to referring to the mothers and midwives who were part of the team, teams were encouraged to consult the principal researcher, who undertook the data collection for the empathy mode to improve their understanding of the problem space.

In line with the evolving framework for an SDL approach to technology-based innovation using design thinking, the teams were asked to address five areas of service delivery in trying to capture their understanding of the problem area. Using the input provided in the empathy session as well as their knowledge and experience, teams were asked to consider the following:-

- What are the key components of post-natal care? [Service]
- Who are the key players in providing these services? [Players]
- What networks affect the provision of these services? [Networks]
- Who are the beneficiaries of the services being provided? [Beneficiaries]
- What institutions coordinate the provision of post-natal care? [Institutions]

Each team was provided with “Handout 1: Definition”, presented in Chapter 4 as Exhibit 1, as well as the “Define Mode” guide from the d.school process guide.

The output from the teams varied and was not only influenced by the empathy presentation at the start of the workshop, but also included additional contributions from both mothers and nurses. While the interview sessions asked specific questions, which were in line with the objectives of the study, the participation of the mothers and midwives in the workshop gave both parties greater appreciation of the problem at hand and allowed them to reconsider the input provided in the earlier interviews, in view of the purpose of the workshop.

Figure 47: Identification of Services

Team 1: A- team	Team 2: Med-Innov
• Baby examination • Immunisation • Nutrition • Mother examination • Family planning • Counselling • Health education 	 • Examination of the mother • Examination of the baby • Initiation of breast feeding • Health education • Immunisation • Growth monitoring • Family planning • HIV testing and counselling • Issuing of birth records • Data capturing • Kangaroo care
Team 3: Tech-Health	**Team 4: Technovators**
• Education on breast feeding • Information on baby care • Perineal care • Hygiene information • Counselling • Physical well-being of mother and child • Immunisation • Nutrition • Monitoring health status of the mother • Monitoring psychological status of the mother 	 • Baby examination • Health education of the mother • Administration of drugs • Birth records • Immunisation of BCG • Post-partum problem ID • Examination of mother • Initiation of breast feeding • Counselling • Kangaroo care

The A-team identified baby examination, mother examination, psychological counselling and health education as essential services, in line with the empathy findings. Additional services that had not been identified in the empathy gathering included immunisation, family planning and educating mothers on nutrition. Med-Innov identified additional services in the areas of breast-feeding, growth monitoring, HIV testing and counselling, kangaroo care and issuing of birth records. The services identified by Tech-health were similar to those identified by Med-Innov, albeit with different terminology being used. The Technovators identified a similar set of services and added administration of drugs, which had not been identified by the other teams. These findings are summed up in Figure 47.

The four teams identified doctors, nurses/midwives, and counsellors as key players in service provision. The A-team added community health workers, pharmacists and clerical staff as being key players in providing service. The other three teams added the mother or the patient as a key player as well. Other keys member listed by the teams included cleaners, social workers, laboratory staff, sonographers and nurse aids. Table 51 presents a summary of the teams' output. This output is summarised from charts with post-it notes produced by the teams.

Table 51: Identification of Players

Team 1: A- team	Team 2: Med-Innov	Team 3: Tech-Health	Team 4: Technovators
Doctors	Midwives	Mothers	Mothers
Nurses	Doctors	Doctors	Nurses/Midwives
Counsellors	Counsellors	Midwives	Doctors
Community Health Workers	Family	Counsellors	Counsellors
Pharmacist	Cleaners	Pharmacist	Social Workers
Admission Clerks	Patient	Social worker	Pharmacist
	Clerks	Laboratory Technicians	Nurse Aids
	Community Health Workers	Sonographers	Villager Workers
		Debtors Clerks	Family Support Unit
		Finance Director	

Most of the teams identified the church and family as key members of networks that influence the behaviour of mothers in seeking healthcare. Other groups identified included support groups, tribal leaders such as chiefs, government outreach programmes and media. Three of the groups identified the internet and social media as influential organs that regulate the behaviour of mothers in seeking healthcare.

Table 52: Identification of Networks

Team 1: A- team	Team 2: Med-Innov	Team 3: Tech-Health	Team 4: Technovators
Church	Church	Church	Community
Family	Family	Family	Church
Support Groups	Community	Newspapers	School
Influencers e.g. Cchiefs	Internet	Internet	Workplace
Outreach Programmes	Media	Radio	Internet
	Support Groups	School	
		Social Media	

Figure 48: A-team discuss their point of view

All the teams identified the mother and the baby as key beneficiaries of services. Three of the teams identified families as indirect beneficiaries of service, along with the community. Businesses and the country at large were also identified as indirect beneficiaries of services. Two of the teams felt that the healthcare workers themselves were beneficiaries of the services on offer.

Table 53: Identification of Beneficiaries			
Team 1: A- team	Team 2: Med-Innov	Team 3: Tech-Health	Team 4: Technovators
Mother	Mother	Mother	Mother
Baby	Father	Baby	Father
Father	Baby	Family	Baby
Community	Family	Community	Family
Business	Healthcare Workers	Country	
Country	Community	Healthcare Staff	
	Country		

The teams initially struggled to distinguish between networks and institutions. The facilitators explained that networks influence behaviour, while institutions participate in the delivery of services. After this explanation had been given, all the teams agreed that hospitals, clinics, and pharmacies were key institutions. Outside the core, private surgeries were also listed as key participants. Private surgeries are generally private clinics run by doctors in their private time. Schools, non-governmental organisations, government departments and churches were also listed as potential participants in the provision of service. Schools and churches were highlighted for their involvement in immunisation exercises.

Table 54: Identification of Institutions			
Team 1: A- team	Team 2: Med-Innov	Team 3: Tech-Health	Team 4: Technovators
Hospitals	Hospitals	Hospital	Hospitals
Clinics	Pharmacies	Schools	Clinics
Pharmacies	Clinics	Pharmacies	Surgeries
Ministry of Health	Schools	Mobile Outreach	Pharmacies
Schools	NGOs	Churches	Dept. of Social Welfare
	Churches		

Having been advised to spend half the allocated time on identifying the components of service delivery, each team was asked to identify a beneficiary for whom they wanted to provide a solution and to decide on how they wished to help this person. Each team came up with the name of the person for whom they wanted to find a solution and framed their POV for this person. Tables 51 to 54 summarise the teams' identification of service ecosystems as identified from the empathy input, focusing respectively on players, networks, beneficiaries, and institutions. The POVs generated by the teams are summarised in Table 55.

Table 55: Point of View	
Team 1: A- team	Team 2: Med-Innov
Chipo needs good nutrition for both herself and baby for her to be in good health and to raise a healthy, happy baby so that she feels responsible, happy, and caring as a responsible mother, which will raise her healthy self-esteem.	Anna is failing to understand the importance of breast-feeding and needs education on the importance of breastfeeding so that she feels she is a responsible mother. Healthy baby = happy mother.
Team 3: Tech-Health	Team 4: Technovators
Janet needs post-natal information so that she feels wanted, cared for and valued and bonds with her baby	Trish needs health education to make her feel proud of being a responsible, good mother and a good wife.

Each team then presented their POV to the larger group before proceeding with the next exercise. The A-Team's POV was focused on Chipo, a new mother. Their self-defined brief was to find solutions to help her raise her baby as a responsible mother with the ultimate goal of raising her self-esteem as a mother. Med-Innov focused on Anna, and set themselves the goal of finding a solution to help her learn more about breastfeeding. Tech-Health felt that they could help Janet bond with her child by providing her with information on caring for her baby after birth. Technovators also concentrated their efforts on educating the mother in an effort to make Trish a better mother and wife.

5.3.1.3. Workshop 1: Ideation feedback

The purpose of ideation was to generate ideas that could be used to solve the problem at hand. During the ideation session, the teams were asked to open their minds to possible solutions to their chosen problem area. Teams were encouraged to be adventurous in exploring possibilities, going beyond the obvious, without spending too much time on investigating the practicality of each of the ideas presented. Because of the focus of the study, teams were encouraged to develop ICT-based solutions, preferably where a mobile application (app) or web-based applications could be deployed. Teams were given the latitude to reconsider the empathy presentation or to re-state their POV, as long as their subsequent input was consistent with their revised POV. At the end of the session, each team was requested to select one or two potential solutions that would be carried forward into the prototyping session. Figure 49 shows one of the design teams at work.

Each team was provided with "Handout 2: Ideation", presented in Chapter 4 as Exhibit 2, as well as the "Ideation Mode" guide from the d.school process guide.

Figure 49: Med-Innov engage in ideation

To help the teams in their ideation, they were asked to revise the services offered or required by mothers. For each of these services, the teams were asked if technology could be used in the process. It was made clear that the team did not, at this stage, need to know how this could be accomplished, but simply needed to understand whether an improvement could be effected. A list of potential technology improvements as listed in Table 56 was provided to each team as part of the workshop guides.

Table 56 : Technology Improvement Opportunities

Concept	How can technology be employed to
Cheaper	Make it cheaper for the beneficiary to access the service
Choice	Allow the beneficiary more choice
Convenience	Allow more convenience for the beneficiary
Dignity	Enhance the dignity of the beneficiary
Easier	Make a process less cumbersome
Faster	Speed up a process
Flexibility	Make service provision changeable while achieving the same result
Privacy	Ensure that the beneficiary's confidentiality is protected
Redundancy	Reduce repeated storage in the storage of data
Security	Make the storage/transmission of data more secure

At this point, the team effort was led by the ICT members of the team who started to explore how technology could be brought to bear on the challenge at hand. As guidance, the technology capability guideline (see Table 57) was provided to the teams to help them come up with ideas of how technology could be used to address their chosen challenge.

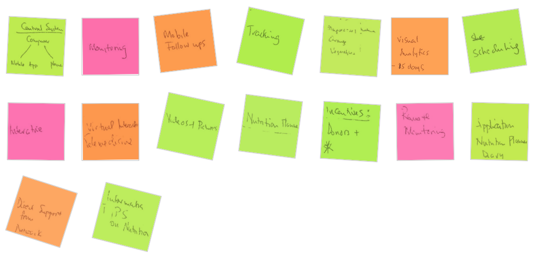
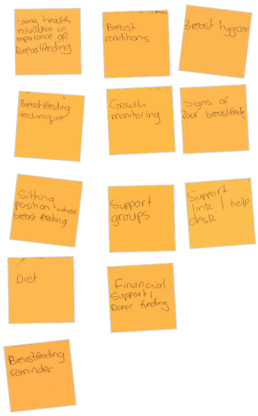
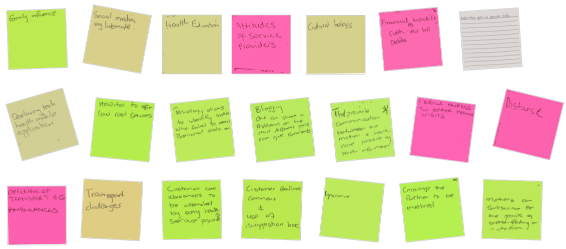
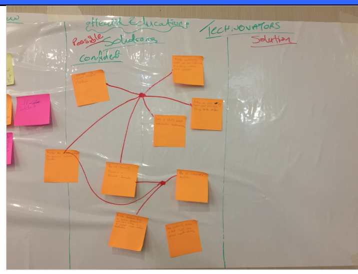
Teams were asked to explore how each of the capabilities listed in Table 57 could be used to help solve their chosen challenge:

Table 57 : Technology Capability Concepts

Analytical	Apply complex analytics
Artificial Intelligence	Replace human intellect
Automation	Replace human labour
Disintermediation	Allow direct communication of parties
Geographical	Make processes independent of geography
Imaging	Allow capture and transmission of high quality imagery
Informational	Bring large amounts of data into a process
Knowledge Management	Facilitate capture, build up and dissemination of information
Location Tracking	Allow positioning
Mobility	Ability to process while on the move
Electronic Payments	Facilitate electronic payments
Sequential	Reorder task/pararellise tasks
Social Mediation	Allow communication among multiple parties
Tracking	Allow detailed tracking of inputs, tasks and outputs
Transactional	Transform unstructured processes into routine transaction

Many of the ideas that were generated appeared to focus on educating mothers on one aspect of their health or the health of their babies. The A-team focused its attention on educating mothers about nutrition in line with their POV. Team Med-Innov built their ideas around breastfeeding, with suggestions being made about how mothers should hold their babies while breastfeeding, the best foods to assist in generating milk and schedules of suggested feeding. They also explored growth monitoring and wanted to include a section on raising funds for the poorest mothers. Tech-Health and Technovators both applied their minds to generic information about post-natal care, but with different ideas of how this would be implemented.

Figure 50 shows images taken from whiteboards of some of the teams ideas from the ideation session.

<table>
<tr><th colspan="2">Figure 50: Selected team ideas</th></tr>
<tr><td>Team 1: A- team</td><td>Team2 : Med-Innov</td></tr>
<tr><td>
Application offering
• Monitoring
• Mobile follow-ups
• Tracking
• Visual analytics</td><td>
Proposed solution to provide information on
• Importance of breastfeeding
• Breastfeeding techniques
• Breastfeeding sitting position
• Breastfeeding reminder
• Diet
• Breast conditions
• Breast hygiene
• Signs of poor breastfeeding
Additional Functions
• Growth monitoring
• Support groups
• Financial support
• Donor funding
• Support link/help desk</td></tr>
<tr><td>Team 3: Tech-Health</td><td>Team 4: Technovators</td></tr>
<tr><td></td><td></td></tr>
</table>

5.3.1.4. Workshop 1: Prototype feedback

The longest session of the day (two hours long) was devoted to the development of prototypes in line with the ideas chosen from the ideation stage. The challenge for the teams was to flesh out their chosen ideas into a format that could be presented to the judges for adjudication. Guidance provided to the teams was that they should focus on mobile technology and each team was asked to suggest the prototype of a solution that could be developed quickly (in no more than four weeks), implemented, and run sustainably with minimal funding.

Each team was provided with "Handout 3: Prototyping", presented in Chapter 4 as Exhibit 3, as well as the "Prototype Mode" guide from the d.school process guide.

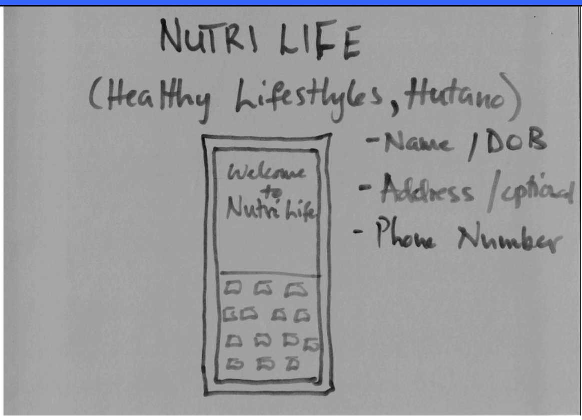
The teams were asked to return to the output of empathy mode, which had been consolidated in the definition mode to help them develop their POV. Teams were asked to identify the services they wanted to offer and match these to needs that had earlier been identified in the definition mode. The players that would influence these services were also identified and matched to the services that were being proposed. In coming up with designs, teams were asked to recall the networks that would affect the deployment of their solutions. The beneficiaries of their services were defined in their POV and teams were reminded to be aware of these in their designs. Finally, attention needed to be paid to institutions of interest, as these were likely to result in the development of interfaces to these institutions' systems.

Figure 51: Tech-Health ask for guidance on their prototype development

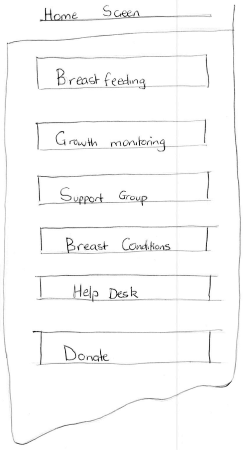
The output expected from this session was a low-fidelity prototype that could be presented to the rest of the team and two senior ICT practitioners that could judge the practically of the solution. Because each non-presenting group served as judges, each solution faced scrutiny from developers and midwives, as well as mothers. Figure 52 shows some of the images produced as part of the prototypes.

Figure 52: Prototype Overviews

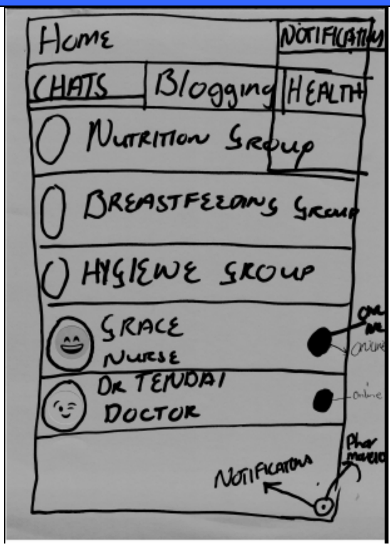
Team 1: A- team



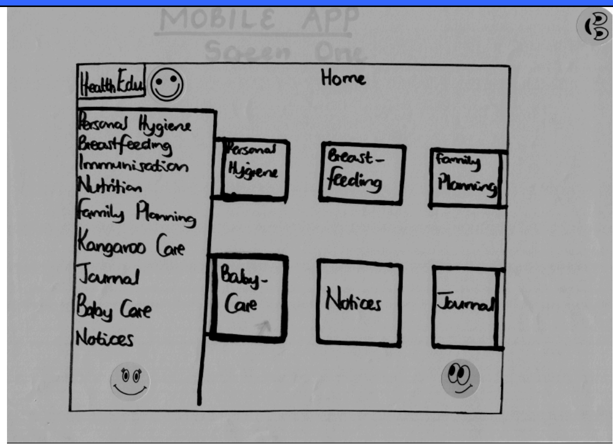
Team 2: Med-Innov



Team 3: Tech-Health



Team 4: Technovators



5.3.1.5. Workshop 1: Testing of the prototypes

Three experienced ICT practitioners joined the group at the end of the day to help in testing the prototypes in a mini-competition. Two of the practitioners were asked to rate the teams individually, while the third joined one of the teams. Each of the three non-presenting teams had its scores averaged and added to the practitioners' scores.

Each team and the ICT practitioners were provided with "Handout 4: Prototype Testing", presented in Chapter 4 as Exhibit 4, as well as the "Test Mode" guide from the d.school process guide.

Guidelines were given to rank the prototypes on two main criteria. Firstly, the judges were asked to rank the teams' prototype on their adherence to the five concepts of SDL as defined in the framework. Successful prototypes would be those whose services met the needs of their main beneficiaries as stated in their POV. Teams would also need to demonstrate that their solution identified and catered for all the necessary players involved in provision of the service. Successful teams needed to demonstrate that they had taken into account networks that would have an impact on the use of their systems while providing for links into any institutions that affected their offerings. Secondly, the teams were judged on the basis of viability, feasibility and desirability.

Teams were given the liberty to present their ideas as slide shows, physical artefacts, flowcharts, storyboards, role-plays or app mock-ups.

5.3.1.6. Workshop 1: Prototype Overviews

Figures 53 to 56 are summary descriptions of the prototypes produced by the four teams. The actual prototypes produced included mock-ups of cellphone screens showing various functions that the proposed solutions would offer.

Figure 53: A-team prototype: Nutri-life

A-Team's solution was called Nutri-life and its functionality was focused on providing mothers with information about nutrition.

The group's POV was stated as:

Chipo needs good nutrition for both herself and baby if she is to remain in good health and raise a healthy, happy baby so that she can feel responsible, happy and caring as a responsible mother and raise her healthy self-esteem.

Their prototype was a mock-up of an application for use by new mothers. The proposed application would be built around four 'tabs':

Tab 1: Tips

- Daily tips for mothers on nutrition

Tab 2: Diet Plan : A daily planner with suggestions for daily meals covering potential sources of

- Protein
- Carbohydrates
- Vitamins
- Minerals
- Fats

Tab 3: Hospital Visit Tracker

- A facility to track hospital visits, with warnings of upcoming visits

Tab 3: Newsfeed

- A facility to deliver local news from the mother's network covering
  - Church news
  - Community news
  - Projects of interest
  - Microfinance

The prototype also provided functionality to register users, requesting them to provide their names, addresses, date of birth and phone number.

The group was unable to provide any information about how the back-office operations of the application would be supported. They also failed to convince the judges that the system could be operated sustainably. The team was unable to explain to the judges how the personal information collected could be used for the benefit of the mother or the child.

Figure 54: Med-Innov prototype
Med-Innov's application was focused on providing mothers with information on breastfeeding. The group's POV was stated as: Anna is failing to understand the importance of breast-feeding and needs education on the importance of breastfeeding so that she feels she is a responsible mother. Healthy baby = happy mother. Their prototype was a mock-up of a mobile app, focused on new mothers to help them with information on breastfeeding. Primary functions included providing information on o Importance of breastfeeding o Breastfeeding techniques o Breastfeeding sitting position o Breastfeeding reminder o Diet o Breast conditions o Breast hygiene o Signs of poor breastfeeding The app provided additional functions for o Growth monitoring (monitored by the hospital) o Support groups o Financial support o Donor funding o Support link/help desk It was explained that the app would be accompanied by a web-based back end application that would be managed by the hospital. Through this application the hospital would be able to provide proactive support by monitoring o Child growth patterns o Contributions/participation on support groups In response to the dire financial conditions of the mothers, the team proposed a platform where mothers in need can launch an appeal for resources and donors could participate in funding mothers directly.

Team Med-Innov presented the winning prototype in the team competition. The team was able to convince the judges that the solution could be developed and deployed quickly and that the solution was likely to be desired by the target users. This was underscored by earning the highest scores from both judges as well as all three adjudicating teams.

The features of the solution that appealed to the judges included

- The completeness of their solution with respect to their POV
- The team's awareness of the institutions for which the service was offered

- The teams awareness of the networks that affected the delivery of services (support groups/donors).

Figure 55: Tech-Health Prototype
Tech-Health presented a solution to access mothers' health information. The group's POV was stated as Janet needs post-natal information so that she feels wanted, cared for and valued and bonds with her baby. . Their prototype was a mock-up of a suite of mobile applications with functionality for mother, nurses and doctors. Their presentation focused on the mothers' application, but they explained that this would be backed up by the nurse and doctor applications, which owing to time limitations they had not explored in depth. Proposed functions were built around the following: Chat Function o To allow mothers to have a one-on-one chat with a nurse/midwife or a doctor Group Discussion Forum o A function allowing mothers to post their experiences and allow discussion with other mothers on the forum Subscription to Information. Mother would be able to subscribe to information on o Nutrition o Breast-feeding o Personal hygiene Personal Health Information Tracking for both Mother And Child o Temperature o Blood pressure o Pulse o Weight Notices o Provision of information of interest from around the community

The team explained that although their presentation was focused on the mother's application, they had considered the back office requirements, including the need for a nurses' and doctors' application. They also explained the need for a back office to monitor the personal health information so that proactive action could be taken if pre-set thresholds were broken.

Figure 56: Technovators prototype

Technovators presented a prototype of an application that would be offered on three platforms. Mothers would have access to the application via a mobile application, a web interface or a USSD interface. The application was focused on providing mothers with continued health education.

The group's POV was stated as

Trish needs health education to make her feel proud of being a responsible, good mother and a good wife.

The team's prototype was built around the following functions:

Primary functions included providing information on

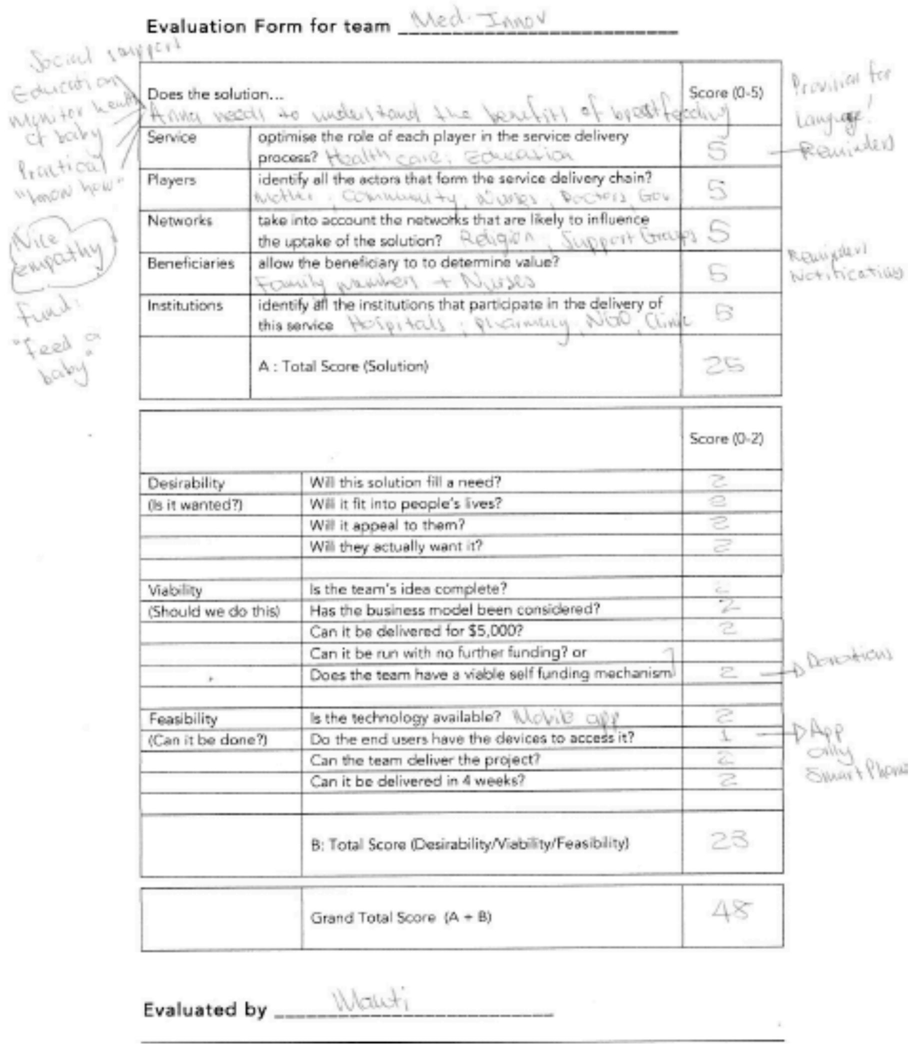
- Personal hygiene
- Breastfeeding
- Immunisation
- Nutrition
- Family planning
- Kangaroo care
- Baby care
- Journal
- Notices

For each of the functions provided for, several topics were covered. For each topic, the application would provide

- A definition
- Hints on how to
- What to avoid

An administration dashboard was proposed as part of a back office application. This dashboard would provide an overview of the mothers on the system, while allowing nurses to review mothers' journal information and to provide notices on issues of interest to the mothers.

Figure 57: Sample evaluation form



Evaluation Form for team Med-Innov

Does the solution…		Score (0-5)
Service	optimise the role of each player in the service delivery process? Health care; Education	5
Players	identify all the actors that form the service delivery chain? Mother, Community, Nurses, Doctors, Gov	5
Networks	take into account the networks that are likely to influence the uptake of the solution? Religion, Support Groups	5
Beneficiaries	allow the beneficiary to to determine value? Family members + Nurses	5
Institutions	identify all the institutions that participate in the delivery of this service Hospitals; Pharmacy, NGO, Clinic	5
	A : Total Score (Solution)	25

		Score (0-2)
Desirability	Will this solution fill a need?	2
(Is it wanted?)	Will it fit into people's lives?	2
	Will it appeal to them?	2
	Will they actually want it?	2
Viability	Is the team's idea complete?	2
(Should we do this)	Has the business model been considered?	2
	Can it be delivered for $5,000?	2
	Can it be run with no further funding? or	
	Does the team have a viable self funding mechanism	2
Feasibility	Is the technology available? Mobile app	2
(Can it be done?)	Do the end users have the devices to access it?	1
	Can the team deliver the project?	2
	Can it be delivered in 4 weeks?	2
	B: Total Score (Desirability/Viability/Feasibility)	23

	Grand Total Score (A + B)	48

Evaluated by Mauti

Table 58: Evaluations

	SM	MG	A Team	Technovators	Tech-Health	Med-Innov	Total
Team							
A Team	34	40		27	20	25	145
Technovators	33	44	29		19	30	155
Tech-Health	27	28	23	23		19	120
Med-Innov	35	48	33	27	24		168
							-

5.3.2. Findings from Design Workshop 1

5.3.2.1. Introduction

The purpose of the design thinking workshop described above was to evaluate the efficacy of the framework for an SDL approach to technology-based innovation using design thinking, as described in Chapter 4. The framework was used to guide the work of four design teams, each one consisting of two mothers, two midwives and two designers. Although the design teams worked in parallel, two facilitators worked with all teams and were able to provide feedback and clarifications on the framework to all teams based on any issues that arose in any other team. The main observations from this testing exercise are documented below.

5.3.2.2. Emotion aids empathy

The empathy session was made up of feedback from research carried out with doctors, midwives and mothers and culminated in three stories of mothers as documented in interviews and journals. This presentation ended on such an emotional note that there were tears in the room and a few people appeared shocked at the quality of care provided to mothers. This set a powerful tone for the rest of the day, ensuring the active participation of all the players. The key lesson from this was that to achieve co-creation that involves the people who are affected in delivering or receiving service, this session must appeal to them so that they feel that they are solving their own problem. According to public value theory (Moore, 2013), the public gains maximum value from those initiatives with which they identify and about which they feel that they have authorised them and participated in them. The observations from this session seemed to concur with the theory.

5.3.2.3. Participants stick to what they know

Although all the members of the teams appeared engaged at all stages of the workshop, it was observed that the mothers appeared more engaged at the start, whereas the “experts” drew from their own circumstances as the empathy input was distilled into a POV. During the definition mode and ideation modes, the midwives became more vocal as they weighed in with their subject matter expertise. As the process moved into prototyping, the members with ICT skills became more vocal with their input.

5.3.2.4. Technology is frightening, but technology capabilities are understandable.

Initially, the technical team members appeared to have solutions in mind by the time a POV was agreed and struggled to walk with the rest of the members in trying to reach consensus on a final solution. It is worth noting that the winning team, which was the one with the most complete solution, had the least domineering technical people and was largely driven by a senior midwife who was part of the team. Team participation in the technology discussion improved drastically when the discussion was redirected from a technology discussion to a technology capability discussion. The least literate of the team members, in most cases the mothers, had ideas about how services could be made more efficient and together with the more technical members were able to find appropriate technology capability to bring about the necessary improvement.

5.3.2.5. Networks influence, institutions participate in service delivery

There was considerable confusion in the group about what was a network and what was an institution. The confusion was resolved by agreeing that networks were those relationships that were likely to affect the actions of participants in the provision and receipt of service, while institutions were those organisations that had a role to play in the provision of services. Thus churches, families and social media were viewed as networks, while the hospital, pharmacy and Ministry of Health were all considered to be institutions.

5.3.2.6. Solutions must adhere to industry rules

During the testing of the various solutions, it was made clear by the medical personnel in the group that no matter how attractive a solution was, it had to abide by industry rules, especially in the medical sector. Industry rules included legislation and guidelines on service provision as proposed by world bodies such as the WHO, as well as local rules set by the hospital. Similarly, ethics played a major role in guiding practice in the health sector. While it was possible to challenge these, it was explained that extensive research on the efficacy of such changes would need to be undertaken. Industry rules are a presentation of institutions and institutional arrangements as described in Axiom 5 of SDL (Vargo & Lusch, 2016).

5.3.2.7. Validity and utility of the framework

The framework was successfully used in the development of four prototype solutions. Aherence to the framework varied among teams, but the solution that was deemed most useful by the group appeared to respect the guidelines provided by the framework. Because of their adherence to the framework, the team ensured maximum participation by team members and produced a solution that the judges deemed most comprehensive and in line with their POV. By paying attention to the framework, the team also applied their minds to the ecosystem around the application, making it more applicable to the beneficiaries. Reference to the technology capabilities provided as part of the framework allowed members to explore several technology options that were incorporated into their eventual solution.

5.3.3. Framework Revision 1

The lessons learnt from observations and feedback from the design teams was used to enhance the framework and process. Two major changes resulted from the work undertaken in the first workshop. The first change had an impact on the framework itself, with the introduction of an additional construct in the form of industry rules, which needed to be taken into account in the testing of solutions. The second change was the introduction of templates, with the intention of streamlining and focusing the design process.

5.3.3.1. Summary of Findings from First Testing

The first workshop to evaluate the efficacy of the Technovation Framework resulted in a number of findings, as listed in Table 59. An emotional connection between the design team and the empathy material presented resulted in highly engaged teams that felt they were solving personal problems, even though most of them were not affected by the circumstances that resulted in the plight of the subjects described in the empathy session. The presence of some of these subjects also helped to bring home the reality of their situations.

Table 59: Lessons from the First Testing Cycle

Finding	Learning
Emotion aids empathy	Empathy output must resonate with designers to maximise engagement
Participants stick to what they know	Participants must be encouraged to participate in all aspects of the design in order to maximise their influence on the output
Technology isfrightening , but technology capabilities are understandable.	Focus on technology capabilities rather than technology itself encourages participation by non-technologists
Networks influence, Institutions participate in service delivery	The distinction between networks and institutions must be made clear
Solutions must adhere to industry rules	Solution testing must include consideration of the rules that relate to the industry in question

While all participants in the workshop were found to be engaged during the empathy-to-definition transaction, the non-technical participants gradually fell silent as the discussion moved into ideation and was dominated by the technical players, despite the provision of guidelines, which could have been used by all the team members. A change was required that would enable all members to participate in the ideation despite having limited technical skills. All teams struggled to distinguish between networks and institutions and it was felt that prior clarification was required in order to allow teams to develop appropriate designs. Finally, the evaluation of solutions needs to take into account the rules that govern the industry for which the solution is being designed. This necessitated a change to the framework as well as the process.

5.3.3.2. Technovation Framework CF_1

The main change proposed to the Technovation Process relates to the introduction of an industry rules filter during the evaluation process. While service innovation is focused on improving how services can be offered, this must be done within the rules of the industry at which the solution is aimed. Industry rules include legislation, ethical practices and industry guidelines. Legislation includes laws governing the delivery of services themselves as well as those governing the handling of data, privacy, confidentiality, disclosure and the general security of information and its access. Ethical practices are unlikely to be reduced to law but will in most industries be inculcated as part of professional training. Industry guidelines are issued by governing bodies as well as standards associations and will in many cases be issued as recommendations for best practice. Examples of these would be WHO guidelines or ISO for best practice. A summary of industry rules is presented in Table 60.

Table 60: Concepts behind Industry Rules

Concept	Examples
Ethics	Moral principles that govern a person's behaviour or the conducting of an activity
Guidelines	General rules, principles of pieces of advice
Legislation	Laws regarding the conduct of services as well as the collection, processing, storage and dissemination of data
Standards	A required or agreed level of quality or attainment.

5.3.4. Changes to Technovation Process

The major change to the Technovation Process from the last iteration was the introduction of templates for capturing data through the process.

5.4. Design Thinking Workshop 2: The Margaret Project

5.4.1. Design Workshop 2: Introduction

The second design thinking workshop was a low-key event compared to the first. Participants in the workshop included a midwife, a developer and a designer, as well as the facilitator. All the participants were experienced practitioners in their fields. The workshop was conducted in a normal restaurant setting with few of the props that were used in the first workshop. The objectives of the second workshop were to:

1. Test the efficacy of the Technovation Process using templates as proposed at the end of the first design cycle;
2. Test the industry rules construct as proposed in the first cycle.

The team was given access to the same empathy input as the larger group that formed part of the first workshop. The researcher walked the development team through the Technovation Process then asked them to go through the templates based on their understanding of the empathy input. The researcher was available throughout the design session to provide clarifications as well as to observe the team. The output of this workshop is presented in this section, while the output spread sheets are in Appendix I.

5.4.1.1. Workshop 2: Empathy feedback

In the first workshop, a presentation of the highlights was made to the design group consisting of four teams. In this design cycle, the design team was given access to the empathy write-up presented in Section 5.2 in its entirety a day before the workshop. The empathy input in the first design cycle turned out to be richer, as the presence of both mothers and nurses meant that additional perspective was derived from their participation. The role of nurses, for example, was clearly enhanced through better understanding of the exercise by the nurses and the mothers. In this session, there was little in the way of additional insight from the team, even though a midwive was part of the design team.

5.4.1.2. Workshop 2: Definition feedback

The templates that were developed as part of the second version of the revised Technovation Process were designed to faciliatate the process of transitioning from one mode to the next. A header worksheet presents basic information about the project. The empathy-definition spread sheet (Figure 58) summarises the empathy input. During the second design workshop, the design team was asked to identify all the service offerings as presented in the empathy input. For each of the services offered the team was asked to identify the components of a service ecosystem, such as who the players/actors were in the provision of service, who the beneficiaries were, the institutions that participated in service delivery, as well as the networks that affected service delivery. The team was asked to identify unmet needs and repeat the process of associating them with the components of the service ecosystem for each potential service identified and to identify potential improvements for each of the services identified. All the fields of the empathy-definition transition spread sheet were free form fields. The fields highlighted in orange were carried over from the header worksheet.

Figure 58: Extract from empathy-definition template: Workshop 2

Project Name :	The Margaret Project
Date :	5-Sep-17

	Services	**Beneficiaries**	**Actors**	**Institutions**	**Networks**	**Improvement possible?**
	What services are offered?					
1	Hsp Mother physiological examination	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
2	Hsp Baby Examination	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
3	Hsp HIV Education and counselling	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
4	Hsp Initiation of baby on breast	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
5	Hsp Monitoring mother	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
6	Hsp Monitoring baby	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping

The team identified current services, which were classified into four groups. Hospital services [Hsp] were identified as those services that are offered in the hospital. These services included physiological and psychological examination, monitoring and taking care of the mother and baby. Hospital services also included education, counselling and administering of drugs as required. Services offered at the three-day visit [3D] included physiological and psychological examination of the mother and a baby check. The seven-day visit service [7D] was also to check the growth of the baby. This was also done at the six-week [6W] visit, along with immunisation of the baby.

Table 61: Services Identified from Empathy Input: Workshop 2

Current services offered	Needed services not offered
Hsp Mother physiological examination	Hom Monitoring mother
Hsp Baby examination	Hom Monitoring baby
Hsp HIV education and counselling	Hom Mother attention
Hsp Initiation of baby on breast	Hom Baby attention
Hsp Monitoring mother	Mobile bill payment
Hsp Monitoring baby	
Hsp Administration of BCG	
Hsp Mother psychological evaluation	
Hsp Mother education	
Hsp Mother attention	
Hsp Baby attention	
3D Mother physiological examination	
3D Mother psychological evaluation	
3D Baby check	
7D Baby check	
6W Baby check	
6W Immunisation	

The team also identified services that were currently not being offered but that the mothers needed, eg remote monitoring and attending to the mother and baby at home, as well as a mobile payment facility. The services on offer and those required but not on offer are summarised in Table 61.

The ecosystem for service delivery was identified as being built around the mother who was seen as the main beneficiary of service. The actors involved in the provision of service were identified as midwives, doctors, social workers, pharmacists and the finance team with which they interacted at the hospital. These actors were identified as being part and parcel of the institutions providing service, these being the hospitals, the clinics and pharmacies. Major networks identified included the family, church and social media.

The team was also asked to highlight if they felt that a current process could be improved through the use of technology, or if technology could be used to make a new process more efficient. The focus at this stage was on whether improvement was possible, and in what area. The team was not pressured into explaining how this improvement would be applied. The "Improvement Possible" column associated with each service was used to document their ideas. The most frequently highlighted improvement was in the area of record-keeping, which the team associated with 21 of the 22 services identified. For services that required mothers to travel to the hospital or hospital staff to travel to the mothers, the team identified advance booking as an area in which technology could be used to bring about improvements. Remote monitoring and remote payments were also seen as possibilities for improvement.

Figure 59: Extract from definition-ideation template: Workshop 2

Project Name :	The Margaret Project
Date :	5-Sep-17

We can improve the life		
mothers	providing them with easier access to medical services	to become better mothers

After analysing and debating the nature of the services, the user needs and the ecosystem around them, the team was able to formulate a POV. The template for this is presented in the definition–ideation transition spreadsheet (see Appendix I), an extract of which is shown in Figure 59. As in the first workshop, the design team was asked to reduce their POV to a statement following the syntax:

> "We would like to help X by providing a service Y that would allow them to be a better Z."

The team's POV was stated as:

“We can improve the lives of mothers by providing them with easier access to medical services to allow them to become better mothers.”

5.4.1.3. Workshop 2: Ideation Ffedback

The main input of the ideation mode was the POV. Using this statement as a guiding principle for their design, the team was asked to formulate ideas of how they could achieve the improvement they proposed to bring into the lives of mothers. To help guide their thinking, the ideation-prototype transition worksheet was used. In this spreadsheet, the services identified in the transition from empathy-definition were pre-populated (shown in orange in Figure 60) on a spreadsheet together with the initial ideas for improvement. For each service, the team was asked to identify potential technology opportunities. This was effected through a dropdown menu next to each service offering. The team could choose up to three technology opportunities associated with each offering. The drop-down options were drawn from the same technology opportunities table presented in Table 56 as part of the first workshop.

For each selected technology opportunity, the team had to provide a technology capability that could deliver this improvement. This was effected through a dropdown menu based on the same technology capabilities presented in Table 57 in the first workshop.

Figure 60: Extract from ideation-prototype spreadsheet: Workshop 2

Project Name :	The Margaret Project
Date :	5-Sep-17

	Services	**Improvement possible?**		**Improvement**		**Capability**		**Improvement**		**Capability**
	What services are offered?									
1	Hsp Mother physiological examination	Record Keeping		Easier		Knowledge Management		Convenience		Tracking
2	Hsp Baby Examination	Record Keeping		Easier		Knowledge Management				
3	Hsp HIV Education and counselling	Record Keeping								
4	Hsp Initiation of baby on breast	Record Keeping		Easier		Knowledge Management				
5	Hsp Monitoring mother	Record Keeping		Easier		Knowledge Management				
6	Hsp Monitoring baby	Record Keeping		Easier		Knowledge Management				

The team’s ideas appeared to focus on offering the mother convenience and making it easier for her to access services through the use of technology. The three technology capabilities that were most commonly highlighted were knowledge management, tracking and imaging.

5.4.1.4. Workshop 2: Prototyping feedback

The main task of this exercise was to go through the defined services and start building a solution offering services consistent with the defined POV. The team was encouraged to start thinking about technology that could be used to deliver the identified technology capabilities associated with the services.

The main output of this exercise was the prototype definition described in Figure 61.

Figure 61: The Margaret project prototype

This is an overview of the system proposed by the Margaret team.

The group's POV was stated as:

We can improve the lives of mothers by providing them with easier access to medical services so that they can become better mothers.

The prototype is a combination of a web-based application for use in hospitals and clinics, together with a mobile-based application for use by the mother. The team proposal is for an education campaign to accompany the launch of the system so that the issues concerning the social networks that affect mothers' access to medical services are addressed.

The proposal is for a number of applications for use by different stakeholders involved in post-natal care services.

1. A web-based application for use by the hospital/clinic/doctor with tracking of the following:
   a. Mandatory service record (keep track of who provided service, when and what they observed)
      Physiological assessment of mother
      Psychological assessment of the mother
      Checking baby condition
      Initiation of breast feeding
   b. History of ad hoc service provided in the hospital
      What service was provided, by whom, what was observed, what drugs were administered
   c. Mandatory 3D check
      Who attended to the mother/child, observations, treatment if any
   d. Mandatory 7D check
      Who attended to the mother/child, observations, treatment if any
   e. Mandatory 6W immunisation
      What service was provided, by whom, what was observed, what drugs were administered
   f. Scheduling application for mothers' visits
   g. A facility to proactively poll mothers on their health

2. A mobile application for mothers' use
   a. Record of all services offered by hospital, clinic or doctor involved in the service provision
   b. A facility to schedule visits to the hospital with image-sending feature
   c. A facility to request services with feature to send images
   d. An information channel that provides educational information for mothers
   e. A facility to respond to poll request on mother/child health from hospital

The system proposed by the team was a combination of a web-based application for use in the hospitals and in clinics, together with a mobile-based application for use by the mother. The team also proposed an education campaign to accompany the launch of the system so that the issues concerning the social networks that affect mothers' access to medical services are addressed.

The proposed web-based application would allow the hospital to maintain a record of all service interaction with mothers in the hospital and after discharge. It would also allow the mothers to access help at other institutions, such as clinics and private surgeries that would also have access to the system. The application would allow the health system to determine any lapses in attention to the mother and baby and provide corrective action as required. It would allow the mothers to pre-schedule visits to the hospital and allow the hospital to poll mothers proactively on health issues. The mothers' mobile application would allow mothers to contact the hospital to seek assistance and interact with nurses and doctors without needing to travel to the hospital.

5.4.1.5. Workshop 2: Testing feedback

The testing of the prototype was undertaken as a self-evaluation exercise in which the team evaluated their prototype against the requirements that had been built up from the empathy, definition, and ideation modes. The team was also challenged to examine if their solution met the industry rules as defined by the framework.

For each of the services identified, the team went through a yes/no/limited checklist. A "Yes" indicated that the solution fully met the requirement as expected at the definition stage. A "Limited" response meant that the solution would only partly meet the requirement, while a "No" indicated that this would not be provided in the solution. For each "Limited" or "No" response, the team was asked to provide an explanation of how this would be satisfied once the solution was implemented. An extract of this spreadsheet is shown in Figure 62.

Figure 62: Extract from Prototype – Testing Spreadsheet : Workshop 2

Project Name :	The Margaret Project
Date :	5-Sep-17

		Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the		Is this service consistent with POV as per definition mode?	
	Services	**Benefit:**		**Actors**		**Institutions**		**Networks**		**POV**	
	What services are offered?										
1	Hsp Mother physiological examination	Mother	Yes	Midwife, Doctor	Y es	Hsp, Clc	Y es	0			Yes
2	Hsp Baby Examination	Mother	Yes	Midwife, Doctor	Y es	Hsp, Clc	Y es	0			Yes
3	Hsp HIV Education and counselling	Mother	Yes	Midwife, Doctor	Y es	Hsp, Clc	Y es	0			Yes
4	Hsp Initiation of baby on breast	Mother	Yes	Midwife, Doctor	Y es	Hsp, Clc	Y es	0			Yes
5	Hsp Monitoring mother	Mother	Yes	Midwife, Doctor	Y es	Hsp, Clc	Y es	0			Yes

5.4.2. Findings from Design Workshop 2

The output of the workshop is presented in the form of the filled-in templates that were produced by the team, presented in Appendix I.

5.4.2.1. Efficacy of the Technovation Process

The second design session was relatively quick as opposed to the first set of design sessions. Part of the reason for this may have been that the empathy input was provided in advance of the workshop session so the participants were familiar with the input. The two technologists were a very experienced systems analyst and a mobile application developer. Having reviewed the input prior to the session, the developer suggested some ideas of what a mobile application would be like. These were discarded to allow the team to focus on the process. This finding was consistent with the first workshop where developers immediately wanted to proceed to a solution as soon as they felt they understood the problem. Another reason for the quick process may have been that the design team was smaller and therefore more focused on the task at hand.

The use of templates allowed for a more controlled process that allowed the team to progress rapidly through the exercise. The initial approach to ideation taken by the team was generally to discuss potential opportunities for improvement before selecting the appropriate option from the dropdown menu. As the process progressed, the team members appeared to switch to the reverse process, looking for a potential opportunity on the list and discussing it within the team.

5.4.2.2. Industry rules

A discussion was held on the industry rules; the team felt that these rules were dependent on the knowledge of the design team. The team was of the opinion that as part of the initial information-gathering prior to the start of a design workshop, all the industry rules should be catalogued and a table should be presented. The design team would then apply their minds to ensure that these rules were being adhered to by their solution.

5.4.2.3. Participation of beneficiaries

The team felt that the absence of beneficiaries did not influence their understanding of the empathy input. Team members also felt that the role of beneficiaries was important during empathy building but beyond that, their role was limited. The only involvement of beneficiaries was likely to be during the testing mode. Participants felt that this could be achieved through field-testing in addition to their own evaluation of the proposed solution.

5.4.3. Revisions to the framework

There were no further changes to the framework after this workshop.

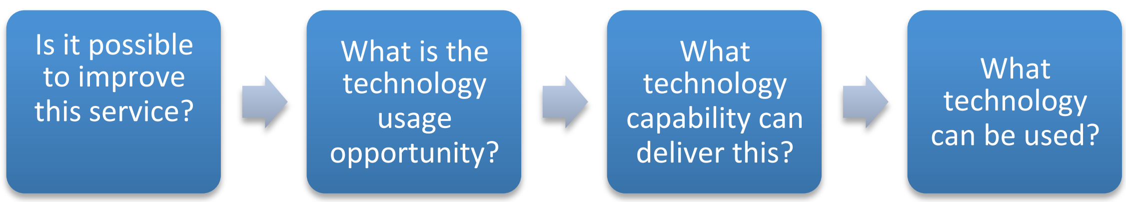
5.5. Design Thinking Workshop 3: Post-natal Healthcare Reloaded

5.5.1. Design workshop 3: Introduction

No further changes were made to the Technovation Process after the second workshop. The same version of the process was tested on 12 September 2017, using a single design team consisting of two midwives and two developers. The developers were given access to the same empathy input as the larger group that formed part of the first workshop, prior to the workshop itself. The researcher walked the development team through the Technovation Process, then asked them to go through the templates based on their understanding of the empathy input. The researcher was available throughout the design session to provide clarifications, which clarifications were noted in addition to observation of the team.

The main objective of this iteration was to test the effectiveness of the Technovation Process in extending the technology capabilities into actual technology options. In briefing the design team, the facilitator emphasised the need to extend the proposed solution to cover possible technology implementation. The process illustrated in Figure 63 was followed in getting to the technology possibility.

Figure 63: Technology exploration process



5.5.1.1. Workshop 3: Empathy feedback

As in the second workshop, the design team was given access to the empathy write-up presented in Section 5.2 in its entirety a day before the workshop. Unlike the first design cycle, and similar to the second cycle, there were no further additions to the empathy input with the team focusing on the input provided.

5.5.1.2. Workshop 3 : Definition feedback

The first part of the workshop focused on the analysis of the empathy input, resulting in the output summarised in Appendix J, with an extract shown below in Figure 64 and reproduced in Table 62.

The team identified 13 current services, which included examination of mother and child at birth, administration of drugs and care in the hospital. The team also identified 20 requirements that they felt were essential for the provision of good post-natal care. Some of the requirements appeared to be channels as opposed to services and included call centres, health outposts and communication channels. The team identified a number of enabling services that were not directly aimed at mothers or their babies but at those who offered them services. These included training of those in the patient's support system and their continued education. The team also identified the sharing of information among service providers as a requirement; this was a requirement all the other teams had accepted as essential, but had not explicitly stated.

Figure 64: Extract from empathy-definition template: Workshop 3

Project Name :	Postnatal Healthcare Reloaded
Date :	12-Sep-17

Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
What services are offered?					
Vaccination	Baby	Midwives	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Infant health checkup	Baby	Midwives	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Information dissemination	Mother	Midwives	Hosps, Clinics	IF, EF, NF, RG	Remote communication.
Day to day advice	Mother	IF, EF, NF, RG	Hosps, Clinics	IF, EF, NF, RG	Communication
Child day care	Mother, Baby	Father, IF, EF, NF	Hosps, Clinics	IF, EF, NF	Education
Baby feeding	Mother, Baby	Mother, Father, IF, EF		IF, EF, NF	Education
Diagnosis	Baby	Midwives, Doctors, IF, EF, NF	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Medication	Mother, Baby	Midwives	Hosps, Clinics, Pharmacies	IF, EF, NF, RG	Record keeping
At birth medical examination	Mother, Baby	Midwives	Hosps, Clinics	IF	Record keeping

EF = Extended Family
IF = Immediate Family
RG = Religious Groups
NF = Neighbouring Families

Although most of the other design teams identified the mother and baby as primary beneficiaries of service, this team also identified the father as a primary beneficiary. In some cases the team also treated the immediate and extended family as beneficiaries of service. The team felt that the actors responsible for service delivery extended beyond the doors of the institutions at which services were offered, a position that differed from that of the other teams. Actors were thus expanded beyond midwives and doctors as identified by the other teams, but also included families and neighbours. The same actors, consisting of family, neighbours and religious groups, were identified as being part of the network that influenced how service was delivered. The approach taken by this team seemed to indicate that they believed that a symbiotic relationship existed between the different players, allowing them to feed off each other at different times.

Table 62: Services Identified from Empathy Input: Workshop 3

Current services offered	Needed services not offered
Vaccination	Home visits
Infant health checkup	On-demand advice
Information dissemination	Appropriate transport
Day-to-day advice	Financing
Child day care	Psychological health monitoring
Baby feeding	Reporting/feedback
Diagnosis	Training of primary health support system (friends and family)
Medication	Counselling
At birth medical examination	Direct communication between hospital and patient
At birth psychological and risk evaluation	Support system education
At birth counseling	Medication adherence monitoring
Emergency healthcare at major hospitals	Medical record-sharing across health service providers
Birth records	Prioritisation and streamlining of resource allocation
Vaccination	Educational outreach
	Healthcare outposts
	Hospital call centres
	Child day care (alleviate mother's duties and allow her to rest)
	Remote diagnostics
	Accessible communication channels
	Remote appointment system or similar outpatient wait time limiting system

Suggested improvements to service delivery were in record-keeping, education/training, remote communication and the maintenance of electronic health records. With this identification of the service network around post-natal care and the potential improvements identified, the team came up with a multi-pronged POV.

Figure 65: Extract from definition-ideation template: Workshop 3

Project Name :	Postnatal Healthcare Reloaded				
Date :	12-Sep-17				
We can improve the life					
of	Jane and her family	by (doing)	1. Providing a unified electronic health record for her newborn baby, that can be shared and used by many different health practitioners. 2. Improve access to information on postnatal care. 3. Improve ability for mothers to communicate with Midwives.	to enable	her to receive better health care from the health system

The team's POV as stated in Section Figure 65 was:

"We can improve the life of Jane and her family by

i. Providing a unified electronic health record for her new-born baby, which can be shared and used by many different health practitioners.
ii. Improving access to information on post-natal care.
iii. Improving the ability for mothers to communicate with midwives.

To enable her to receive better healthcare from the health system."

5.5.1.3. Workshop 3: Ideation feedback

A comprehensive ideation exercise resulted in many potential technology opportunities, as illustrated in Figure 66 (full worksheet is provided in Appendix J). Based on their analysis of the services and proposed services, the team felt that the technology opportunities were to bring more convenience to the mothers, reduce redundancy in the storage of information and make processes cheaper and faster. They also identified opportunities to make processes more flexible and give the mothers privacy.

Figure 66: Extract from ideation-prototype spreadsheet: Workshop 3

Project Name :	Postnatal Healthcare Reloaded
Date :	12-Sep-17

Services	**Improvement possible?**		**Improvement**		**Capability**		**Improvement**		**Capability**		**Improvement**		**Capability**	**What Technology can make this happen**
What services are offered?														
Vaccination	Record keeping		Convenience		Knowledge Mgt		Easier		Geographical					Firebase cloud storage, Mobile app
Infant health checkup	Record keeping		Convenience		Mobility		Flexibility		Mobility		Faster		Sequential	Firebase cloud storage, Mobile app
Information dissemination	Remote communication		Convenience		Geographical		Less Redundancy		Automation					Firebase cloud messaging, Mobile app, SMS
Day to day advice	Communication		Less Redundancy		Automation		Convenience		Mobility		Easier		Artificial Intelligence	Firebase cloud messaging, Mobile app, SMS
Child day care (	Education		Cheaper				Easier							Mobile app, Scheduling system
Baby feeding	Education													Firebase cloud storage, Mobile app
Diagnosis	Record keeping	We can make this	Faster	Through this cap	Artificial Intelligence	We can make this	Convenience	Through this cap	Geographical	We can make this	Cheaper	Through this cap	Imaging	Chat bot, Wit.ai, Mobile app, smartphone camera

The team felt that analytical capabilities could be applied to help healthcare workers in the allocation and prioritisation of resources, while automation could be applied in responding to mothers' day-to-day queries. Cloud computing technology was proposed for sharing of medical information by multiple providers. Disintermediation technology capability was proposed to allow mothers direct access to a reporting platform to update their babies' information. Geographical positioning capability was proposed to help health staff in following up mothers for aftercare. Imaging capability was proposed to help health staff to diagnose ailments in the case of remote care being provided by the hospital. Information management capabilities were proposed to help manage the large amounts of information that would be generated across the service delivery process. Mobility capabilities were proposed to provide a convenient way for mothers to access healthcare while also providing capability for healthcare staff to offer services on the move. Social media capabilities were proposed to help in establishing a platform for mothers to share experiences.

Challenged to identify the potential technology that could be employed to deliver the technology capabilities, the team proposed elements of Firebase technology, a mobile and web application development platform owned by Google Inc. for most of the technology components.

5.5.1.4. Workshop 3: Prototyping feedback

The prototyping began with identifying potential technologies for each of the capabilities proposed, as shown in Figure 67. Firebase technology was proposed as the standard solution for messaging and cloud storage. The team also proposed to develop mobile applications around the same platform and couple it with SMS messaging for customers with no access to mobile phones.

A comprehensive solution was proposed and is described in full in Figure 67.

Figure 67: Post-natal healthcare reloaded prototype

This is an overview of the system proposed by the Post-natal Healthcare Reloaded Team.

The team's POV was stated as

Jane and her husband have just had a new baby. The baby was delivered at a public hospital and from the moment the child was delivered, through the first eight weeks, they would face challenges keeping themselves and their baby healthy and connected to all stakeholders that can assist them to achieve this with ease, affordability, convenience and accuracy.

Actors

The healthcare effort will comprise several human participants working together to maintain the health of the baby and its parents, The following are the key participants that will interact with the proposed solution and need to be coordinated and exchange information:

- Healthcare professionals. Midwives, nurses, doctors and community health workers.
- Baby's parents
- Baby's parents' immediate family. Parents and siblings.
- Baby's parents' extended family. Aunts, uncles, cousins and grandparents.
- Baby's parents' neighbours and friends.

- Baby’s parents’ religious groups.

(cont)

Beneficiaries

The primary aim of the proposed solution is to keep the baby and its parents in the best possible physical and psychological health during these trying first eight weeks after birth:

- Baby
- Baby’s father
- Baby’s mother

Data

The solution will have to have to offer the ability to accept, store, process and communicate different types of health data. The following is a list of key data that the solution has to be able to handle:

- Infant’s digital health record. A health record that can be updated and viewed by all healthcare professionals on examination or treatment of a baby. The health record contains all information currently carried on the government-issued health card, as well as a full history of examinations, vaccinations and treatments carried out.
- Infant’s digital birth record. A digital record issued before a mother is released from the hospital. The document may be used to obtain a birth certificate.
- Activity and care log. An activity log to be updated by an infant’s caregivers. This will include daily updates on the infant’s health and wellbeing, feeding habits and any other issues pertaining to the day-to-day activities of the infant and the infant’s parents. The psychological and physical health of the infant’s parents will also be recorded on this log.
- Diagnostic information. This will be information submitted in a request for a diagnosis on a health issue pertaining to the infant or the infant’s parents. It may carry video or audio recordings, images and text descriptions.
- Courses. Instructional courses that carry educational material and tests that may be completed for various caregiver certifications.
- Informationals. Articles containing educational material, tips, advice and announcements pertaining to any health subjects.
- Conversations. Messages and strings or communication between and among various stakeholders involved in the care of the infant and the infant’s parents.

Solution

The solution will be a system of apps and software interacting with actors and data. The following types of data are what the researcher has identified to be key to seamless coordination or the various parties involved in maintaining health. It should consist of the following software and applications:

<u>1. A caregiver mobile app</u>

A mobile app to be used by the baby’s caregivers, i.e. members of the family and the family’s immediate support system, which includes the following:

- The baby’s mother
- The baby’s father
- The baby’s parents’ extended family
- The baby’s parents’ friends and neighbours
- The baby’s parents’ religious group members

This mobile app will serve the following purposes

- Allow the baby’s mother to record daily progress and activities in the care of the baby
- Record the mother’s breastfeeding and other feeding habits
- Record the child’s growth
- Record the mother’s health, psychological and social wellbeing
- Record the father’s health, psychological and social wellbeing
- Access information, advice and tips from midwives
- Ask any health-related questions and get responses expediently
- Receive information and training content as they are produced by midwives
- Communicate with and report to midwives as they check in for regular updates
- Book appointments at the hospital ahead of hospital visits
- Provide automated diagnosis on non-critical health issues
- Provide reminders to take medication to promote adherence
- Provider reminders for vaccination days to prevent any missed vaccinations
- Two-factor authentication, to allow the infant’s parents to give consent to every request to view the infant’s health record by a healthcare professional
- Allow the mother to request a babysitter at a set time and for her friends and family to volunteer to look after the baby if they are free at the said time.

(cont)

To allow for as much accessibility as possible, i.e. for the app to be usable by as many people as possible from as many different socioeconomic backgrounds as possible. To achieve this the app must have the following capabilities:

- Simple and clean user interface and user interactions that are easy to understand and use
- Available and multiple vernacular languages
- Internet-enabled to allow real time communication
- Ability to perform simple network tasks by falling back on SMS in cases where data are expensive or unavailable.

To achieve the app's main objectives, it will have the following functionality:

- Informationals. Articles carrying information educate the caregivers on how to take care of the baby, baby's mother's and baby's father's physical and mental health.
- Training courses. Training courses to be completed by caregivers, including topics such as how to carry a baby, how to feed the baby, how to communicate with the baby's parents and be mindful of their psychological health in this potentially stressful period. The courses will contain tests and soft certifications that are awarded to caregivers on completion of the courses
- Remote diagnosis. A remote diagnosis functionality that allows video, audio and image capture and text descriptions. The remote diagnosis feature will connect to a server that can screen non-critical cases using artificial intelligence as a means to minimise load on the midwives, doctors and nurses, but forward potentially critical cases to a human health practitioner to evaluate the case further and recommend treatment or a visit to a clinic or hospital
- An activity log. An activity log to record all important aspects of the baby's and baby's parents' development. The baby's parents will record such activities as feeding habits, bowel movements, baby's responsiveness and general wellbeing, treatments and medications taken. The activity log will also record the health and well-being of the baby's parents, both physical and psychological health, as a way to identify possible cases of insufficient support systems for the baby's parents and any risk of postpartum depression. Caregivers other than the baby's parents will also be able to record their own observations to allow for external monitoring and promote community engagement in the wellbeing of the baby and the baby's immediate family.
- A conversational interface to allow for conversations between the caregivers and healthcare professionals (e.g. midwives). These conversations will be initiated by midwives and regular checkup intervals and may also be initiated by caregivers when they have concerns or trouble or request information
- A babysitter request interface where a mother can request a volunteer to look after her baby while she gets some rest or attends to other issues. The mother sets a time and date and a notification is set out to all her connected caregivers; any one of them can volunteer to take care of the baby at the said time if they are available to do so.

<u>2. A healthcare professional app</u>

A mobile app to be used by midwives, nurses or doctors to monitor information on patients and interact with patients or provide information to be sent out to all, some or specific patients.

The information available for each baby will comprise

- A complete medical record updated by all healthcare professionals as they attend to a baby, including all information currently viewable on an infant's health card, a complete medical history of the infant
- Child care progress as it is reported by the infant's caregivers using the caregivers' app

To achieve full interaction and seamless health support, the app will have the following functionality:

- Interfaces to view the infant's health record
- Interfaces to view progress information on the baby and baby's parents as submitted through the caregivers' app
- Interfaces to create and distribute information to caregivers using the caregiver's app
- A conversational interface to communicate directly to the baby's mother and other caregivers
- An interface to update the infant's medical record after examination, vaccinations or treatments
- An interface to produce diagnostic information as submitted by a baby's caregiver if the artificial intelligence diagnostic engine has deemed it potentially critical
- Possibility to view appointments made by caregivers to visit the hospital so as to improve scheduling and minimise hospital wait times.

<u>3. An automated diagnostics artificial intelligence bot</u>

The bot will be the first responder when a caregiver submits diagnostic information through the caregiver's app. The bot will recommend care approaches and non-prescription treatments to any cases that it deems non-critical and recommend a visit to the nearest clinic. On cases that it is unable to resolve or deems potentially critical, it will forward the conversation to a healthcare professional (midwife), who can view the information and make recommendations based on that.

The primary purpose of the of the bot is to minimise load on healthcare professionals so that they can spend more time on more important issues while the caregivers still get the information they need to solve simpler issues

(cont)

4. Automated appointments and hospital visit scheduling service.

A service that will receive requests for outpatient hospital visits and recommend best possible dates and times for the caregivers to visit the hospital with the infant could have great utility. This service will use data collected on outpatient visits, evaluating busy times and the relative availability of midwives, nurses and doctors to attend to patients so as to minimise the waiting time for patients visiting the hospital.

The scheduling service also accepts scheduling requests by healthcare workers for community outreach programmes, road shows and door-to-door visits, ensuring that healthcare workers only plan to visit a patient's home at a time they will be at home and plan community programmes at times that promote the highest possible attendance.

To achieve this, this service will carry the following functionality:

- Data analysis. It will analyse data on hospital visit trends and behaviours to manage outpatient traffic.
- Hospital visits appointment scheduling. Accept a request for a hospital visit by a caregiver through the caregiver app and recommend a date and time to visit the hospital.
- Door-to-door visits appointment scheduling. Accept a request by a healthcare professional to visit a patient's home. The request is generated from the healthcare professional's app and accepted by the mother or father of the baby through the caregiver's app.
- Community outreach appointment scheduling. Accept a request by a healthcare professional to conduct a community outreach programme such as a road show. The request is generated from the healthcare professional's app and caregivers in the community can mark their intent in attendance through the caregivers' app.

Limitations

The proposed solution manages to solve many critical issues but owing to some technological and logistical constraints, some problems remain out of reach of the proposed solution.

The limitation associated with the solution largely stems from the question of finance, which the researcher has excluded from the solutionThe following problems are directly affected by financing and are consequently excluded from the solution:

- Transportation.
- Medication.

5.5.1.5. Workshop 3: Testing feedback

A self-evaluation of the solution indicated that the solution could meet most of the requirements as understood from the empathy input. In a number of areas, the team felt that the solution would only provide limited functionality for the requirements. An extract of this evaluation is provided in Figure 68.

Figure 68: Extract from Prototype – Testing Spreadsheet: Workshop 3

Project Name :	Postnatal Healthcare Reloaded							
Date :	12-Sep-17							
	Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the	
Services	**Benefit:**		**Actors**		**Institutions**		**Networks**	
What services are offered?								
Vaccination	Baby	yes	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Infant health checkup	Baby	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Information dissemination	Mother	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Day to day advice	Mother	Y	IF, EF, NF, RG	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Child day care (watching a child while mom is resting or incapacitated)	Mother, Baby	Y	Father, IF, EF, NF	Y	Hospitals, Clinics	Y	IF, EF, NF	Y
Baby feeding	Mother, Baby	Y	Mother, Father, IF, EF	Y	0	Y	IF, EF, NF	Y
Diagnosis	Baby	Y	Midwives, Doctors, IF, EF, NF	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Medication	Mother, Baby	L	Midwives	L	Hospitals, Clinics, Pharmacies	L	IF, EF, NF, RG	L

5.5.2. Findings from Workshop 3

The output of the workshop is presented in the form of the filled-in templates that were produced by the team (Appendix J). The team itself evaluated the prototype through an evaluation form provided as part of the template.

The solution proposed was significantly more comprehensive that any of the prototypes presented before. The solution catered for multiple instances of the technology, allowing access for mothers, nurses and a back office application. The design centred on the mother and baby as the primary beneficiaries of service and provided functionality for all those involved in providing service to the mother and baby.

The main objective of the third design workshop was to test if the process could be used to identify technology options. The design team was able to identify possible technology options for most of the functions identified.

5.6. Summary

5.6.1. Reflection on design workshops

The extensive gathering of empathy data at the start of the empirical phase of this project was meant to provide input for a design thinking process. This same input was presented to six different design teams. Six different solutions were proposed. This raises the question of how six different teams looking at the same empathy input could reach six different solutions. Equally important would be the question of whether a set of requirements presented to different teams should lead to exactly the same solution each time. The discussion below looks at some possible explanations.

There is strong evidence that experience plays an important role in what was included in potential solutions and what was excluded. Experience could be looked at from two different angles, **life experience** and **work experience**. The experience of a mother who lost her baby and was part of one of the design teams in the first workshop seemed to weigh heavily on the decisions taken by that team. The fact that her baby died from complications with breastfeeding seemed to influence that team's decision to focus on breastfeeding issues in their POV. In another team, a mother who had experienced complications originating from an improper diet seemed able to draw her team towards designing a solution to address poor nutrition. This finding poses a dilemma regarding whether beneficiaries should be included in design teams. Those putting together design teams should consider whether personas created by designers are a better representation of empathy.

Designers must, however, be careful to discount their own experiences in creating the personas to be used.

Two work experience dynamics were observed to be at play during the first set of design workshops. Midwives appeared to lobby for solutions to solve problems they were experiencing in their daily work. This was consistent with the objectives of the workshop. The technologists, on the other hand, appeared to push towards problems they had experience in solving. In at least two cases, workshop one and workshop two, developers made it clear that they had components of solutions that could very quickly be adopted to deal with the problem being investigated. Although this was quickly discouraged in both cases, the direction in which the discussions were headed seemed to suggest a push towards a pre-existing solution. In both cases, although the developers had some experience in their fields, their actions suggested lack of professional maturity, which made it difficult for them to separate the problem space from the solution space.

Commercial interests are likely to have a strong bearing on the way in which solutions are built. The push by the developers towards existing solutions may also have been purely because they already had solutions built and simply wanted to get the buy-in of the audience to make it easier for them to sell their solutions in future. This behaviour is not very different from the push by peddlers of solutions that are generally termed "best practice" solutions, which may not bear any resemblance to the solution that customers need.

The **expertise** of team members had a bearing on the solutions proposed. The output of the second workshop, although brief, indicated clarity of thought that ensured all the key requirements of a potential solution were covered. This may have been a result of the more solid experience in that team as a whole. The third workshop produced a solution that was even more comprehensive, and may also have been because of the experience of the team.

Power dynamics in the groups had a strong bearing on the output of the groups. It was made clear at the beginning of the workshops that all ideas put forward would be treated with equal weight. Despite this declaration up front, mothers appeared unwilling to contradict midwives who in some cases had assisted them in giving birth and would probably do the same in future. In one group, a senior midwife was very vocal and it was quite possible that this forced the less senior midwife in the group to withdraw. Participation of the junior midwives in a different group may have led to a different set of outcomes.

The differences in solutions may be attributed to the fact that the **process** itself was evolving. The first design session was very open-ended, with open suggestions. Teams had the liberty to suggest technology opportunities and capabilities beyond what had been proposed. The later teams were restricted by templates that had drop-down options. By the time the second and third workshops were conducted, the researcher had had the benefit of observing four other teams and this had the impact of providing better guidance to the teams, possibly resulting in 'better' designs.

These reflections played a role in the differences between the different solutions that resulted from the various workshops. Their applicability in a different setting could be subject to more controlled testing and observation, which may lead to interesting insight.

5.6.2. Reflection on the research journey

The main objective of this study was to develop a framework that could be used to improve service delivery through the implementation of relatively inexpensive ICT technology. The ideas of co-creation between service providers and those who benefit from the services were explored. The study also explored how innovation is carried and focused on design thinking as a tool to help in carrying out such work. The survey of the literature ended up with a suggestion to develop a framework for use in such work. The initial conceptual Technovation Framework was designed in Chapter 4 of this study. This chapter set out to demonstrate the efficacy of this framework and the design thinking-based process that arose out of it.

Having identified post-natal care as an area of interest early in the study, the researcher undertook an extensive study of the circumstances concerning the provision of post-natal care in a low-resource environment. This work was presented as empathy input for a number of workshops that utilised successive versions of the Technovation Process. Four design teams that competed to provide a prototype of a solution that could be used to improve post-natal care undertook the first evaluation. Changes were made to the Technovation Framework and the associated process and a second workshop was run with one team. This resulted in another prototype for a potential solution. The last workshop, conducted with a single development team, provided further validation of the process and produced a comprehensive solution that can be developed into a solution to aid service delivery.

The first purpose of this chapter was to answer the DRQ:-

DRQ
What are the challenges faced by hospitals and patients in the delivery of post-natal care?

This question was answered in section 5.2 of this study and this answer was used as input into the design thinking workshops using the Technovation Process. The testing and refining of the Technovation Framework and Technovation Process in section 5.3, 5.4 and 5.5 served as an answer to SRQ2:

SRQ2

How can the Technovation Framework be refined in an e-health environment?

Finally, the conduct of the various workshops resulted in the production of several prototypes of systems that can be used, once fully developed to solve specific challenges with service delivery in the healthcare sector. These solutions form part of the answer to the question posed in SRQ3:

SRQ3

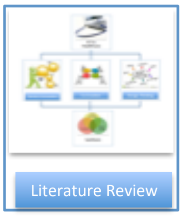
What are the outcomes of using the Technovation Framework in an e-health environment?

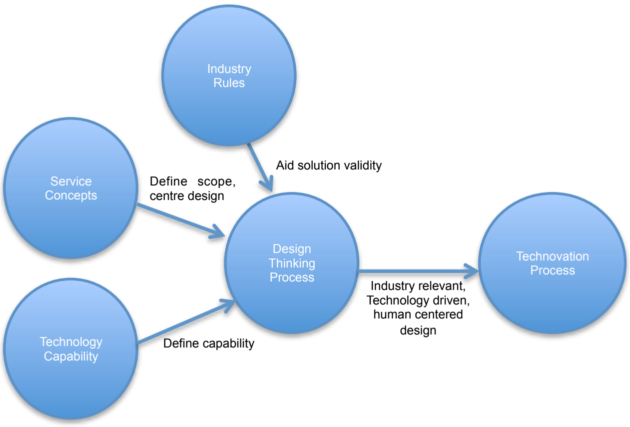
The cumulative effect of answering the sub research questions posed served to build up an answer to the main question (MRQ):

MRQ

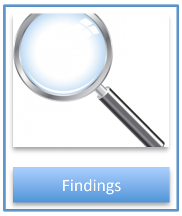
How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

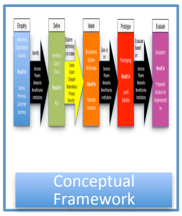
A summary of the experiences in this study presents the answer to the MRQ and is presented in the final chapter of this work.

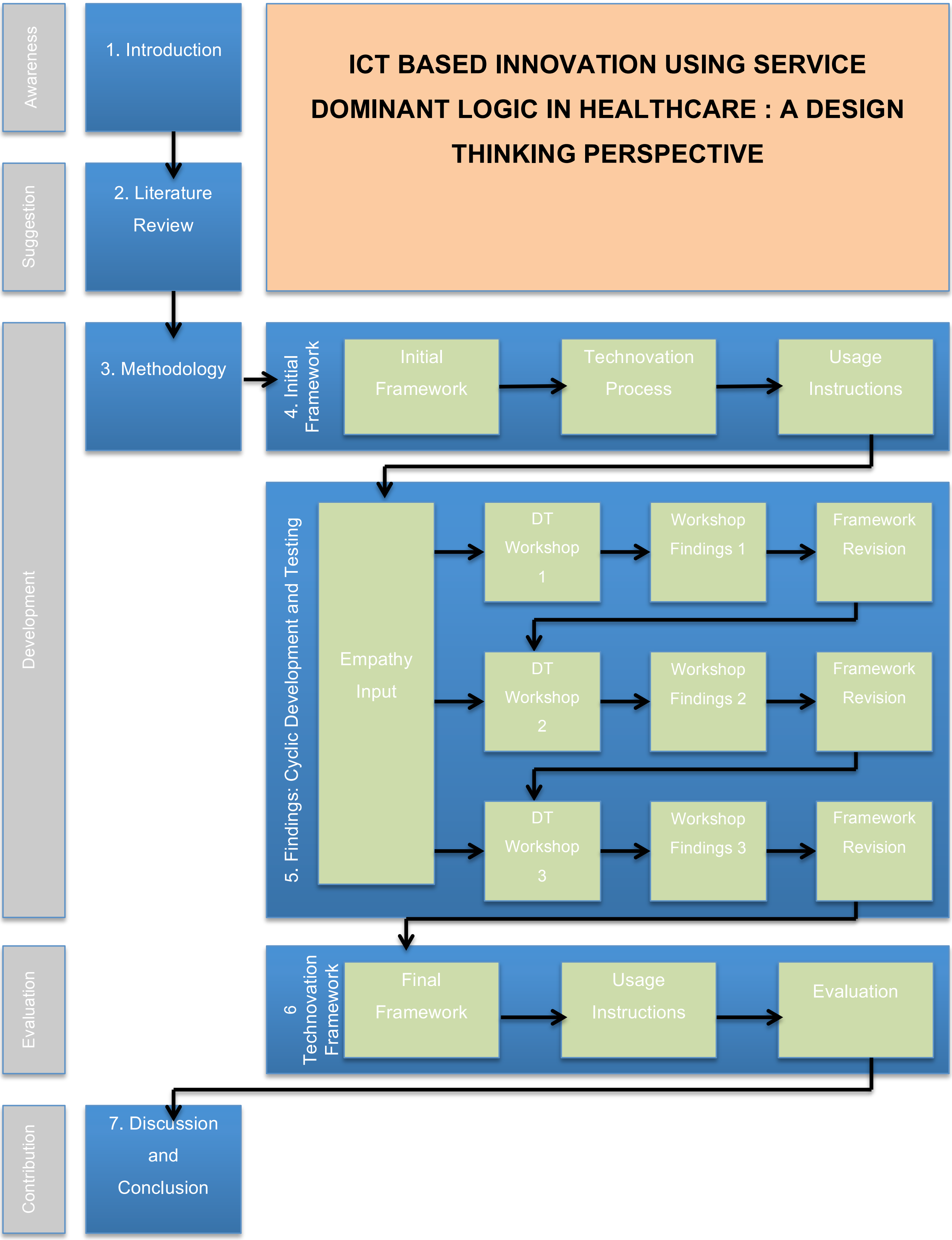


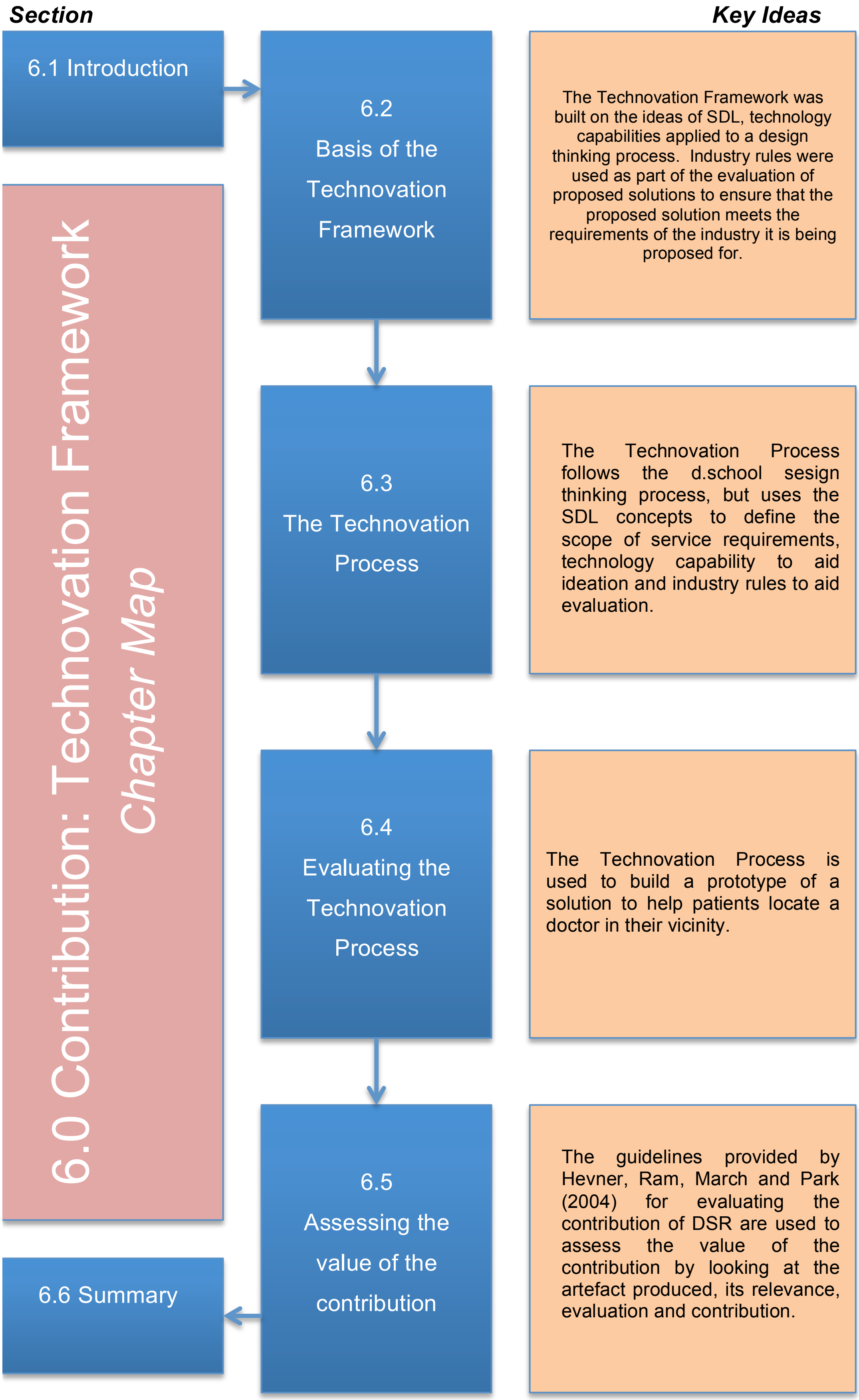


6. Contribution : Technovation Framework and Process






Awareness
1. Introduction
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
Suggestion
2. Literature Review
Development
3. Methodology
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings: Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
Evaluation
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
Contribution
7. Discussion and Conclusion



Section
Key Ideas
6.0 Contribution: Technovation Framework
Chapter Map
6.1 Introduction
6.2 Basis of the Technovation Framework
The Technovation Framework was built on the ideas of SDL, technology capabilities applied to a design thinking process. Industry rules were used as part of the evaluation of proposed solutions to ensure that the proposed solution meets the requirements of the industry it is being proposed for.
6.3 The Technovation Process
The Technovation Process follows the d.school sesign thinking process, but uses the SDL concepts to define the scope of service requirements, technology capability to aid ideation and industry rules to aid evaluation.
6.4 Evaluating the Technovation Process
The Technovation Process is used to build a prototype of a solution to help patients locate a doctor in their vicinity.
6.5 Assessing the value of the contribution
The guidelines provided by Hevner, Ram, March and Park (2004) for evaluating the contribution of DSR are used to assess the value of the contribution by looking at the artefact produced, its relevance, evaluation and contribution.
6.6 Summary

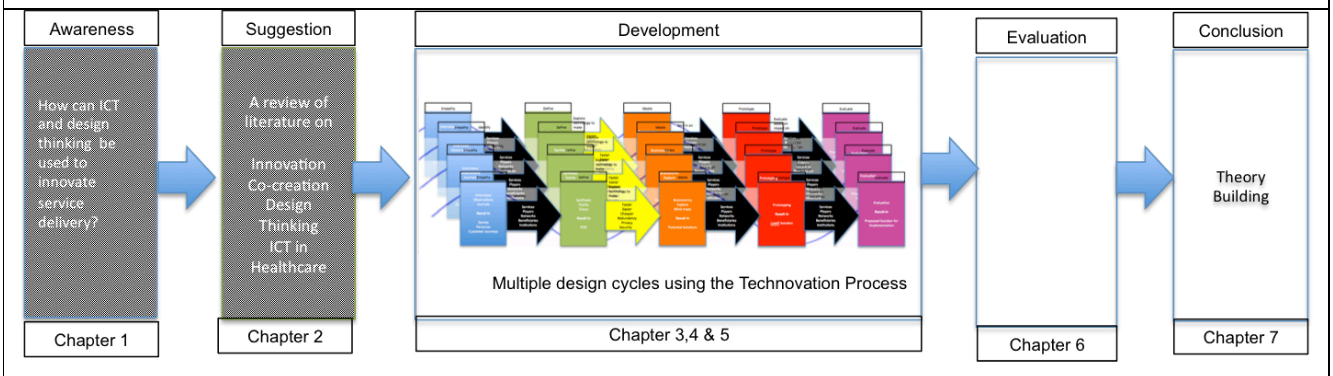
6. CONTRIBUTION: TECHNOVATION FRAMEWORK AND PROCESS

6.1. Introduction

This work is based on an acceptance that the healthcare industry faces challenges in meeting the needs of those seeking service, both in the developed and developing world. Developments in ICT are seen as presenting an opportunity to solve some of these challenges. The ideas of co-creation, i.e. working with those that benefit, to craft new services, are presented as a potential solution. An exploration of these ideas, as well ideas behind service innovation and design thinking in particular, led to the suggestion of a framework that could be used in designing or redesigning service offering using ICTs for use in healthcare. The Technovation Framework and the associated Technovation Process proposed in this study are tools that can help shape design thinking projects that aim to deliver technology-based solutions to business problems.

Design thinking has been used to help solve challenges in healthcare before (Brown, 2008) yet a number of challenges are faced in its implementation. Researchers have argued that design thinking projects can be "think parties" that do not lead to any real results (Cooper et al., 2009). Beckman and Barry (2007) argue that so much information is collected during the empathy mode that design teams are unclear about how to process the information and how to make use of it. Seidel and Fixson (2013) argue that the excessive use of brainstorming causes teams to lose focus and can become counter-productive. Kimbell (2009) bemoans the lack of a "single authoritative definition or description of design or design thinking" leading to confusion among potential users. Lugmayr, Stockleben, Zou, Anzenhofer and Jalonen (2014) discuss the difficulties of acquiring the right skills to put together a solution and provide a platform to express creativity. The Technovation Framework, the main contribution to this study, is designed to solve some of these challenges by presenting a structured process that allows participants who have different skills sets to participate in the design of useful artefacts that can be used to solve business problems.

Figure 69: Journey to Chapter 6



The following research questions were posed at the start of the study:

MRQ

How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

SRQ1

How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?

SRQ2

How can the Technovation Framework be refined in an e-health environment?

DRQ

What are the challenges faced by hospitals and patients in the delivery of post-natal care?

SRQ3

What are the outcomes of using the Technovation Framework in an e-health environment?

The development work that answered SRQ1 was reported on in Chapters 3 to 4, with Chapter 5 enhancing the development as an answer to SRQ2. Chapter 5 also reported on results of the Technovation workshops that produced prototypes of solutions that suggested answers to problems in healthcare in response to question SRQ3. The answer to the DRQ was reported in Chapter 5 and was a necessary input into the Technovation workshops.

This chapter consolidates the answers to the SRQs and in doing so answers the MRQ. This chapter presents the finalised version of the Technovation Framework. Figure 69 summarises the process followed in getting to this contribution.

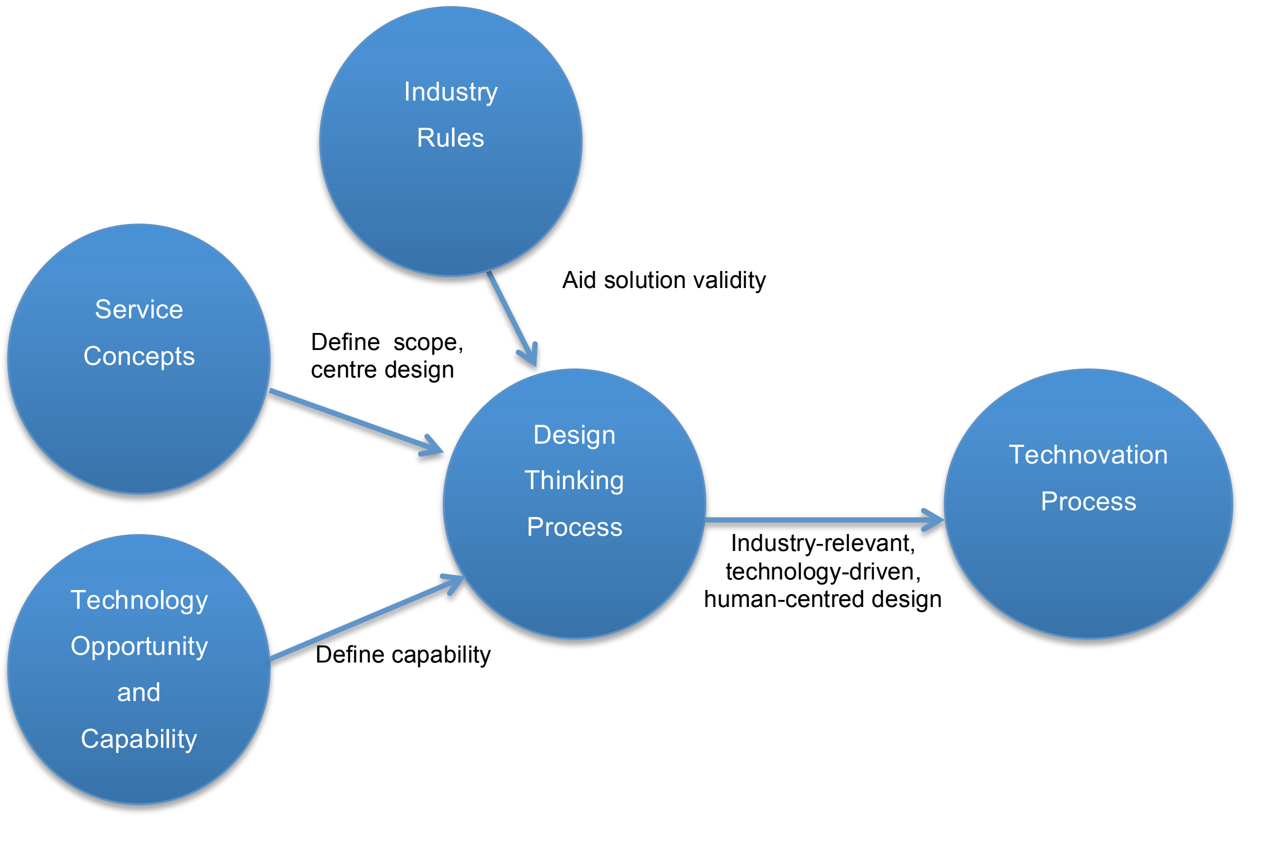
6.2. Basis of the Technovation Framework

6.2.1. Introduction

The design of the Technovation Framework is based on the assumption that while desirable as a process for driving innovation, especially for problems that are particularly difficult to solve, design thinking projects can be chaotic, difficult to manage and lead to solutions that may be difficult or impossible to implement (Cooper et al., 2009; Kimbell, 2009; Beckman & Barry, 2007; Bjögvinsson et al., 2012). A fear of technology among non-technologists results in potential technology-based solutions being ignored by design teams (Bjögvinsson et al., 2012). The Technovation Framework brings several key ideas to a design thinking process that help turn design thinking exercises into more structured endeavours that result in implementable solutions conforming to the rules of the environment for which the solution is intended.

In Figure 70, the service concepts behind the theory of SDL provide a template for defining the ecosystem around service offering. It also helps the design teams to focus on the beneficiaries of service offerings, by forcing the team to identify the beneficiary of each service that is offered explicitly. Technology opportunities and capabilities help design teams to explore technology without needing to understand what that technology is or how it works. This allows non-technologists to participate in discussions about putting technology to work, together with specialists that can then convert these capabilities into actual technology solutions for implementation. Finally, industry rules are used to ensure that solutions being offered will abide by the rules in the specific industry, or alternatively, identify what rules must be changed for their solution to work. These concepts are used to guide a design thinking process, resulting in what we have termed the Technovation Process. Bringing these concepts together results in a process that generates human-centred, technology driven and industry-relevant designs. Figure 70 highlights the relationship between these key concepts.

Figure 70: Concepts behind the Technovation Framework



6.2.2. Service concepts

SDL states that service, the application of competencies on behalf of another (Vargo & Lusch, 2017), is the basis of all exchange. The Technovation Framework (Figure 70) uses this assertion as a starting point for identifying all possible interactions between those offering service and those looking for it. The Technovation Framework, in line with SDL, then investigates the ecosystem around which the service is offered. For each service identified, the players or actors that deliver their expertise are identified, along with the beneficiaries, around whom innovation is centred in a design-thinking setting. Design teams are encouraged to understand how, when and why these beneficiaries use the services they need. The institutions that are involved in the delivery of the service are also identified, together with the networks of social and economic players that influence the delivery of service. Table 63 summarises the SDL concepts around which the Technovation Framework is built. The concepts are referred to by Vargo and Lusch (2017) as the axioms of SDL.

Service refers to the components of service that an organisation proposes to its customers. Value is co-created when the customers 'consume' these services. ***Actors*** or players are all those that participate in the delivery of a particular service. These actors may be within an organisation or elsewhere in the ecosystem and will include the service beneficiary. The ***network*** consists of all players that may not directly participate in the delivery of a service but influence the utilisation of services. ***Beneficiaries*** are the primary actors that seek to derive benefit from the consumption of a service. ***Institutions*** are organisations that participate in the delivery of service.

Identification of the components of a service offering are an essential part of understanding the ecosystem around a service offering and present an ideal way to gain empathy with those that benefit from a service offering. Also of importance is the need to identify services that are not being offered but are likely to be needed by those at whom designs are aimed. In such cases, the ecosystem around them may not be given but may have to be created as part of the design process.

Table 63: Service Concepts Usage Premise	
Concept	The premise on which this concept is employed in the Technovation Framework
Service	In order to fully understand the context and extent of service offering and consumption, service offerings and service needs must be catalogued
Actors	All the actors that participate in the delivery and use of service must be identified.
Networks	All networks that influence the delivery and use of services must be identified in order to fully empathise with the actors that participate in service exchange.
Beneficiaries	All beneficiaries must be identified, along with an appreciation of how, when and why they use the service they need.
Institutions	Institutions and institutional arrangements enabling or hindering the efficient delivery and consumption of service must be identified.

6.2.3. Technology capability concepts

Technology capabilities are constructs that define what technology can do without attempting to describe how the technology works or what products can deliver that capability. As technology develops, the list of these capabilities grows. At the end of this study the list of technology capabilities had grown to 20, with workshop participants at each workshop conducted adding capabilities to the ones that had been built up from literature. The list is provided as an initial guide, but designers and technologist are encouraged to explore other capabilities that are in their spheres of expertise that may help other non-technical participants to present ideas for improving service delivery. A critical part of using this framework is to ensure that all participants to a design workshop are given full understanding of the technology capabilities at their disposal. Table 64 provides the latest list of capabilities available at the end of this study.

Table 64: The Concepts behind Technology Capability (Revised)	
Analytical	Apply complex analytics
Artificial Intelligence	Replace human intellect?
Automation	Replace human labour
Cloud Computing	Allow storage or processing to be conducted in the cloud
Digital Security	Capability to store a digital identity
Disintermediation	Allow direct communication of parties
Geographical	Make processes independent of geography
Imaging	Allow capture and transmission of high quality imagery
Informational	Bring large amounts of data into a process
Knowledge Management	Facilitate capture, build up and dissemination of information
Location Tracking	Allow positioning
Mobility	Ability to process while on the move
Electronic Payments	Facilitate electronic payments
Sequential	Reorder task/pararellise tasks
Social Mediation	Allow communication among multiple parties
Tracking	Allow detailed tracking of inputs, tasks and outputs
Transactional	Transform unstructured processes into routine transaction

Technology capabilities are premised on the understanding that an opportunity to exploit technology exists. The framework provides designers with a set of potential technology opportunities that can be exploited during design. Table 65 summarises these technology opportunities, each of which must be linked to a capability during the design process.

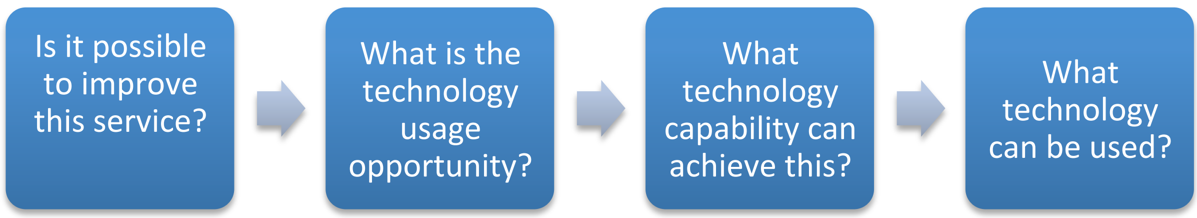
Table 65: Technology Opportunities (Revised)

Concept	How can technology be employed to
Cheaper	Make it cheaper for the beneficiary to access the service
Choice	Allow the beneficiary more choice
Convenience	Allow more convenience for the beneficiary
Dignity	Enhance the dignity of the beneficiary
Easier	Make a process less cumbersome
Faster	Speed up a process
Flexibility	Make service provision changeable while achieving the same result
Privacy	Ensure that the beneficiary's confidentiality is protected
Redundancy	Reduce repeated storage in the storage of data
Security	Make the storage/transmission of data more secure

In exploring technology to redesign service delivery, designers start by questioning if a service can be improved. Designers then explore the opportunity to use technology to improve a service. Such improvements could be to make a process simpler, faster, cheaper or any of the presented opportunities. Designers then turn to understanding what technology capability can deliver that benefit. Finally, the technology that can be used to deliver the desired benefit is explored. Although presented as a simple linear process in Figure 71, these activities take place in different states of the design process and are closely intertwined with other design activities as presented in the Technovation Process.

Detailed descriptions of the technology capabilities and technology opportunities are provided in Chapter 4.

Figure 71: Technology exploration process (revised)



6.2.4. Industry rules concepts

The industry rules concept, which was not part of the initial conceptual Technovation Framework, was found to be necessary after conducting field evaluation of the Technovation Process. Healthcare practitioners who participated in the design workshops noted that although a solution's efficacy may be unquestionable on paper, solutions need to take into account the rules governing a particular industry, particularly the healthcare sector. The rules of an industry consist of both documented and undocumented rules that govern professional practice in an industry. Table 66 presents the concepts behind industry rules.

Table 66: Industry Rules Concepts

Ethics	Moral principles that govern a person's behaviour or the conducting of an activity
Guidelines	A general rule, principle, or piece of advice.
Legislation	Laws regarding the conduct of services as well as the collection, processing, storage and dissemination of data
Standards	A required or agreed level of quality or attainment.

Ethics are moral principles that govern the behaviour of actors and are of particular importance during the delivery of services. Ethics may include treatment of beneficiaries of service with compassion, respecting the dignity of others, acting in the public interest and being careful about spending public funds (Winkler et al., 2005). Ethics are unlikely to be documented, but are expected of professionals in an industry. Designers of solutions must be careful to ensure that the solutions they develop are not infringing on the ethical standards of that industry. The Oxford dictionary defines guidelines as "general rules, principles or pieces of advice". Guidelines are issued by national or international bodies and help streamline and standardise service delivery. In the healthcare sector, guidelines such as "Postnatal Care for Mothers and Newborns" (World Health Organisation, 2015) help define the services that institutions must offer and how they should offer them.

Legislation consists of laws that have been passed and will not only affect the way services are delivered, but also be of interest to a technology-driven process and the handling of information relating to actors (including beneficiaries) in a service process. The collection, processing, sharing and dissemination of information are in many jurisdictions subject to laws that must be taken into account in the design of systems. ***Standards***, such as those issues by the ISO, define a level of quality that those who ascribe to them are obliged to keep.

6.2.5. Design Thinking Concepts

The design thinking process as used by the Stanford design school (d.school, 2016), is built around five activities or modes of engagement (Table 67). The ***empathy*** mode is aimed at understanding people, what they do, why and how they do it, and their needs in the context of a design challenge. The ***definition*** activity brings clarity and focus to the design space, challenging designers to improve the circumstances of those for whom innovation is sought. The ***ideation*** activity is a divergent exercise, where designers open their minds to possibilities of solutions to their defined challenge. ***Prototyping*** tries to concretise ideas by linking them to resources and activities that can yield the solutions proposed. The ***testing or evaluation*** of solutions is focused on ensuring that solutions that have been designed can work, can be implemented and can offer value to those they are designed to help.

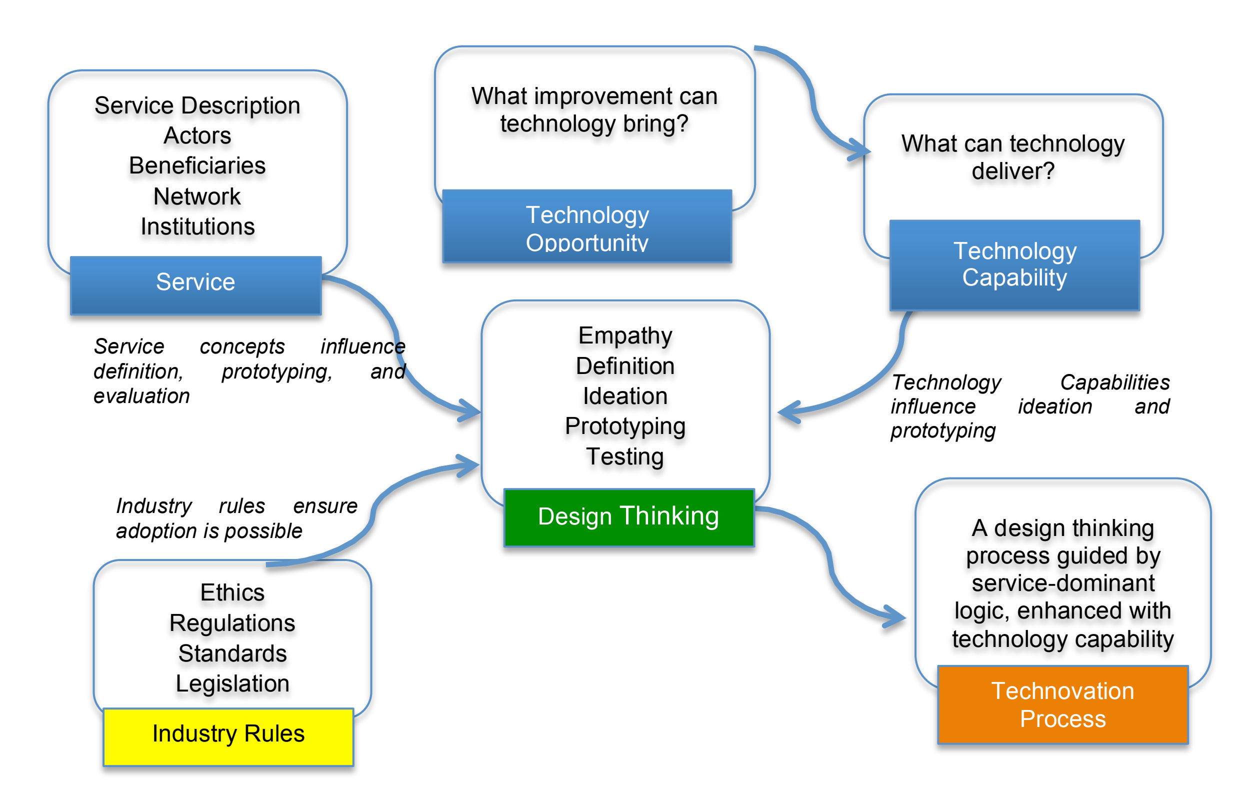
Table 67: Design Concepts

Mode	Purpose
Empathy	Understand people, iin the context of the design challenge
Definition	Bringing clarity and focus to the design space
Ideation	Idea generation.
Prototyping	Iterative generation of artefacts
Evaluation	Solicit feedback, about the prototypes created

6.2.6. Summary

The Technovation Framework brings together the concepts described in this section in the construction of the Technovation Process. Figure 72 summarises the relationship between these concepts. Service concepts influence the problem definition and prototyping and are used in the evaluation of potential solutions. Technology opportunities and technology capabilities guide the ideation process and are useful in the prototyping mode. Industry rules ensure that proposed solutions will be accepted and be consistent with professional practice. The next section brings together these concepts into the Technovation Process.

Figure 72: Key constructs within the Technovation Framework (revised)



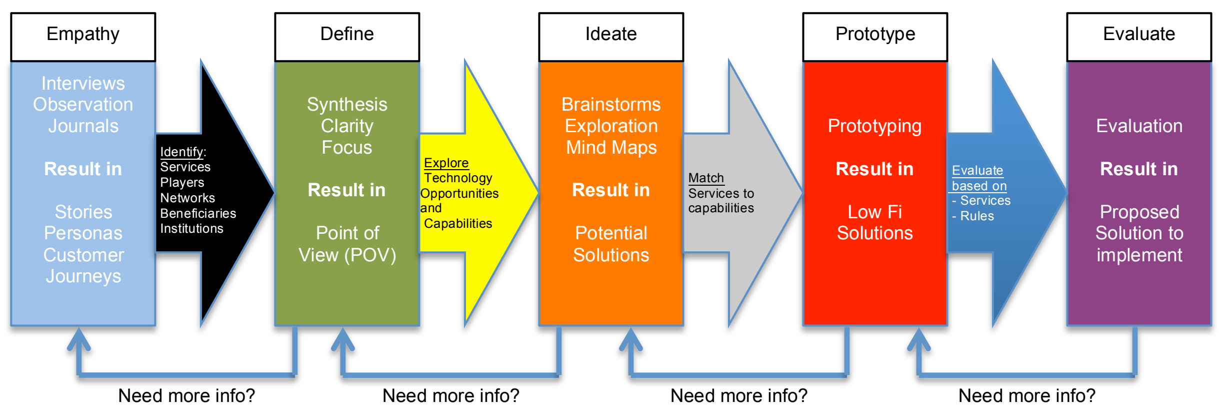
6.3. The Technovation Process

6.3.1. Introduction

The Technovation Process is the practical fulfilment of the Technovation Framework. The process is built on the d.school design thinking process and retains the key attributes of the process. The main contribution of the Technovation Process is that a bridge is inserted between each activity/mode, which either provides a checklist of the completeness of the previous mode or provides a set of additional aids for the next mode. Consistent with a normal design thinking process, an incomplete checklist should prompt the design team to return to the previous activity and reiterate until complete.

The Technovation Process begins with empathy-building, which is bridged to a definition mode. Definition is bridged through to ideation that in turn is bridged to a prototyping mode. The last bridge evaluates the prototype prior to field evaluation/testing. The final output of a Technovation Process is a tested prototype, which may then be fully developed for implementation. An overview of the process is presented in Figure 73.

Figure 73: The Technovation Process



The Technovation Process is designed for use by multidisciplinary design teams that consist of designers, technologists and subject matter specialists. Potential end users of the service being designed may also be incorporated into the team. Early versions of the process were supplied with usage guidelines for the teams. Templates were found to be more effective for purposes of keeping track of the completeness of the information provided, as well as documenting the information generated. Suggestions have been made to develop the process into an application that will capture the information provided and churn out a prototype description. Excel spread sheets with basic functionality to carry the output of one process from one worksheet into the next are presented in the appendix.

6.3.2. Empathy in the Technovation Process

Empathy in the Technovation Process is conducted according to the normal d-school design thinking process; however, prior understanding of the service concepts will help ensure that the design teams gather complete information regarding the service ecosystem. During the empathy space the focus is on obtaining understanding of the people for whom designers wish to design solutions. Understanding will come from asking questions and listening to stories about these people's lives. Observing them at home or at work will help designers understand their lives better. Designers must be careful to understand not only what people say they do, but to try to understand that sometimes what they do contradicts what they say they do. Designers need to understand both those offering service and those receiving serviceand to identify and understand the different players that deliver and receive service. Networks that affect how service is delivered need to be understood, along with the influence of these networks. Networks may be formal or informal, and those being investigated may feel that these do not matter until they are specifically asked. In the same vein designers need to understand the institutions that are part of the service delivery process.

6.3.3. Problem definition in the Technovation Process

Building empathy, the first task of a design thinking exercise, is typically a divergent thinking exercise, generating large amounts of information about people, their lives, their needs, their wants and their circumstances. The next design space condenses these ideas into an actionable problem statement. The framework employs the concepts of SDL to help designers analyse the large amounts of information into clusters of information that are easier to consume so that a problem statement can be constructed.

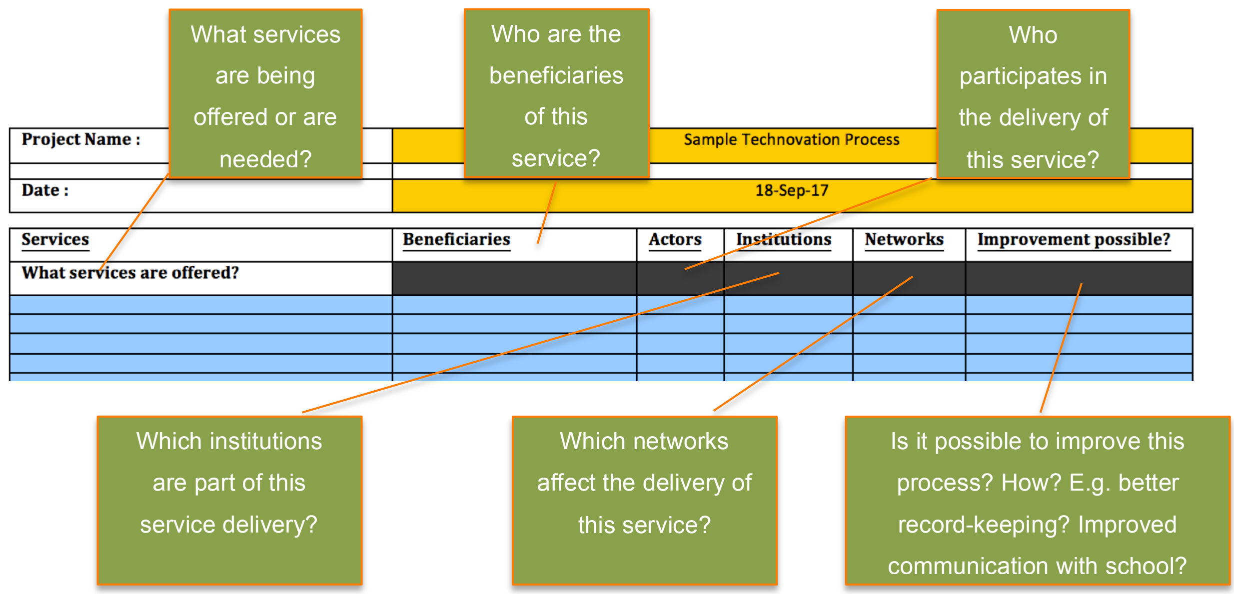
Starting with the service concept in SDL, designers aim to catalogue and understand the services currently being offered, as well as those that users need, in the problem space. Cataloguing and comprehension of the various actors/players that have a role to place both in delivering and receiving services are necessary to bring clarity to players in the field. Networks with which the various actors in the problem space align themselves always affect service delivery and these must be catalogued and understood. The human-centredness of design thinking is best brought to the fore in understanding the beneficiaries of the services on offer, along with their needs and wants. Equally important are the institutions and organisations that affect the delivery of services. This exercise allows designers to view a large amount of information that has hitherto been presented in stories, personas, journey maps and pictures into a structured form that is easier input into a process of converging to a problem statement, or POV, the deliverable of the definition space.

Addressing the matters listed below will help designers in defining the problem they would like to solve. The input for this will come from the empathy build-up, and help define the service ecosystem:

- What services are offered, and what services are needed? [Service]
- Who are the key players in providing these services? [Players]
- What networks affect the provision of these services? [Networks]
- Who are the beneficiaries of the services being provided? [Beneficiaries, in order of importance/relevance with the most important or relevant listed first]
- What institutions coordinate the provision of the services identified? [Institutions]

The template allows design teams to identify services that are currently being offered as well as services that beneficiaries need, but that are currently not being offered. Although this is an analysis and convergent phase of a design thinking workshop, the framework encourages design teams to apply their abductive minds to fill in the gaps regarding who could potentially provide the required services, which networks would have an impact on them and institutes that would participate in the delivery of these services. The iterative nature of design thinking allows design teams to validate such ideas with service beneficiaries before a POV is settled on.

Figure 74: Using the empathy-definition template



Analysis of the answers to the questions about the service ecosystem will help designers identify a suitable POV to address. The templates provided with this process help design teams with analysing and cataloguing of empathy input. It also makes it easier for design teams to identify gaps in the understanding of the problem space for which they aim to design solutions. The template provided for bridging empathy building and problem definition also prompts the design team to identify opportunities for improvement in the services they catalogue. These opportunities for improvement provide a good basis for arriving at a POV in the next template. Figure 74 illustrates the key questions to be addressed as part of this activity.

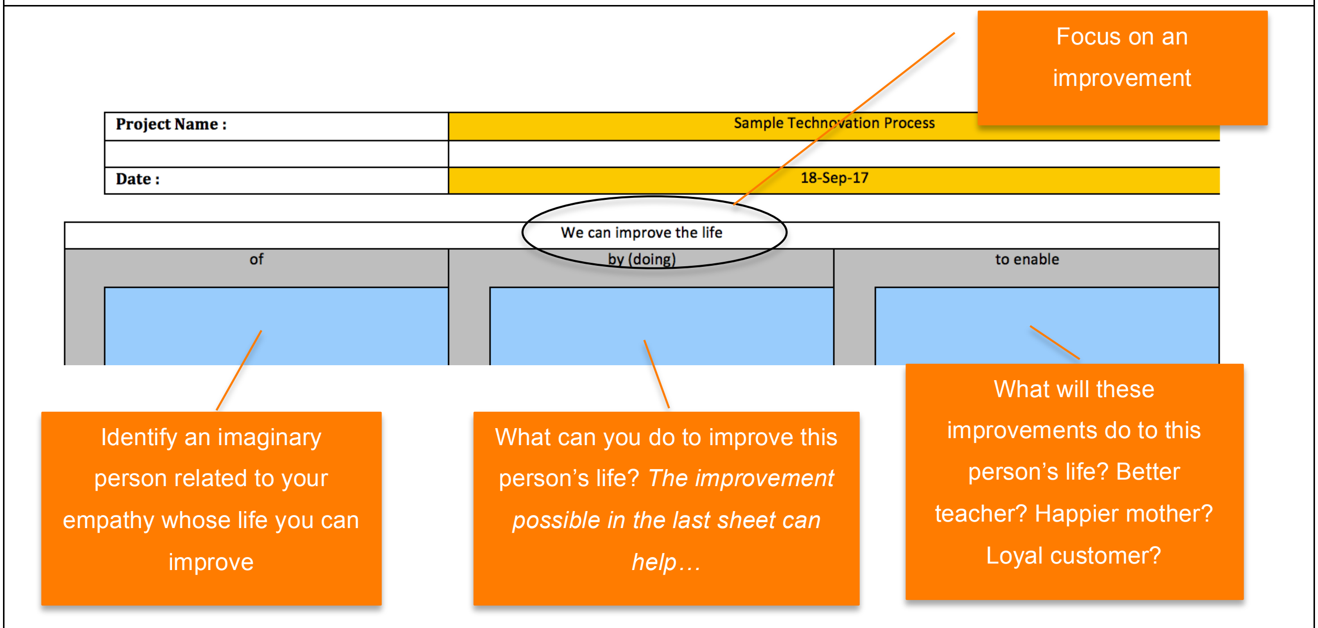
A good POV is constructed around a person and identifies not only the benefit the designers wish to bring to this person's life, but also a motivation for why it is important to them.

"We would like to help X by providing a service Y that would allow them to be a better Z."

It is unlikely that one POV will capture all the areas of opportunity and propose the building up of multiple points of view. Where resources are limited, designers may then choose to address the most pressing of problems to address. Figure 75 illustrates the key considerations for coming up with a POV.

Some problems are likely to be immediately clear, such as a need a user has that an organisation already provides. Some potential problems are more obscure and need closer inspection of the data to understand. An example is a service users need that the organisation offers but users are unable to access. Another example could be a service that is offered but can be improved on.

Figure 75 : Using the Definition-Ideation Template



It may become clear during this exercise that designers do not have sufficient information to formulate a useful and meaningful POV. In this case, designers are advised to revise the empathy mode until a clear POV is established.

6.3.4. Ideation in the Technovation Process

Ideation is an opportunity for designers to apply their minds to potential solutions to problems faced. While the definition space reduces a large amount of data into one or a few points of view in a convergent process, the ideation space tries to get as many ideas as possible related to their selected POV. Ideation is the opportunity to get passionately creative, coming up with potential solutions but without worrying about how these will actually work at this stage. Designers are encouraged to step beyond the obvious and explore unusual and previously unexplored solutions.

The Technovation Process provides a set of technology capabilities that can help designers think about what can be done, without focusing on the technology itself. The use of technology capabilities separates the desired improvement from the technology that will make it happen, allowing team members who may have limited knowledge or understanding of technology to engage in the discussion. A facilitator can lead the design team into the discussion by posing questions about opportunities that exist to introduce improvements. Most participants could probably spot opportunities to improve a service by making it faster, cheaper, more flexible or more convenient without knowing how this can be achieved. Design teams are encouraged to explore and capture these opportunities. Table 68 provides a list of potential opportunities that teams can employ to jog their minds about what can be done.

Figure 76: Using the Ideation–Prototyping Template

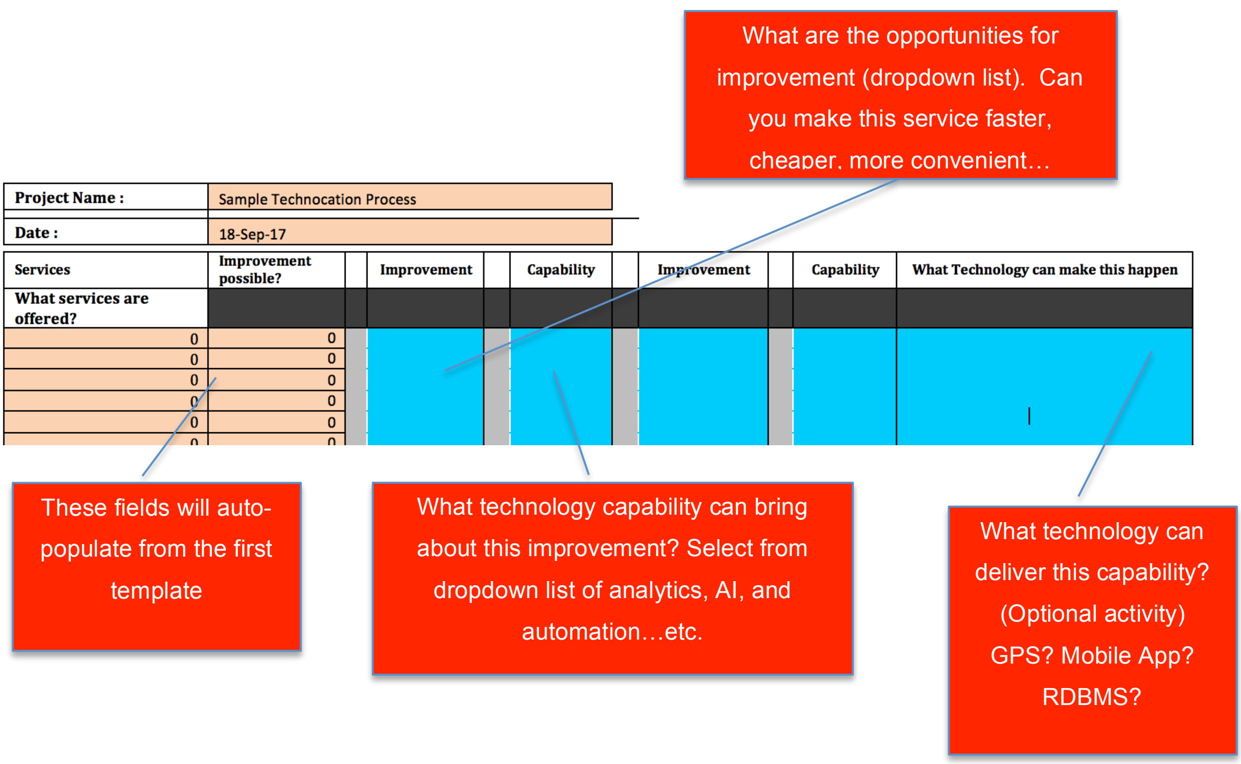


Figure 76 summarises how to ideate in a Technovation Process.

Table 68: Technology Opportunities	
Concept	How can technology be employed to
Cheaper	Make it cheaper for the beneficiary to access the service
Choice	Allow the beneficiary more choice
Convenience	Allow more convenience for the beneficiary
Dignity	Enhance the dignity of the beneficiary
Easier	Make a process less cumbersome
Faster	Speed up a process
Flexibility	Make service provision changeable while achieving the same result
Privacy	Ensure that the beneficiary's confidentiality is protected
Redundancy	Reduce repeated storage in the storage of data
Security	Make the storage/transmission of data more secure

For each of the services identified for which an improvement opportunity exists, teams must choose a technology capability that can offer this improvement. The technology capability table (Table 64) provides a catalogue of capabilities that can be employed to improve the service experience.

Finally the team needs to match each technology capability to an actual technology that can be employed to allow that service to deliver the proposed innovation. This forms the start of the exercise of building a prototype that will deliver the desired solution.

6.3.5. Prototyping in the Technovation Process

The prototype space represents an opportunity to start concretising the components that make up the design of a potential solution and getting feedback from users on how these will be received. Designers are likely to go through many iterations of this process as they apply their minds to what will work and what will not work. Low-fidelity prototypes that allow users to get an idea of what they will get must be produced and used to gain user feedback.

Consideration needs to be paid once again to the service concepts, while acknowledging the technology capabilities. The prototype solution must identify the service offering, ensuring that all actors that participate in that offering are accounted for. Networks that influence the delivery of the service must be identified and their potential influence must be understood and provided for in the solution. Equally important is the explicit identification of the beneficiaries and the institutions that will govern their experience of the service being offered.

For each POV that has been identified and carried forward, designers must match each technical capability with a likely technical solution and try to imagine how this will work. A description of this solution forms an important part of the prototype. Prototypes must be quick and cheap to produce, to allow many options to be pursued. Designers must keep a record of the components of a solution that users like and what they do not like, so each iteration must focus on one or two key features that are being tested.

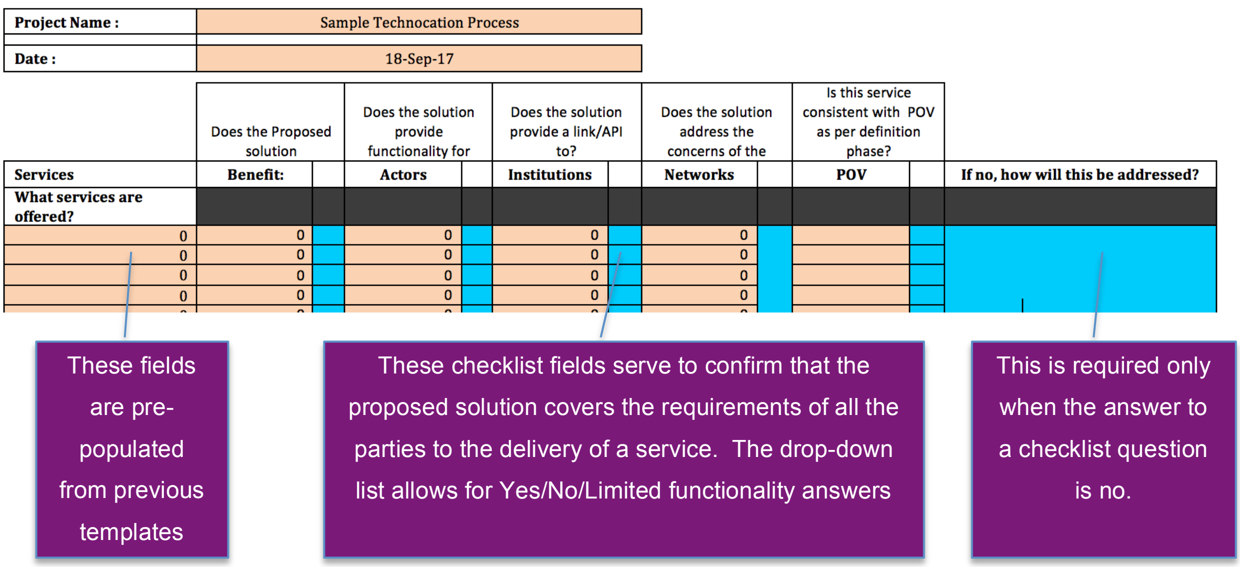
The “What technology can make this happen?” column in the ideation–prototyping template provides the initial ideas of how a prototype can be put together.

6.3.6. Prototype testing in the Technovation Process

Testing of the prototype presents an opportunity to gain further understanding of the beneficiaries of a solution. This is achieved by showing users low-fidelity mock-ups of what their solution will look like as built in the prototype mode. User feedback must focus not only on what they like, but also on why they like that particular portion of the solution. Feedback is fed back into the definition space, if the design team feels that they did not understand the problem sufficiently in the first place. If the problem was understood and the users do not like the solution because parts or all of it do not address the problem adequately, then re-entry into the prototype space is required.

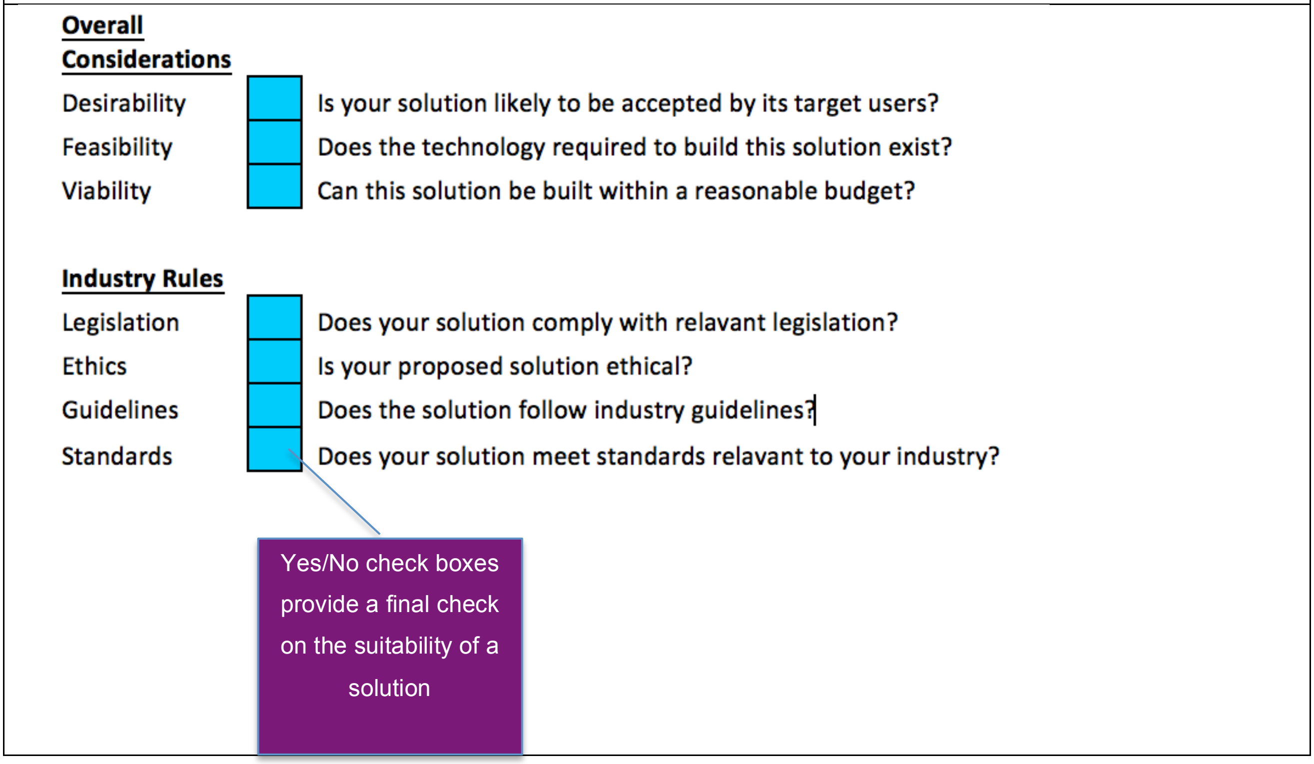
The prototyping–evaluation template presents a tool allowing the design team to undertake a desk exercise that checks the completeness of their solution prior to presenting it to potential users.

Figure 77: Using the Prototyping–Evaluation Template (1/2)



The service concepts provide an opportunity to prompt users into ensuring that all aspects of the service being offered to them is complete. An evaluation of the service requirement, service offering, and the coverage of the proposed solution should form part of the evaluation. The requirements of all the players involved in the delivery of the service must be provided for in the proposed solution. The delivery of solutions often fails because designers underestimate the role of the networks that influence their user base and these must be accounted for. Often service is provided by many institutions or in some cases external institutions regulate the delivery of service. Solutions that are complete must identify these institutions and provide appropriate interfaces or APIs.

Figure 78: Using the prototyping–evaluation template (2/2)



The adoption of a solution is ultimately at the mercy of the beneficiary of the service. While designers are at pains to ensure that the solution they propose is technically feasible and is economically viable, the beneficiaries of the service being offered and primary users of the solution being designed must desire the system for it to be successful. Solutions that fail the tests of feasibility, viability and desirability must be redesigned by revising the problem definition, the POV adopted or the ideas prototyped until a suitable solution is reached. Similarly, solutions that fall foul of the industry rules are likely to face the wrath of the law and be terminated, of not to receive the support of the industry they aim to aid.

6.4. Evaluating the Technovation Process: Find-a-Doc

6.4.1. Introduction

A discussion was held with the head of a development house that participated in one of the Technovation workshops as part of the development of this process. He expressed interest in using the Technovation Process to help his team in conceptualising a new system they were planning to develop. The area of interest was in developing a system to help urban patients to locate a suitable doctor in their vicinity. In order to develop empathy for those they were developing for, two team members were assigned to try to understand the perspective of potential users of the system by talking to family and friends. Another two members were asked to visit doctors to understand their perspective. The researcher did not provide any guidance on what information to collect for the design exercise other than to ask the team to gain understanding of the circumstances of those for whom they were designing. A description of the Technovation Framework and Technovation Process as described in sections 6.1 to 6.3 was presented to the team as pre-reading prior to the workshop conducted on 23 November 2017. Other than being available to observe and provide clarifications where required, the researcher' involvement in this session was minimal. Although the process was tested and refined using three sets of workshops, this last workshop served to triangulate the earlier findings and validate its usefulness.

6.4.2. Find-a-doc: Empathy feedback

The assigned members of the design team set out to understand the challenges faced by patients in trying to access private healthcare. Patients reported that since doctors were forbidden to advertise in Zimbabwe, they had no accurate way of locating a suitable doctor for their ailment. Most patients resorted to visiting their general practitioner first and then getting a reference to a suitable doctor. This process left them at the mercy of their doctor, as they had no way of knowing the competence of the doctor they were referred to. Patients also felt that they were being double-charged for the service, as they had to pay consultation fees to both doctors. Some of the patients interviewed expressed a desire to cut out the "middle-man" in the form of the general practitioner, as they had access to information from the web. The general feeling was that the role of doctors was now to confirm their own diagnosis of their ailment and to obtain a prescription for medication, something that could only be done by doctors in Zimbabwean law.

Doctors' fees were reported to vary, with some doctors accepting medical aid payments while others demanded cash only. The doctors who accepted medical aid payments charged varying amounts of surcharges over and above the medical aid payment. Patients had no way of knowing what this charge was in advance. Some of the patients indicated that they would prefer to visit doctors of their own sex and in some cases, a preference for doctors of their own religion was expressed. Difficulties in booking to see doctors were expressed by some of the patients interviewed. Some doctors did not have booking appointment systems and patients were asked to wait while doctors attended to other patients.

Doctors expressed a desire to regulate the traffic into their practices, noticing that sometimes they were very busy yet at another times had time on their hands. Most expressed a desire to have prior warning of the patients they would see and if possible to review case files in advance.

6.4.3. Find-a-doc: Problem definition feedback

The formal workshop started with an analysis of the empathy input that had been gathered by the various team members. The empathy-definition template was used to analyse the input and understand the context in which service was being offered and used. Figure 79 summarises the output of this session.

Figure 79: Extract from Empathy-Definition template: Find-a-doc

Empathy - Definition

	Project Name :	Find-a-doc				
	Date :	23-Nov-17				
	Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
	What services are offered?					
	What services are needed and not offered?					
1	Find the appropriate doctor/ clininc for my condition	Patient	Patient, Doctor, Family	Surgery/ Clinic	Friends, Family, Social Media & Media	
2	Make a booking	Patient/ Doctor	Admnistrator	Surgery/ Clinic		
3	Reminded of the booking eg a day before	Patient	Family			
4	Share the experience with friends	Patients/ Friends			Friends	
5	Keep track of visits to the doctor	Patient	Family			
6	Keep track of the prescriptions that the doctor has given	Patient	Family			
7	Keep track of medical aid status	Patient	Family	Medical Aid		
8	Hints and tips about my health	Patient	Doctor			
9	More information about the doctor	Patient	Admnistrator, Doctors		Friends, Family, Social Media & Media	
10	Appropriate doctor for my medical aid	Patient	Medical Aid, Administrator			
11	Likely short falls	Patient	Medical Aid, Administrator	Medical Aid		
12	Ability to make bookings with labs	Patient/ Labs	Administrator, Doctor	Labs		
13	Pharmacy recommendations	Patient	Doctor		Friends, Family, Social Media & Media	
14	Seasonal disease notifications	Patient	Doctor	Ministry of Health		
15	Access convenience (dogs, kids, parking, working hours/ day	Patient/ Family	Administrator		Friends, Family, Social Media & Media	
16	Search for a specific doctor	Patient				
17	Post treatment services	Patient	Doctor			
18	Nutritional recommendations	Patient	Doctor		Friends, Family, Social Media & Media	
19	Acceptable payment methods	Patient	Administrator			
20	Initial diagnosis	Patient				
21	Next of kin notifications ?	Patient/ Family				

As a new service offering, the team did not focus their efforts on existing services, but rather looked at what services could be offered. Many of the services offered were for the benefit of the patient for whom the service was being designed. The team was also conscious of the fact that they would need to provide functionality for other participants in the service offering. Services identified included finding a doctor and making the necessary bookings. Reminders were deemed to be a useful feature, along with a full tracking of the history of visits made to various doctors. The team felt that patients would be interested in rating the service received by a doctor and also getting an impression of how other patients had been treated in the past. The facilities offered by the doctor were seen as useful in locating a doctor. Such facilities included parking, wheelchair access, ability to bring dogs as well as understanding the doctor's working hours.

The team identified services related to the financial aspects of a doctor's visit. These included making sure they were aware of the doctor's charges and the acceptable payment methods. In the event that a doctor accepted medical aid payments, patients would want to know the likely shortfalls associated with the service on offer. The team also felt that patients would want to keep track of their medical aid status so as to avoid surprises in the event of a doctor's visit and identified services related to a doctor's visit as being essential to the provision of a doctor's appointment system. This included making bookings with laboratories recommended by doctors for tests, locating pharmacies for prescriptions given and finding post-treatment services such as physiologists. It was agreed that an ideal system would allow the doctor and the patient to agree on bookings in the event of a long-term treatment plan. Information provision was also seen as a necessary function. The design team felt that patients needed access to relevant information about their health as well as nutritional information. Notices about disease outbreaks were also viewed as a desirable feature.

Doctors and their administrators were seen as key players in the provision of service. Family members were also considered to be participants, as they currently offered the services that the envisioned system would offer. Institutions of interest included the doctor's offices, laboratories, pharmacies, medical aid companies and the Ministry of Health. Networks that were likely to influence service offerings included friends, families, neighbours and social media.

Having analysed this feedback, the team decided on a multipronged POV that was stated as:

> *We aim to improve the lives of patients by providing them with*
>
> *i. easier access to healthcare services*
>
> *ii. access to relevant healthcare information*
>
> *to allow them to live healthier lives.*

6.4.4. Find-a-doc: Ideation feedback

The ideation session focused on finding ways of keeping the promise expressed in the POV agreed on in the definition session. The team recursively referred to the technology opportunities table presented, as well as the technology capabilities for potential solutions. The researcher explained that the team was free to explore other opportunities and capabilities beyond those that were listed.

The design team felt that they could bring about convenience, choice, and dignity to the lives of patients through the use of technology capabilities. Opportunities to make processes more secure, faster, cheaper, and easier and to reduce redundancy in the storage of information were also identified. These opportunities and capabilities are highlighted in Figure 80.

Figure 80: Extract from ideation-prototype spreadsheet: Find-a-doc

Ideation - Prototype

	Project Name :	Find-a-doc							
	Date :	23-Nov-17							
	Services		**Improvement**		**Capability**		**Improvement**		**Capability**
	What services are offered?								
	0								
	What services are needed and not offered?								
1	Find the appropriate doctor/ clininc for my condition		Faster		Geographical		Choice		Analytical
2	Make a booking		Convenience		Mobility		Faster		Automatically
3	Reminded of the booking eg a day before		Convenience		Tracking				
4	Share the experience with friends		Easier		Social Mediation		Less Redundancy		Informational
5	Keep track of visits to the doctor		Dignity		Tracking		Easier		Informational
6	Keep track of the prescriptions that the doctor has given		Easier		Informational		Convenience		Tracking
7	Keep track of medical aid status		Convenience		Informational		Convenience		Disintermediation
8	Hints and tips about my health		Convenience		Informational				
9	More information about the doctor		Convenience		Informational				
10	Appropriate doctor for my medical aid		Easier		Informational		Cheaper		Informational
11	Likely short falls		Dignity		Informational				
12	Ability to make bookings with labs		Convenience		Geographical				
13	Pharmacy recommendations		Choice		Informational				
14	Seasonal disease notifications		Choice		Informational				
15	Access convenience (dogs, kids, parking, working hours/ d		Security		Informational		Convenience		Informational
16	Search for a specific doctor		Easier		Informational		Convenience		Informational
17	Post treatment services	We can make	Cheaper	Through this	Informational	We can make		Through this	
18	Nutritional recommendations		Convenience		Disintermediation				
19	Acceptable payment methods		Convenience		Informational				
20	Next of kin notifications ?		Faster		Disintermediation				

The application of geographic capabilities could be used to help patients locate doctors in their neighbourhoods. Through the use of analytical capabilities, patient's choice of doctors could be enhanced. Bookings could be made convenient by using mobile technology and automation of the booking process. A tracking capability could be used for convenience by sending patients reminders of their appointments with doctors. The use of social media for sharing experiences with doctors could help make it easier for patients to choose appropriate doctors. A discussion was held on the ethics of this practice and the team agreed that an anonymous rating system would divorce an individual from a specific rating of a doctor.

The team felt that tracking doctors' visits online would ensure patients' dignity by allowing doctors to understand the patient's medical history prior to a visit. This capability was coupled with an information management capability. The design team felt that a disintermediation capability would assure patients' dignity by allowing them to check their medical aid status beforehand, rather than having to be turned away at the doctor's surgery. Keeping track of prescriptions would be convenient to patients and make it easier for doctors to prescribe medication in the future. The ability to search for information about doctors or to receive information about their health would ensure more convenience in patients' lives. Similar convenience would be brought about by an ability to search for ancillary services such as medication and laboratory services. Recommendations of pharmacies, in much the same way that doctors could be recommended, would offer patients greater convenience.

6.4.5. Find-a-doc: Prototyping feedback

The prototyping session began by identifying technology that could be used to offer the capabilities explored in the ideation session. These were then brought together to describe the prototype solution. Figure 71 below provides a description of the prototype solution as presented by the design team.

Figure 81: Find-a-doc Prototype

The find-a-doc design team worked on a system to help patients locate a doctor in their vicinity.

The POV was stated as

We aim to improve the lives of patients by providing them with

- *i. easier access to healthcare services*
- *ii. access to relevant healthcare information*

to allow them to live healthier lives.

This is an overview of the system proposed by the find-a-doc team.

Find-A-Doc System Write-up

Our main objective in creating this system is improving access to healthcare. In order to achieve our objective, our system is going to provide a number of services as outlined:

1) The system is intended to help users find the appropriate doctor/clinic for their condition according to their search criteria. This will make access to healthcare faster because of a geographical capability, and which is achieved through GPS technology. This service also provides options/choices for users to choose from the list of doctors, which improves access to healthcare. To achieve this, we use the analytical capability that is implemented using Google Analytics software/GPS Analytics functionality.

2) Another service to be provided is allowing the patient to make a booking. This will greatly improve convenience for patients because of the mobility capability. They can book their appointments using the Mobile App/Web technology (with database technology included). Providing this service to the patients makes the booking process faster through the automatical capability, as patients can easily do the booking using the Mobile App/Web technology (with database technology included).

3) The system will remind the patient of the booking (e.g. a day before). This greatly improves access to healthcare, as it provides convenience for the patient. The convenience is brought about by the tracking capability and it is achieved using SMS technology, email technology and push notifications technology.

4) Sharing the experience is another service to be provided by the system. Patients can share their experience after their visits to the doctor and this is done centrally, which makes the process easier. To achieve this the social mediation capability is used and this is achieved using mobile app/web technology. This service also reduces information redundancy, since it will be done from a central point. This is achieved by the informational capability using the mobile app/web technology (with database technology included).

5) The system will also enable keeping track of doctor's visits. This preserves the patient's dignity and to achieve it we use the tracking capability achieved by the mobile App/Web technology. This service will also make it easier for the patient to track the visits, which is achieved by the informational capability. The mobile app/web technology (with database technology included) is used to achieve this.

6) Another service offered is keeping track of the prescriptions that the doctor has given the patient. This improves access to health care by making it easier to get that information. This is achieved by the informational capability through the mobile app/web technology. It also provides convenience for the patient through the tracking capability. This is achieved by the mobile app/web technology (with database technology included).

(Cont)

7) The system will also keep track of the patient's medical aid status. This greatly improves convenience for the patient through the informational and disintermediation capabilities. These capabilities are achieved through the mobile/Web technology (with database technology included).

8) The system will send tips and hints to the patient; this provides convenience for the patient using the informational capability and achieved by the push notification technology.

9) More information about the doctor is also provided by the system, which is convenient for the patient using the informational capability achieved through the mobile app/web technology.

10) The system will show the patient the appropriate doctor for his/her medical aid. This makes the process easier because of the informational capability and also makes it cheaper using the same capability. This is achieved by using the mobile app/web technology.

11) The system will also advise on the likely shortfalls on the patient's medical aid packages. This assures the customer's dignity and is achieved through the informational capability by using the mobile app/web technology.

12) The system will help the patient/doctor to make bookings with laboratories. This brings convenience through the geographical capability and is achieved using GPS technology.

13) Pharmacy recommendations are another service provided by the system. This gives the patient more choice through the informational capability and it is achieved using the mobile app/web technology (with database technology included).

14) Seasonal disease notifications can be sent to the patient, offering the patient choices through the informational capability; this is achieved through the mobile app/web technology.

15) The system will also provide information on convenience of access to the doctor's surgery (dogs, children, parking, working hours/days). This improves security for the patient's property and adds to convenience for the customer as well. All this is achieved through the informational capability and the mobile app/web technologies (with database technology included) used.

16) The system will provide a service to search for a specific doctor (e.g. by name). This makes the process of looking for a doctor easier and improves convenience for the patient. This is through the informational capability and it is achieved through the mobile app/web technologies (with database technology included).

17) Post-treatment services offered by a particular doctor are also shown to the patient. This makes it cheaper for the patient and it is achieved through the informational capability using the mobile app/web technology (with database technology included).

18) The system will also give nutritional recommendations to the patient and this ensures convenience through the disintermediation capability and is achieved by the mobile app/web technology (with database technology included).

19) The system will provide information to the patient on the accepted payments methods for a particular doctor. This offers convenience to the patient through the informational capability and it is achieved using the mobile app/web technology (with database technology included).

20) The system will also have a service to send next of kin notifications, which will make the process faster through the disintermediation capability; this is achieved using the mobile app/web technology (with database technology included).

6.4.6. Find-a-doc: Testing feedback

The find-a-doc prototype summary was evaluated by an evaluation team consisting of the researcher, the head of the development house and an outsider who represented the views of a patient. The evaluation team felt that the solution as proposed was consistent with the POV stated by the design team. The evaluation team also agreed that the proposed solution covered the basic requirements as stated in empathy-definition (Figure 79) and noted that the design team had aligned the technology capabilities with generic technologies, albeit at a high level.

The evaluation team expressed concern that the design team had not described the components of the solution that would be used by other players forming part of the service offering. The design team did not, for example, describe the component of the solution that would be used by doctors, their administrators or family members. The prototype did not discuss the interfaces that would have to be developed for external parties to make the system complete, nor did the design team describe the steps they would take to ensure that the system would be acceptable, with the network of influence around the main beneficiaries of the system.

A large part of the shortcomings of the prototype description by the find-a-doc team resulted from the fact that the team followed the process up to the penultimate stage and failed to undertake an own evaluation before handing the prototype to the evaluating team. Had the process been followed to the end, the team would have ensured completeness of their prototype.

Figure 82: Extract from prototype-testing spreadsheet: Find-a-doc

Prototype - Evaluation

	Project Name :	Find-a-doc									
	Date :	23-Nov-17									
		Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the		Is this service consistent with POV as per definition phase?	
	Services	**Benefit:**		**Actors**		**Institutions**		**Networks**		**POV**	
	What services are needed and not offered?										
1	Find the appropriate doctor/ clininc for my condition	Patient	Yes	Patient, Doctor, Family	No	Surgery/ Clinic	No	Friends, Family, Social Media & Me	No		Yes
2	Make a booking	Patient/ Doctor	Yes	Admnistrator	No	Surgery/ Clinic	No	0			Yes
3	Reminded of the booking eg a day before	Patient	Yes	Family	No	0		0			Yes
4	Share the experience with friends	Patients/ Friends	Yes	0		0		Friends	No		Yes
5	Keep track of visits to the doctor	Patient	Yes	Family	No	0		0			Yes
6	Keep track of the prescriptions that the doctor has given	Patient	Yes	Family	No	0		0			Yes
7	Keep track of medical aid status	Patient	Yes	Family	No	Medical Aid	No	0			Yes
8	Hints and tips about my health	Patient	Yes	Doctor	No	0		0			Yes
9	More information about the doctor	Patient	Yes	Admnistrator, Doctors	No	0		Friends, Family, Social Media & Me	No		Yes
10	Appropriate doctor for my medical aid	Patient	Yes	Medical Aid, Administrator	No	0		0			Yes
11	Likely short falls	Patient	Yes	Medical Aid, Administrator	No	Medical Aid	No	0			Yes
12	Ability to make bookings with labs	Patient/ Labs	Yes	Administrator, Doctor	No	Labs	No	0			Yes
13	Pharmacy recommendations	Patient	Yes	Doctor	No	0		Friends, Family, Social Media & Me	No		Yes
14	Seasonal disease notifications	Patient	Yes	Doctor	No	Ministry of Health	No	0			Yes
15	Access convenience (dogs, kids, parking, working hours/	Patient/ Family	Yes	Administrator	No	0		Friends, Family, Social Media & Me	No		Yes
16	Search for a specific doctor	Patient	Yes	0	No	0		0			Yes
17	Post treatment services	Patient	Yes	Doctor	No	0		0			Yes
18	Nutritional recommendations	Patient	Yes	Doctor	No	0		Friends, Family, Social Media & Me	No		Yes
19	Acceptable payment methods	Patient	Yes	Administrator	No	0		0			Yes
20	Next of kin notifications ?	Patient/ Family	Yes	0	No	0		0			Yes

6.4.7. Technovation Process evaluation summary

The find-a-doc team was able to use the Technovation Process with minimal input from the researcher. Their process led to the specification of a system that can be deployed to solve a practical problem faced by patients seeking the services of a doctor. The specification was deemed incomplete by the evaluation team mainly because the team's solution did not encompass all the elements that would make the solution complete. This shortfall arose because the team did not carry out the final step of self-evaluating their solution. Undertaking this step would have meant revising the prototyping stage and producing specification for the missing components of the solution.

6.5. Assessing the Value of the Contribution

6.5.1. Why Technovation?

The Technovation Framework and the resultant Technovation Process are built on an already widely used design thinking process. Why then should it be important for practitioners to consider using this framework? The answer to this lies in the components that have been brought together to make up this Technovation Process.

Service components of the Technovation Process

The use of services allows for better ***consolidation of empathy*** input. One of the major criticisms of design thinking is that a large amount of information is collected and design teams are overwhelmed. Much of what is collected is lost in the process of collecting it and design thinking offers no discernible means of collating empathy input and presenting it to design teams. Teams are therefore left to participate based on their understanding of the empathy collected. Other than storyboards and post-it notes, the process of moving content from empathy into the rest of the design process appears informal and poorly controlled. This observation was apparent as the Technovation Process developed, with the early stages being based on the use of storyboards and post-it notes; much of the empathy input was lost at subsequent stages of the development process, as team members appeared to rely on their memories of what had been presented before. The use of templates in later versions allowed for better consolidation and transmission of information from one mode of design to the next.

The service component of the framework presents a ***checklist of information*** that designers need to formulate a comprehensive solution. During the various design exercises, team members became aware that there were gaps in their understanding of the empathy input presented to them. In the workshops where service beneficiaries were present, it was possible to ask additional questions that allowed them to furnish the complete information required to paint a complete picture of the service ecosystem. Understanding networks, for example, are key to ensuring the success of new or improved services, yet few of the designers consciously thought of these. The use of the template allowed them to focus on what would otherwise have been a blind spot in their design.

The use of the service component of the framework forces designers always to ***consider the beneficiary*** of the service. This approach, when carried through to the definition mode of the design, ensures that designs are human-centred and are being undertaken with a specific user in mind. Each of the service components explored must have a beneficiary in mind, ensuring that the resulting design is human-centred, in line with good design thinking principles.

The Technovation Process uses the service requirements as a checklist of the ***completeness of a design***. This process ensures that all services that have been proposed within the specification of user needs are carried through in the design and that appropriate solutions are assigned to satisfy the requirement. The use of the templates also ensures that all aspects of service offering have been catered for. In addressing a particular requirement, the process demands the proposed solution to provide coverage for the actors that offer service. APIs must be provided to organisations that participate in service delivery. The solution must also address how the network that has an impact on service delivery will be addressed.

In all the design workshops conducted, designers immediately started to focus on solutions as soon as empathy input was revealed. This meant that solutions were incomplete, as invariably their understanding of the empathy input was incomplete, something that became immediately apparent the moment they started filling in the components of the service ecosystem. The use of the Technovation Process therefore served as a means to ***distance designers from the solution***, at least until the needs of service beneficiaries were fully understood. This also ensured that by the time the design team moved into ideation, they had a fuller understanding of the requirements space.

Technology components of the Technovation Process

The Technovation Process is anchored on two aspects of technology, technology opportunity and technology capability. The observed benefit of these two components was a continuation of **buffering designers from technology solutions** to allow better exploration of the solution options.

The Technovation Process demands that the design team apply their minds to possible improvements or technology opportunities in each and every service offering. This step is distinct from identifying <u>how</u> the technology will be delivered; it simply explores <u>if</u> technology can be applied to improve a service. This process requires little understanding of technology and allows lay people, those that do not have detailed understanding of how technology works, to suggest potential improvements. It was observed during the workshops that the technologists tended to rush to dismiss ideas and argued that certain things could not be done or would be difficult to do. This needs to be discouraged to ensure that all potential solutions are explored at a later stage. Although the name Technovation suggests technology-based innovation, this process ensures that technology is only brought into play once the problem space has been fully explored and potential solutions have been considered.

The use of the technology capabilities allows the design teams to focus on technology independent of the solution sought. Prior to design workshops, technologists are encouraged to create their own appropriate technology capability catalogue that can be presented to the design team. Distinct from the required solution, this catalogue will simply state in laymen’s terms what the technology on offer can do. Technologists must try to resist limiting their catalogue to what they believe is required for the solution. Bringing the technology opportunities and technology capabilities together allows non-technologist and technology specialists to work together to find a solution.

Three key benefits therefore arise from this process:

- Abstraction of technology capabilities prevents technologists from being distracted by the solution in their minds.
- Technology opportunities and capabilities allow non-technologists to participate.
- The process ensures that a solution is considered for each and every service offering.

Industry rules components of the Technovation Process

Industry rules ensure that the applicable rules are considered as the solution is being designed. On the one hand it forces design teams to consider whether the solutions they are designing are in line with existing rules. On the other hand it forces them to consider recommendations for changes to existing rules that may need to be made to allow their proposed solutions to work.

6.5.2. Evaluating the contribution

Hevner, Ram, March and Park (2004) suggest a way of evaluating the contribution of DSR. This study follows the guidelines for producing acceptable research and Table 69 presents evidence of compliance with the various guidelines provided. DSR must result in the production of an artefact. The Technovation Framework described in this chapter is an example of such an **artefact**. This framework was further developed into the Technovation Process, whose usage is also described in this chapter. The **relevance** of the problem that the Technovation Framework is targeted at is service innovation in the healthcare sector. The resulting process, however, is of such a generic nature that it can be employed in a service sector. Several design activities undertaken as part of this study showed that the Technovation Process could be used to design technology solutions that would solve real-life problems.

Table 69: Evaluation of Contribution		
Guideline	Description	Evidence
Design as an Artefact	DSR must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.	The Technovation Framework, along with the resulting process and user guide, is described in Chapter 6 of this work
Problem Relevance	The objective of DSR is to develop technology-based solutions to important and relevant business problems.	The Technovation Process was employed to develop seven prototypes of technology-based solutions as summarised in Table 69 in Chapter 7.
Design Evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.	The evaluation of the Technovation Process is documented in Chapter 5; further evaluation of the process is provided in Chapter 6.
Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.	The main contribution of this study is the artefact described in Chapter 6.
Research Rigour	DSR relies on the application of rigorous methods in both the construction and evaluation of the design artefact.	The construction and evaluation of the Technovation Framework follows the process as described in the literature and is documented in Chapter 3 and Chapter 4.
Design as a Search Process	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment.	The search for the artefact started from the literature and its evaluation in a healthcare setting was subject to ethical guidelines as produced by the university.
Communication of Research	DSR must be presented effectively to both technology-oriented and management-oriented audiences.	The output of this research is published in this thesis and will in future be published in research journals.

Six design exercises were used to refine the development of the process and a seventh was used to validate its efficacy. These processes were documented initially through photographs of stick-up boards and in subsequent workshops through Excel spreadsheet templates. Each design exercise was followed by an **evaluation** of the resulting prototype as well as the design process itself. The main **contribution** of the study is the Technovation Framework and the associated Technovation Process. The research **rigour** in the development of the framework is documented in Chapter 4, where the theoretical constructs are brought together to form the initial framework and in Chapter 5, where a cyclic development process is followed in fine-tuning the framework. The **search process** for the various constructs that make up the framework started with the literature review in Chapter 2 and continued with the practical evaluation in Chapter 5. This work will be **published** as a research thesis and articles will be extracted for publication in industry journals.

This work fits in with the research agenda proposed by Barrett, Davidson, Prabhu and Vargo (2015), particularly in the areas of digital innovations, user experience and inter-organisational innovation, given the emphasis on user engagement, technology capability and the focus on service ecosystems. Aspects of this study also resonate with the emerging research areas of digital and open innovation, service ecosystems and networks and co-creation, and co-design as indentified by Sangiorgi, Prendiville, and Ricketts (2014) in setting a research agenda for the UK. Bitner, Ostrom and Morgan (2007), with agreement from Chuang, Liu and Tsai (2010), identify the absence of disciplined innovation in service industries, calling for renewed focus on innovations methods, techniques and practices for services. This work is a contribution to this desire to focus on service delivery.

The results of the work undertaken align with the findings of Robbins et al. (2014) that participants from different backgrounds can work together to innovate through the use of design thinking techniques. The results also support the findings of Patel, Moore, Blayney and Milstein (2014), who find that design thinking approaches can help practitioners think beyond their day-to-day practices. The findings on the nature of the service delivery ecosystem in healthcare as identified by the various design teams align with the findings of Price and St John (2014) who argue that innovation in healthcare should be focused on meeting the needs of the patient and those responsible for the patient's care.

This work collaborates the work of Reijonsaari (2013) along with Chen, Tsou, and Ching (2011) and McColl-Kennedy et al. (2012), who argue that co-creation must be tailoired to suit the circumstances, represented in the framework as industry rules, and the customer. The use of diaries for collection of data validates the work undertaken by Elg et al. (2012). Sauro, Sara and Alberto's (2013) finding that co-production in healthcare redefines the relationship between professionals and users was validated by the conduct of mothers as they put across their points to midwives in the design workshops. The complexity of the healthcare ecosystem highlighted in the design workshops collaborates the work of Pinho et al. (2014), as well as the findings of McColl-Kennedy et al. (2009). The collection of empathy data prior to the conduct of a design workshop validates the process undertaken by Das et al. (2015).

6.6. Summary

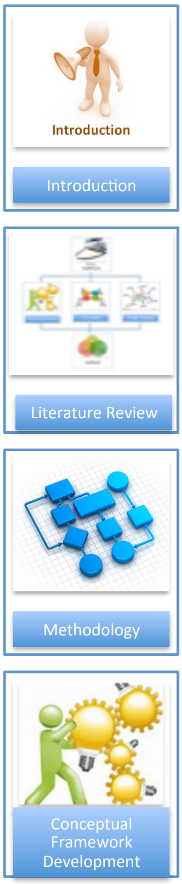
The focus of this chapter was on answering the MRQ as posed as the start of the study:

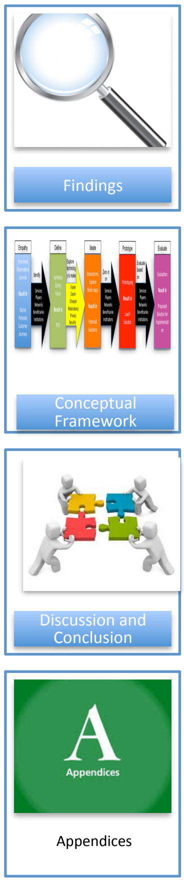
MRQ
How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

In providing the answer to the MRQ, the chapter has consolidated the work done in answering the SRQs as well as the DRQ. This chapter therefore briefly reconsidered the construction of the Technovation Framework and process in answer to SRQ1:

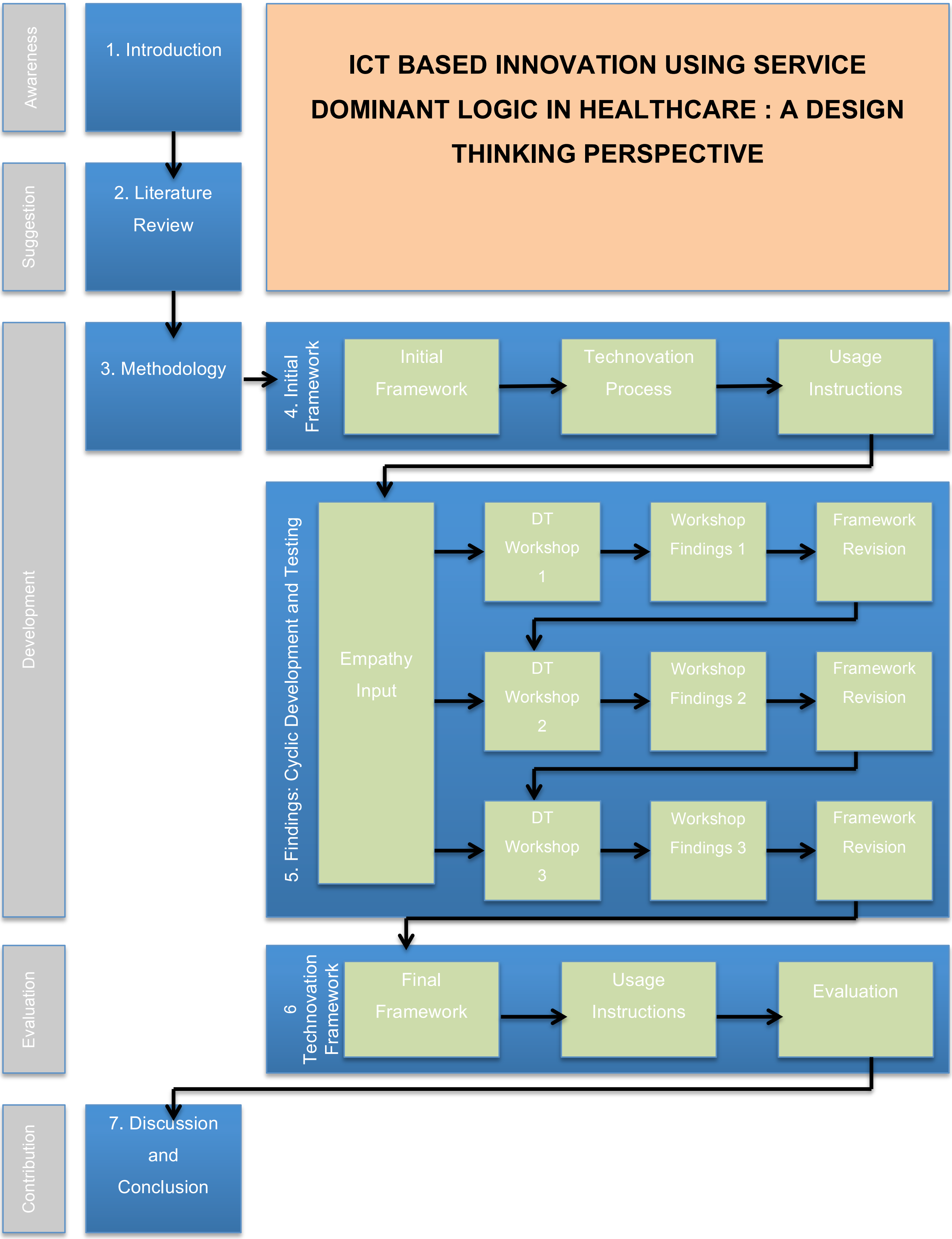
SRQ1
How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?

This chapter did not attempt to recreate or summarise the work undertaken in refining the framework (answer to SRQ2) or recalling the domain experience (answer to DRQ). However, it reports on the conduct of an additional Technovation workshop, which leads to further evidence of the efficacy of the technovation and triangulates the findings reported in Chapter 5 in response to SRQ3. This chapter therefore presented the components of the Technovation Framework, starting with the theoretical basis of the framework and the empirical observations that led to changes in the initial framework. A description of the Technovation Process, which arose from the framework, was followed by a guideline for using the Technovation Process. The Technovation Process was used by a software development team to explore the development of a system to help patients locate a doctor in their vicinity. The process undertaken by this team is documented in section 6.4 and was used as a final validation of the efficacy of the process.





7.
Discussion and Conclusions


Awareness
1. Introduction
ICT BASED INNOVATION USING SERVICE DOMINANT LOGIC IN HEALTHCARE : A DESIGN THINKING PERSPECTIVE
Suggestion
2. Literature Review
Development
3. Methodology
4. Initial Framework
Initial Framework
Technovation Process
Usage Instructions
5. Findings: Cyclic Development and Testing
Empathy Input
DT Workshop 1
Workshop Findings 1
Framework Revision
DT Workshop 2
Workshop Findings 2
Framework Revision
DT Workshop 3
Workshop Findings 3
Framework Revision
Evaluation
6 Technovation Framework
Final Framework
Usage Instructions
Evaluation
Contribution
7. Discussion and Conclusion

7.0 Discussion and Conclusion:

Chapter Map

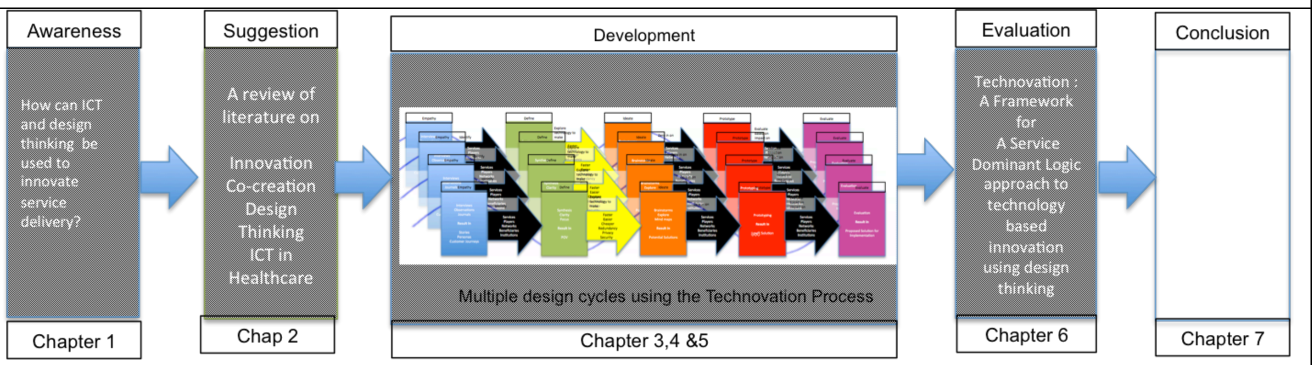
Section		***Key Ideas***
7.1 Introduction		
	7.2 Summary	This section summarises the research, focusing on answering the research questions posed. Answers to the research questions are provided in the summary, with references to the detailed discussion in the body of the thesis.
	7.3 Discussion	This section discusses the lessons learnt from the research. A methodological reflection looks at what could have been done better. A substantive reflection locates the research in the context of other work on design thinking in ICT. Finally, a scientific reflection turns to the contribution made by the study.
	7.4 Recommendations	The study makes no policy recommendations, but recommendations for further research are presented together with a suggestion for further development work on the Technovation Process.
	7.5 Closing Remarks	The closing remarks are a personal reflection of the journey undertaken.

7. DISCUSSION AND CONCLUSIONS

7.1. Introduction

This study explored the intersection of the ideas of innovation based on co-creation, technology capabilities and the application of design thinking techniques in human-centred design. The study explored SDL (Vargo & Lusch, 2004; Vargo & Akaka, 2009; Vargo et al., 2014; Vargo & Lusch, 2016; Vargo & Lusch, 2017) as the foundational theory and combined the key constructs espoused in the five axioms as a basis for defining the ecosystem around which service is offered. This was combined with technology capabilities based on a design thinking process to develop the Technovation Framework and process. As an area of application, the study looked at how these concepts could be applied to improve healthcare service using ICT, particularly in low-resource environments that typify the African landscape. The proposed framework was evaluated in a number of design workshops, which resulted in the design of several prototypes that could be developed into solutions to aid service delivery in healthcare.

***Figure 83: Journey to Chapter 7**



This work is presented in seven chapters. Chapter 1 presents a broad outline of the study area, justifying the need for a study of this nature. Chapter 2 presents an overview of the literature, investigating the areas of ICT in healthcare, co-creation, innovation and design thinking. Chapter 2 concludes with the recommendation to develop a framework that links the key ideas presented in the literature reviewed. Chapter 3 describes the methodological choices adopted in advancing this work, settling on a pragmatic philosophical stance to underpin a DSR project. The proposed conceptual framework was developed in Chapter 4, tested and refined in Chapter 5, in which the results of a study into the lives of women receiving post-natal care are presented as empathy input into a series of workshops that use the Technovation Framework to design service improvements using ICT.

Chapter 6 presents a finalised Technovation Framework, which reflects the changes that arose from the iterative testing presented in Chapter 5. Chapter 6 also presents the results of a final evaluation workshop to validate the findings of Chapter 5. The final sector of Chapter 6 is an evaluation of the artefact as well the conformity of the design process to DSR principles. Chapter 7 serves as a conclusion to the study and discusses the key lessons from this study, as well as serving as a reflection of the journey undertaken. Chapter 7 ends with recommendations on how this work can be advanced in future.

7.2. Summary

This section presents the main lessons from the study, which are presented here in the form of summaries of answers to the research questions posed at the start of the study.

7.2.1. Addressing the main research question

The primary research question defined for the study was:

MRQ
How can information and communication technology and design thinking be used to innovate service delivery in healthcare?

In order to answer the MRQ, a literature review was conducted to understand how ICT has in the past been employed to improve service delivery, especially in healthcare (Chapter 2). During the literature review thematic coding was used to identify concepts used in the later framework.

The literature showed a long history of use of ICT in healthcare, starting with databases on diseases in 1940s and 1950s, diagnostics in the 1960s and 1970s, patient records in the 1980s and 1990s and an increasing focus on mobility, homecare and concerns about privacy heading into the new millennium. The focus of the study thus turned to how the innovation process could be made easier, especially in the face of a push for patient-centred services.

The study looked at how innovation is conducted and how design thinking, a human-centred way (Section 2.6.3) of driving innovation, could be used. The study further investigated the concept of co-creation and the ideas abput SDL gave 'hints' on how designers could take an ecosystem view to innovation that centred on the beneficiaries of services. This led to the development of the Technovation Framework, a tool that can be used by design teams to come up with innovative solutions based on ICT for improving service delivery (Chapter 4).

Refinement of this framework indicated that although beneficiaries of service delivery could be included in design teams, their contribution was less important than an in-depth understanding of their circumstances by the design teams (Chapter 5). In the workshops conducted with mothers, the power dynamics of having mothers and midwives at the same table seemed to disempower the mothers. Empathy input collected from the mothers in their home environments appeared to carry more weight and the result of subsequent workshops held without the mothers appeared to produce equally compelling solutions (Section 5.4.2.3). Design thinking advocates that solutions be taken back to the beneficiaries to test acceptance of the experience, implying that this is a valid recommendation.

One of the justifications for designing a framework for use in innovation was based on criticism of design thinking projects as often being chaotic and long-winded. Observation from this study showed that teams that followed the process closely produced solutions that were more comprehensive and did so in a much shorter time frame. Part of the efficiency may have come from a focus on understanding the empathy input as opposed to regenerating it, as may have happened in the earlier phases in which mothers were present. Another fact that may have resulted in greater efficiency may have been the focus that the framework brought about, in that it requested that the team spend time on specific input that would be required in the development of solutions later in the design process.

The use of technology capabilities brought about the desired effect of abstracting technology capability from the technology itself. This, coupled with the ideas of technology opportunities, allowed non-technical design team members such as the midwives to make comments such as "This could be faster if …", "This would be more convenient if …" A casual acquaintance with technology meant that they could ask for a technological capability without having any inkling of how that technology would actually work or what that technology could be (Section 5.3.2.4). A menu of technology capabilities was used as a way to jolt ordinary subject matter experts into improvements that could be brought about in their lives.

A late addition to the framework was the concept of industry rules. During the testing of the first set of prototypes generated from the Technovation Process workshops, it became clear that industry rules often dictate the success or failure of solutions (see Section 6.2.4). While innovations such as Uber may suggest that their success will force changes in legislation, contemporary experience (Telegraph, The, 2017) suggests that designers need to understand the rules, and if necessary push for changes in legislation with full understanding of the constraints in mind. Industry rules such as ethics, standards, guidelines and legislation play an important role in the health sector and must be carefully considered prior to the launch of any service (Chapter 5).

The role of social networks in influencing service delivery was very clear in the empathy collection mode of the project. Families, neighbours and churches played a very important role in influencing how services were consumed. Equally influential were social media networks such as Whatsapp, Facebook, Instagram, Twitter and Google, all of which served as a source of information for service beneficiaries. This information was occasionally used to challenge the narrative provided by professional service providers. In designing service interactions, design teams struggled to conceptualise how these networks could be turned into tools that could be used in favour of the service providers.

The lessons learnt from the study suggest that the Technovation Framework (presented in Chapter 6, Section 6.2.6), with continued development, could serve as part of the answer to how ICT can be used to improve service delivery, not just in healthcare, but in any service-focused business.

7.2.2. Addressing the sub- research questions

The following SRQs were posed and addressed in tackling the objectives of this study:

SRQ1
How can a Technovation Framework that guides technology-based service innovation in healthcare be constructed?

Chapters 3 to 5 of this study deal with the mechanics of the construction of the Technovation Framework and the associated Technovation Process. Starting with a suggested conceptual framework that arose from a search of the literature in Chapter 2, Chapter 3 describes the methodological choices made and maps out the process of developing, refining and evaluating the framework. Chapter 4 explores the components that make up the Technovation Framework and these are developed into a functional process for use in technology-based innovation. Chapter 4 also builds up the components of the Technovation Process and develops the instructions for using the process.

The proposed framework is built on the concept of service as the fundamental basis of all economic exchange as espoused in the theory of SDL. Adopting the five axioms (Chapter 2: Table 23) of service in SDL, the Technovation Framework proposes basing all service design and re-design on the identification of the service ecosystem. Thus, for each service offering being designed/redesigned, designers must identify who the beneficiaries are, the players involved in co-creating the service, the institutions that participate in service delivery and the networks that affect the delivery of these services. The service ecosystem is used to frame empathy input that goes into a design thinking process, helping designers consolidate their empathy findings in an effort to shape an appropriate POV. This POV is used to guide an ideation process that challenges designers to look for technology-based improvements in each area of the service ecosystem as defined in the empathy mode.

The ideas of technology opportunities and technology capabilities are used to keep the technological exploration process at a conceptual level, allowing non-technologists to participate well into the design process and delaying any discussion of actual technology options to the prototyping mode and beyond. The service ecosystem comes into play again as the design team validates the completeness of a prototype against the user needs, as specified in the POV and the service ecosystem definition. Also of relevance at this stage are the industry rules that are likely to affect the adoption of the proposed solution.

Chapter 5 describes the collection of empathy data to be used in testing the Technovation Process, identifying post-natal care as a problem area requiring service innovation. Using the initial Technovation Process as a starting point and the empathy data as input, several design workshops were conducted, resulting in a refined process with each iteration. Each of the workshops result in the development of a prototype solution that employs readily available ICT tools.

SRQ2

How can the Technovation Framework be refined in an e-health environment?

Starting with the Technovation Framework and Technovation Process as constructed in Chapter 4, Chapter 5 was devoted to refining both the framework and the process.

An intensive eight-week study into the lives of new mothers and those offering them post-natal care was conducted at a hospital in Zimbabwe. This study provided a window into the lives of those for whom solutions were being sought. The output of the study was used as empathy input into a series of design thinking workshops, guided by the Technovation Process. Six design teams reviewed the same empathy input and came up with six different prototype solutions. The experience of each team was captured and where necessary adjustments were made to the framework and the process.

The workshops also provided a valuable opportunity to observe design teams at work, leading to valuable lessons on team dynamics in a design environment. The impact of life experiences as well as work experience was seen as affecting the outcome of designs. Equally influential was the expertise of those involved in the design exercise. Commercial interests among team members were also seen as playing an influential role in how designs unfolded. Other variables that affected the design outcomes included power dynamics with the team and the stage of evolution of the process.

The final Technovation Process as described in Chapter 6 was put to the test in the development of a solution independent from the empathy input collected for the refinement process. The design workshop described in Chapter 6 was focused on designing a solution for patients attempting to locate a suitable doctor in their neighbourhood.

SRQ3

What are the outcomes of using the Technovation Framework in an e-health environment?

The empathy input collected in the eight-week-long study into the provision of post-natal care services was presented as empathy input into a series of design initiatives. Equipped with the Technovation Process, the teams were asked to study the empathy input and suggest potential solutions. Although the initial focus of the study and one of the reasons for choosing Chitungwiza Hospital for this study was an attempt to expand the use of their SAP healthcare platform, lack of cooperation from the local SAP service provider meant that the researcher had to find alternative solutions within reach of the hospital. In the end, mobile application developers were approached and challenged to come up with prototypes of solutions that would cost no more than $5 000 to develop. Six prototypes were produced, covering a range of potential improvements to service delivery.

Table 70: Prototypes

Team/ Solution	Solution
A-Team: Nutrilife	A mobile-based solution to provide mothers with information on nutrition and to monitor baby growth
Med-Innov	A breastfeeding application whose primary functions included providing information on the importance of breastfeeding, breastfeeding techniques, breastfeeding sitting position, breastfeeding reminder, diet, breast conditions, breast hygiene, signs of poor breastfeeding. The proposed application provided additional functions for growth monitoring (monitored by the hospital), support groups, financial support, donor funding, support link/help desk.
Tech-Health	A general information system providing mothers with information on nutrition, feeding and information on mothers' hygiene.
Technovators	A general information system for mothers providing information on personal hygiene, breastfeeding, immunisation, nutrition, family planning, kangaroo care, a journal functionality, baby care and notices
The Margaret Team	The prototype is a combination of a web-based application for use in hospitals and in clinics, together with a mobile-based application for use by the mother. The team proposal is for an education campaign to accompany the launch of the system so that the issues concerning the social networks that affect mothers' access to medical services are addressed
Post-natal Healthcare Reloaded	A comprehensive suite of applications for caregivers (including mothers), healthcare professionals, an automatedartificial intelligence bot and a hospital scheduling system designed to automate and coordinate post-natal service delivery.

The tremendous interest in breastfeeding by the first four groups was a result of a touching presentation of the story of a mother in the study who lost her baby because of poor breastfeeding. All the teams at the session felt that they had to incorporate functionality into their solution to aid breastfeeding and monitor baby growth.

The solutions proposed ranged from simple single-use applications such as for breastfeeding, to a comprehensive proposal to coordinate the efforts of all service providers while making accessing healthcare simple and affordable for mothers. Although none of these solutions had been developed into working solutions at the time of writing, at least one of the development teams had indicated that they would be working on producing working systems. The hospital at which this research was conducted had also expressed willingness to pilot the systems.

As part of the final evaluation of the Technovation Framework in Chapter 6, the design team focused on the development of an application to help patients locate a suitable doctor in the neighbourhood. The find-a-doc solution was designed to cover the chain of activities that patients encounter when then need a doctor and soon after they have seen a doctor. The proposed solution offered functionality to locate a doctor, book an appointment and send reminders of the appointment to both patient and doctor. Patients would be able to find more information on the doctor, including a rating of the doctor based on other patients' experiences, the payment methods accepted by the doctor and access to the doctor's rooms, such as operating hours, parking and wheelchair access. After the appointment, patients would have the ability to rate the doctor and to keep track of the bookings history and future bookings. An information service would provide information on medical tips, seasonal disease information and nutritional tips.

While the focus of this study was the development of the framework, the production of the prototypes present an opportunity to improve healthcare, should these prototypes be developed into full solutions. The usefulness of mobile phone in improving healthcare is documented in the literature (Lewis et al., 2012) and similar applications to the ones developed by the teams were highlighted in the literature. Examples of these include a solution for midwives (Chib, 2010), a mobile application for use in clinical settings (Svanoes et al., 2010) and a health information application (Cocosila & Archer, 2010).

7.2.3. Domain Research Question

DRQ
What are the challenges faced by hospitals and patients in the delivery of post-natal care?

The eight-week study into the work of healthcare workers providing post-natal care and the experiences of mothers after birth provided the basis for answering the DRQ.

Challenges: The hospital perspective

Both sides of the service delivery expressed frustration with the manner in which the service was being delivered and used. Hospital staff complained about the availability of resources to allow them to do their jobs. Midwives were overworked, poorly remunerated and had little in the way of resources required for them to do their jobs. Linen was in short supply and the number of beds was limited, leading to early discharges, and they did not have access to sufficient drugs. The use of manual systems meant that midwives spent many hours that could have gone to attending to patients on administrative work. Nurses felt that they could not devote sufficient time to training mothers on baby care, as the process was highly manual and mundane and mothers paid little attention anyway, as they were in pain.

Existing practice meant that midwives could not follow up new mothers after discharge, leaving a large part of the post-natal care in the hands of the mother herself, who was expected to look for any further assistance from elsewhere in the healthcare system, such as clinics and private doctors. Of major concern to the midwives was the lack of coordination between the hospital and other healthcare providers. Those who were taking over the provision of care for the mothers depended on a card that the mother carried around. These cards were often misplaced or damaged or had limited information on them. More concerning for the hospital was that the hospital had no way of knowing if the mother had indeed received follow-up attention in the days after giving birth.

The lack of a proper information management system meant that the management of information was largely manual. Although an SAP system has been installed, the lack of terminals and the heavy licensing cost of the software meant that the system was only used for registering patients and maintaining their financial information. This lack of a system meant that the hospital maintained minimal information on the mothers and their babies in a register. This register gave no information on the services delivered to the mother even during their stay in hospital, yet was time-consuming to compile and took midwives away from the duty of attending to mothers and their babies.

Challenges: The mothers' perspective

This study was conducted in a low-income community and it came as no surprise that funding was a major challenge for the mothers. This challenge manifested itself in many ways that were either observed or reported by the mothers themselves. Several mothers faced the embarrassment of being detained at the hospital for failing to pay the bills due to the hospital. Because the hospital itself failed to provide drugs to the mothers, some mothers went without simple drugs such as painkillers while they waited to raise funding to buy them. At home some mothers lacked resources to buy adequate food for themselves to be able to produce enough milk for their babies. Mothers lacked resources to travel to hospital to attend mandatory baby inspections. Occasionally mothers did not return to the hospital for fear of being confronted about outstanding bills.

First-time mothers struggled with information on how to take care of their babies, many relying on family and neighbours. Many felt that the education provided to mothers at the hospital was inadequate and was delivered while they were in pain and therefore did not sink in sufficiently to enable them to take advantage of it when faced with a challenge at home. The internet, when they could afford it, served as a supplementary source of information on which mothers relied. Mothers also used pharmacies as a proxy for clinics and hospitals, noting that they were treated with more dignity and respect at the pharmacies than at the hospitals.

The issue of dignity was a recurring theme with most mothers, who felt that hospital staff did not treat them with the dignity they deserved. A few mothers described the behavior of nursing staff as cruel and dreaded having to face them. Mothers were generally unhappy with the quality of care they received from the midwives, with a few exceptional commendations being made.

Families, neighbours, churches and other social networks played an important role to assist mothers in accessing service from hospitals and clinics. Some mothers reported that their husbands did not allow them to leave home alone and as a result they could not return to the hospital for mandatory inspections. One mother explained that her church did not allow her to look for any further medical attention other that the delivery of the baby, which was demanded by law, so she would not return to the hospital and risked breaking a law that demanded the immunisation of babies.

7.2.4. Addressing the objectives of the study

Figure 84: Addressing the study objectives and questions

	Research Objective	Research Question	Addressed in	Evidence
MRQ	To develop a framework for ICT-based service innovation using design thinking techniques. This framework is tested and enhanced in a healthcare setting.	How can ICT be used to innovate service delivery?	Chapter 6	Technovation Framework and process
SRQ1	To construct a framework that guides technology-based service innovation	How can a Technovation Framework that guides technology-based service innovation be constructed?	Chapter 4	Technovation Framework and process
SRQ2	To refine the Technovation Framework in an ehealth environment	How can the Technovation Framework be refined in an e-health environment?	Chapter 5	Technovation Framework and process
SRQ3	To produce sample prototype solutions through the use of the Technovation Framework and process.	What are the outcomes of using the Technovation ramework in an e-health environment?	Chapter 5	Prototypes
DRQ	To obtain domain knowledge and identify a problem to be solved using the Technovation Framework	What are the challenges faced by hospitals and patients in the delivery of post-natal care?	Chapter 5	Health workers and mothers' perspectives

The main objective of this study was to develop a framework for ICT-based service innovation using design thinking techniques. This framework was tested and enhanced in a healthcare setting. The sub-objectives were:

- Construction of the framework
- Refining the framework
- Producing sample solutions
- Obtain domain knowledge and identify problem to be solved using the framework.

The main objective of this study led to the development of the Technovation Framework and the associated Technovation Process. This objective was met through the work undertaken in Chapter 3 to 5 and is finalised in Chapter 6 where the final Technovation Framework and final process are presented. The sub-objectives as stated were designed to satisfy the main objectives.

Construction of the Technovation Framework started in earnest in Chapter 3 where the roadmap was defined and was continued in Chapter 4 where the initial framework was laid out and the process defined. ***Refining*** the framework was conducted over six workshops, as described in Chapter 5. Each of these workshops resulted in a prototype of a ***sample solution*** and these solutions are summarised in Table 70. A further solution was developed in Chapter 6 as part of the testing of the final version of Technovation Process. ***Domain knowledge*** in healthcare, particularly in the area of post-natal care, was a necessary pre-requisite for testing the framework and associated process and this was achieved in Chapter 5.

7.3. Discussion

7.3.1. Methodological reflection

The purpose of this study was to build a framework for use in technology-based service innovation in healthcare. The process of developing the framework followed a five-step process as summarised in Figure 78. The problem ***awareness*** was focused on a healthcare environment on which much of the justification was based. As the study unfolded, it became clear that the framework could be used in any industry. The introduction of the industry rules construct after the first set of workshops provides a platform for applicability in any other industry. This applicability was not explored in this study and could be the subject of future work.

The search for solution ***suggestions*** looked broadly at innovation, SDL theory and co-creation, as well as design thinking, as tools that could be used to construct an appropriate design artefact. In line with the justification in Chapter 1 around the healthcare domain, a survey of existing solutions focused on the healthcare industry. It is unlikely that broadening the domain area would have added extra value to the process.

Chapter 3, which signalled the start of the ***development*** phase, was largely domain-agnostic, and could have served a similar purpose even with a different application domain. This independence was carried through into Chapter 4, where the initial framework was discussed. The cyclic development in Chapter 5 was based on the healthcare case study, producing specialised solution prototypes for the industry. Each of the development cycles described in Sections 5.3, 5.4 and 5.5 resulted in the development of solution prototypes, which were tested as part of the Technovation Process. At the end of the development cycles, a formal evaluation of the Technovation Framework and Technovation Process was conducted in Chapter 6. With hindsight, use of the same formal evaluation process at the end of each of the development cycles (in 5.3, 5.4 and 5.5), applied to the evolving Technovation Framework and process, would have enhanced the rigour and validity of the resulting process.

7.3.2. Substantive reflection

In exploring the role of design thinking in IT projects, Plattner, Meinel, and Leifer (2012) propose four models of using design thinking in such projects (see Table 71). In the split project model, design thinking is pre-development work that is undertaken by a specialist design thinking team that hands over requirements to a development team. In the overlapping teams model, some of the developers participate in the design-thinking workshop, then continue with the development work without some of the earlier participants. In the toolbox model, design thinking is seen as a tool set that developers can call on to solve specific problems in the development environment. The Technovation Process proposes the engagement of design teams that include the development staff that will carry the project through to completion. Developers will take with them a solution prototype with sufficient information to allow them to build a solution that is consistent with the requirements specified in the design thinking workshops. This method is therefore consistent with the "unified project model" in which design thinking plays a central role in the front end of the development process.

Table 71 : The Role of Design Thinking in Technology Projects

(Plattner et al., 2012)

Model	Description
Split project model	Design thinking is handled as a separate process performed by a specialised "design thinking team" before the IT-development process starts (→ design thinking as a service). Its main purpose is to map out potential directions in terms of user needs and to inform the IT development process with an initial "package" that is handed over to the subsequent development
Overlapping teams model	An initial design process is used to inform the subsequent development process, but instead of "throwing the package over the fence", one or more project members of the development team participate in the design thinking process to be able to act as an communication agent to explain and maintain the design knowledge gained throughout the development process.
Unified project model	Design thinking is a central technique for the front end of the development process itself. The overall process is changing from design thinking to an IT development process when the conceptions of problem and solution are specified enough to translate them to development tasks. This implies that there is a strong overlap of personnel and management responsibilities between both the design thinking and the development phases.
Toolbox model	Design thinking is not regarded as a distinct project or process phase, but as a bundle of methods developers can draw on to solve certain design problems they could not solve by means of common IT development methods. In this case, design thinking is narrowed down to a well-defined box of tools for adaptive support.

Frow, Nenonen, Payne and Storbacka (2015) offer a different context to review this work. The co-creation design framework looks at the different categories and dimensions of co-creation work. Table 72 maps out the locus of the Technovation Framework within the co-design framework. Thus the workshops conducted in the evaluation of the framework engaged customers in the form of mothers/patients and suppliers in the form of nurses/midwives in the co-design of a technology platform to enhance customer experience. The level of engagement was largely emotional during the empathy-gathering phase in a one-off design exercise.

Table 72: Co-creation design framework

Frow, Nenonen, Payne and Storbacka (2015)

	Dimensions					
Categories	**Co-creation motive**	**Co-creation form**	**Engaging Actor**	**Engagement Platform**	**Level of Engagement**	**Duration of Engagement**
	Access to resources	Co-creation of ideas	Focal Firm	Digital Application	Cognitive	One-off
	Enhance customer experience	Co-design	Customer	Tool of product	Emotional	Reccurring
	Enable self service	Co-production	Supplier	Physical resources, spaces/events	Behavioural	Continous
	Create more competitive offerings	Co-promotion	Partner	Joint processes		
	Decrease cost	Co-pricing	Competitor	Personnel groups		
	Faster time to market	Co-distribution	Influencer			
	Emergent strategy	Co-consumption				
	Build brand awareness	Co-maintenance				
		Co-outsourcing				
		Co-disposal				

Observation from the evaluation of the Technovation Framework suggests that the developers involved found the process a quick and effective way for them to understand requirements and clarify any misunderstandings they might have had about the requirements. It is hoped that this body of work will help to bridge the gap between those expecting improvements to service delivery and having faith in technology, and those that have the capacity to deliver these solutions.

7.3.3. Scientific reflection

This study's main contribution to knowledge is the Technovation Framework and the associated process. According to Gregor (2006), one of the five types of information systems theory is a class of theory referred to as design and action theory. This type of theory explains how an activity is conducted, more specifically prescribing how an artefact can be constructed. The Technovation Framework and process build up knowledge by proposing a process that makes it easier for design teams to understand user circumstances, document their needs and enlist the participation of non-technologists in solution design. The Technovation Process results in the production of a system prototype as the main deliverable.

While the process is likely to be of interest mainly to practitioners, the observations of the behaviour of designers during the testing of the process present useful information that may be of interest to other scientists who wish to study the behaviour of practitioners. The empathy input collected presents useful domain information to those wishing to understand the lives of those seeking post-natal care services and the perspectives of those who provide the services. The prototype solutions generated are likely to be of interest to those developing solutions for the healthcare sector.

7.4. Recommendations

7.4.1. Recommendations for further research

The technology capabilities that were used as part of this project are based on work that was at least 27 years old at the time of writing. An attempt was made to update these capabilities, but the reality is that they will continue to change as technology advances and will need to continue to be updated. Further work therefore needs to be done to expand the technology capabilities that are relevant in contemporary times. The Technovation Framework uses an industry rules construct that the researcher believes can be expanded on. The current construct lists as its components legislation, standards, guidelines and ethics. It is possible that other rules exist that will make this framework more relevant in all settings. Having made that point, it is important to note that the rules that make up these components are of necessity local and must be tailored to each environment and industry in which the framework is used. In line with the two recommendations above, while the researcher believes that the framework should be applicable in any industry setting subject to the use of an appropriate rules framework, more work needs to be done to evaluate it in other settings.

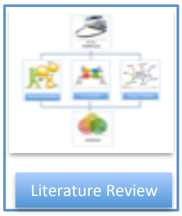
Vargo and Lusch (2017) discuss the issue of operant and operand resources and how these affect service delivery. In the Technovation Framework, resources are only considered as a factor in deciding if a solution is implementable or not. A more thorough treatment of the role of resources in service delivery and service quality may be required in future.

7.4.2. Recommendations for further development work

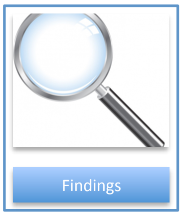
The first iteration in the development of the Technovation Process was in the form of a set of guidelines for undertaking design thinking projects. The second iteration produced an updated process, using Microsoft Excel spreadsheets to facilitate the capture of output and to ease the process of transferring output from one mode of the design process to another. A useful extension of this would be to develop the process into an application that captures the key outputs and allows design team members to share this output electronically. A further development proposed during one of the design cycles was to develop the application so that sufficient information could be captured to allow the application to output a requirements document that can be used as design input by a developer.

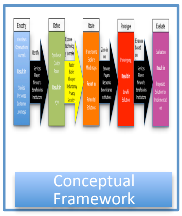
7.5. Closing remarks

One is always hesitant to conclude that one has done enough. As a participant in the online Design Thinking Group on LinkedIn (www.linkedin.com), the researcher is aware of the multitude of issues that the more than 101 000 members raise. The discipline continues to grow in all dimensions. The use cases are varied, the industrial applications are many and the challenges members raise can be both trivial and game-changing. One's contribution always seems so insignificant, paltry maybe, even trivial. Yet the process of getting this work done has been satisfying. The experience of understanding the lives of new mothers and presenting them with an opportunity to tell their stories was worthwhile. The chance to sit with young developers and suggest to them a better way of doing what they do was priceless. Above all, the opportunity of immersing oneself deeply into an area of interest can only bring satisfaction.



8. Appendices





Appendix A – Data Collection Guides Overview

This appendix presents an overview of the data collection instruments used to collect data as part of this research. The actual guides are presented in full in the appendices that follow.

Section	Interviewee	Questions
Problem Diagnosis: The purpose of the problem diagnosis activity is to zero in on a real-life problem that is of interest to practice. In this case, post-natal care has been identified as being problematic based on literature (World Health Organisation, 2015). This activity now identifies what aspects of offering this service are of concern to the different players, including the patients (mothers)	Hospital Heads	What challenges do you face in offering post-natal care?
	[IG 01]	Who are the key players, within and outside the hospital?
		What is their role?
		What is the desired level of contact with the hospital after birth?
		How do you communicate with mothers?
		How proactive is the hospital in initiating contact with them?
		How involved is the hospital in the lives of the patients after discharge?
		How is post-natal care funded? How do you relate to the funders?
		What ICT tools are in use to make this service offering easier?
		If you could, what would you do to improve the service; what stops you?
	Nurses/Doctors	What is your role in offering in post-natal care?
	[IG 02]	What challenges do you face in delivering this service?
		How often are you in touch with mothers after a birth?
		Are there any proactive efforts involved or you expect mothers to come in?
		How do you contact mothers?
		How do you keep track of information about mothers?
		How long do mothers stay in hospital after birth?
		What ICT tools are in use to make this service offering easier?
		How do you educate new mothers on health issues?
		Are there any activities that the mother comes in for that could be done at home?
		If you could, what would you do to improve the service; what stops you?
	Mothers - Initial	What challenges do you face in obtaining help from hospital post-birth?
	[IG 03]	Who do you normally deal with at the hospital?
		How often have you been in touch with the hospital since you gave birth?
		How do you communicate with the hospital?
		Do you keep a record of your interaction with the hospital?
		How do you get information on your child's health?
		Do you have access to a TV? Radio? Landline? Cell phone? Smartphone?
		~~Are you on social media (Whatsapp??), what do you use it for?~~
		How can the hospital better serve you?
	Mothers - Follow	~~What has been your experience with the baby since you gave birth? (Focus on non-clinical information only)~~

	[IG 04]	Have you had to contact the hospital since then?
		How did you contact the hospital?
		Did you have to go there?
		Did they remember you?
		Did they have any information about your baby?
		Describe your experience with the hospital.
		What other issues have you had with the baby?
		What is your experience with the journal? Any suggestions?
	Journal Guide	Journals will be given to mothers who pass the initial selection criteria. These criteria are aimed at selecting mothers who are literate, can maintain a private diary or have no issues with sharing it with their family, and are willing to accept visitors into their homes for follow-up visits. The purpose of the journal, to collect information that can help the hospital improve service delivery, will be explained to mothers. Mothers will be encouraged to write out, in free format, their thoughts and experiences with their babies on a daily basis. It will be explained that there are no right or wrong answers and their personal details will not be written in the journal; they will be identified by a code written in the journal upon issue.
	[JG 01]	
[redacted]		[redacted]

Section	Interviewee	Questions
Solution Design This activity takes the problem defined above as input and challenges the workshop participants to develop and prototype a solution to the problem	All stakeholders [WG 01]	This instrument is built around a design thinking workshop. The Stanford d.school "An Introduction to Design Thinking PROCESS GUIDE" is used to guide this process. Each workshop session begins with a presentation on the expectations of the session. Overview cards, with information on the expectations of the session, are presented prior to participants being broken up into groups. Each session starts with a set of inputs and is expected to produce some output for use in the next session. This workshop is held in an environment conducive to thinking with minimal disruptions, preferably off-site. The researcher provides lunch, tea and other refreshments for the day. Other necessary arrangements include: • Posters with ideas on innovation • Design thinking posters • A projector and screen • Multi-coloured post-it notes • Enough boards for the teams to work on • Notepads • Miscellaneous materials for prototyping ideas (tape, cardboard, paper) • WIFI access? • Printing facility The agenda for the session is as follows: 08:30 Introductions and workshop objectives 09:00 Empathy: The empathise mode is the work you do to understand people, in the context of your design challenge. It is your effort to understand the way they do things and why, their physical and emotional needs, how they think about world, and what is meaningful to them 10:00 Define The define mode of the design process is all about bringing clarity and focus to the design space. It is your chance, and responsibility, as a design thinker to define the challenge you are taking on, based on what you have learned about your user and about the context. After becoming an instant expert on the subject and gaining invaluable empathy for the person you are designing for, this stage is about making sense of the widespread information you have gathered. 11:30 Ideate Ideate is the mode of the design process in which you concentrate on idea generation. Mentally it represents a process of "going wide" in terms of concepts and outcomes. Ideation provides both the fuel and the source material for building prototypes and getting innovative solutions into the hands of your users. 13:00 Lunch Break 14:00 Prototype The prototype mode is the iterative generation of artefacts intended to answer questions that get you closer to your final solution. 15:30 Test The test mode is when you solicit feedback from your users about the prototypes you have created and have another opportunity to gain empathy for the people for whom you are designing. Testing is another opportunity to understand your user, but unlike your initial empathy mode, you have now probably done more framing of the problem and created prototypes to test. 16:30 How do we implement this? 17:00 Close

Section	Interviewee	Questions
Technology Evaluation This activity evaluates the efficacy of the proposed solution. This will be done through interviews with key stakeholders.	Hospital Heads	The session begins with a brief presentation of the proposed solution.
	[IG 05]	What are your thoughts on the proposed solution?
		Is the solution consistent with the expected service offering?
		If you could change any aspect of the solution, what would you change?
		What would make it difficult to implement this solution?

Appendix B - Invitation to Participate in Research Letter

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Department of Informatics
IT Building, Level 5
University of Pretoria
Cor. Lynnwood Road & Roper Street
Hatfield
Pretoria, 0083
Republic of South Africa

15 November 2016

Dear Sir/Madam,

RE: Research into the use of ICT in Service Innovation in Healthcare

I am a student within the Department of Informatics at the University of Pretoria, Gauteng Province, South Africa. I am currently conducting research for the purposes of my doctoral thesis focusing on the use of Information and Communication Technology in driving service innovation in healthcare. Due to the broad nature of healthcare, I have decided to focus my work on post-natal (in the broader sense to include postpartum) care and how this can be improved by using information and communication technology.

The objective of this study is to investigate how health workers utilize IT to improve service delivery and to develop a framework for the implementation of ICT in healthcare. In order to achieve this objective, I will seek to work, with both patients and a team of professionals, through the process of identifying the current challenges with delivering post-natal care. I also intend to, using design-thinking techniques, to work with the team to identify potential solutions; prototype and test selected solutions; and with the right approvals implement them. From a research perspective, I intend to document this process and ultimately develop a framework that can be used to address similar problems in healthcare.

Your participation in the study as a respondent is herewith requested. In the case of interviews, this will be no more than one and half hours of your time. In the case of a workshop, a full day's participation will be required. Please be assured that the information provided will be utilised for research purposes only and all responses will be strictly confidential. No individual responses will identified as such and the identities of the respondents will not be published or released to anyone. All information will be used for academic purposes only.

Your input will be greatly appreciated. If you have any queries please do not hesitate to contact me on: +27-79-612-8424 or alexmarufu@gmail.com. Also, note my research supervisor is Prof. Alta van der Merwe and she is available on 012 420-3798 or alta@up.ac.za.

Yours sincerely,

Alex Masiya Marufu

University of Pretoria

+27-79-612-8424

Approved by: -

Prof. Alta van der Merwe

University of Pretoria

012 420-3798 or alta@up.ac.za.

Appendix C: Researcher Declaration

RESEARCHER DECLARATION

APPLICATIONS MUST INCLUDE THE FOLLOWING STATEMENTS

Hereby I, Masiya Passmore Alex Marufu in my capacity as a PhD student and researcher, declare that

1 Research subjects will be informed, information will be handled confidentially, research subjects reserve the right to choose whether to participate and, where applicable, written permission will be obtained for the execution of the project (example of permission attached).

2 No conflict of interests or financial benefit, whether for the researcher, company or organisation, that could materially affect the outcome of the investigation or jeopardise the name of the university is foreseen.

3 Inspection of the experiments in loco may take place at any time by the committee or its proxy.

4 The information I furnish in the application is correct to the best of my knowledge and that I will abide by the stipulations of the committee as contained in the regulations.

5 Signed: ______________________ Date: 15 October 2016

Appendix D: Informed consent form (Mothers)

PICD 2

PATIENT OR PARTICIPANT'S INFORMATION AND INFORMED CONSENT DOCUMENT

STUDY TITLE:

CO-CREATION FOR SERVICE INNOVATION USING INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN THE HEALTH SECTOR: A DESIGN THINKING PERSPECTIVE

SPONSOR:

Professor Alta van der Merwe
Deputy Dean, EBEIT
University of Pretoria
012 420-3798 or alta@up.ac.za

PRINCIPAL INVESTIGATOR:

Masiya Passmore Alex Marufu (PhD Information Systems Student)

INSTITUTION:

Department of Informatics
Faculty of Engineering, Built Environment and Information Technology
University of Pretoria

DAYTIME AND AFTER HOURS TELEPHONE NUMBER(S):

Daytime numbers: +263-717-801188 or +27-79-612-8424
Afterhours: +263-717-801188 or +27-79-612-8424

DATE AND TIME OF FIRST INFORMED CONSENT DISCUSSION:

Day	Month	Year

:
Time

Dear Miss / Mrs. ____

Date of consent interview/workshop: ______/_______/ 2017

1) INTRODUCTION
You are invited to volunteer for a research study. This information leaflet is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. If you have any questions, which are not fully explained in this leaflet, do not hesitate to ask the investigator. You should not agree to take part unless you are completely happy about all the procedures involved.

2) THE NATURE AND PURPOSE OF THIS STUDY
You are invited to take part in a research study. The aim of this study is to evaluate the manner in which hospitals deliver post-natal care. By doing so we wish to learn more about service delivery and how we can utilize Information and Communication Technology to improve how hospitals serve their patients.

3) EXPLANATION OF PROCEDURES TO BE FOLLOWED
This study involves answering some questions with regard to your contact with the hospital and how they deliver services to you. Some of the questions will focus on any needs that you have that the hospital is failing to service.

4) RISK AND DISCOMFORT INVOLVED.
This study will only involve answering of questions and in the case of mothers, the filling in of journals over a six-week period. The purpose of these journals is to allow mothers to track their service needs on a daily basis and use these as a trigger to remind them of assistance they would require from the hospital if it was more easily accessible. This journal exercise should not affect the physical condition of the mother in any way. The researcher and a qualified midwife will conduct follow up interviews in the patient's home to check on the progress with filling in journals. Neither the interviews nor the journals should be seen as replacing the normal contact that the mother has with the hospital.

All interviews conducted with mothers, nurses and doctors will be recorded. Those participating in the workshop that forms a part of this study may be recorded on video.

5) POSSIBLE BENEFITS OF THIS STUDY.
Should this study be successful, and the necessary approvals received for the implementation of its recommendations, this study should lead to improvements in how hospitals provide services to mothers after their discharge from hospital.

6) CONTINUATION OF SERVICE
I understand that if I do not want to participate in this study, I will still receive the normal services expected from the hospital.

7) WITHDRAWAL
I may at any time withdraw from this study.

8) HAS THE STUDY RECEIVED ETHICAL APPROVAL?
This Protocol was submitted to the Faculty of Health Sciences Research Ethics Committee, University of Pretoria, telephone numbers +27-12 356 3084 / +27-12 356 3085 and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2013), which deals with the recommendations guiding doctors in biomedical research involving human/subjects. A copy of the Declaration may be obtained from the investigator should you wish to review it.

9) INFORMATION If I have any questions concerning this study, I should contact:

Dr ________________________________ Tel : ________________or cell: ________________

10) CONFIDENTIALITY
All records obtained whilst in this study will be regarded as confidential. Results will be published or presented in such a fashion that patients remain unidentifiable.

11) CONSENT TO PARTICIPATE IN THIS STUDY.

I have read or had read to me in a language that I understand the above information before signing this consent form. The content and meaning of this information have been explained to me. I have been given opportunity to ask questions and am satisfied that they have been answered satisfactorily. I understand that if I do not participate it will not alter my management in any way. I hereby volunteer to take part in this study.

I have received a signed copy of this informed consent agreement.

____________________________ ________________

Patient name Date

____________________________ ________________

Patient signature Date

____________________________ ________________

Investigator's name Date

____________________________ ________________

Investigator's signature Date

____________________________ ________________

Witness name and signature Date

VERBAL PATIENT INFORMED CONSENT

Not applicable as such patients who are unable to fill in the journals will be excluded from the study

Appendix E: Informed consent form (Others)

Informed consent form for HealthCare workers

(Form for research participant's permission)

(Must be signed by each research participant, and must be kept on record by the researcher)

STUDY TITLE:

CO-CREATION FOR SERVICE INNOVATION USING INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN THE HEALTH SECTOR : A DESIGN THINKING PERSPECTIVE

SPONSOR:

Professor Alta van der Merwe
Deputy Dean, EBEIT
University of Pretoria
012 420-3798 or alta@up.ac.za

PRINCIPAL INVESTIGATOR:

Masiya Passmore Alex Marufu (PhD Information Systems Student)

INSTITUTION:

Department of Informatics
Faculty of Engineering, Built Environment and Information Technology
University of Pretoria

DAYTIME AND AFTER HOURS TELEPHONE NUMBER(S):

Daytime numbers: +263-717-801188 or +27-79-612-8424

Afterhours: +263-717-801188 or +27-79-612-8424

DATE AND TIME OF FIRST INFORMED CONSENT DISCUSSION:

Day	Month	Year

:
Time

Dear Dr. / Mr. / Mrs./ Miss ____

Date of consent interview/workshop: ______/_______/ 2017

1) INTRODUCTION

You are invited to volunteer for a research study. This information leaflet is to help you to decide if you would like to participate. Before you agree to take part in this study you should fully understand what is involved. If you have any questions, which are not fully explained in this leaflet, do not hesitate to ask the investigator. You should not agree to take part unless you are completely happy about all the procedures involved.

2) THE NATURE AND PURPOSE OF THIS STUDY

You are invited to take part in a research study. The aim of this study is to evaluate the manner in which hospitals deliver post-natal care. By doing so we wish to learn more about service delivery and how we can utilize Information and Communication Technology to improve how hospitals serve their patients.

3) EXPLANATION OF PROCEDURES TO BE FOLLOWED

This study involves answering some questions with regard to how hospitals deliver post-natal care and how these services can be improved especially through the use of Information and Communication Technology.

4) RISK AND DISCOMFORT INVOLVED.

This study will only involve answering of questions and possible participation in a workshop to explore potential solutions to problems identified. All interviews conducted will be recorded. Those participating in the workshop that forms a part of this study may be recorded on video.

5) POSSIBLE BENEFITS OF THIS STUDY.

Should this study be successful, and the necessary approvals received for the implementation of its recommendations, this study should lead to improvements in how hospitals provide services to mothers after their discharge from hospital.

6) CONTINUATION OF SERVICE

I understand that if I do not want to participate in this study, I will still receive the normal services expected from the hospital.

7) WITHDRAWAL

I may at any time withdraw from this study.

8) HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This Protocol was submitted to the Faculty of Health Sciences Research Ethics Committee, University of Pretoria, telephone numbers +27-12 356 3084 / +27-12 356 3085 and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2013), which deals with the recommendations guiding doctors in biomedical research involving human/subjects. A copy of the Declaration may be obtained from the investigator should you wish to review it.

9) INFORMATION If I have any questions concerning this study, I should contact:

Dr ____________________________________ Tel : _________________or cell: _________________

10) CONFIDENTIALITY

All records obtained whilst in this study will be regarded as confidential. Results will be published or presented in such a fashion that patients remain unidentifiable.

11) CONSENT TO PARTICIPATE IN THIS STUDY.

I have read or had read to me in a language that I understand the above information before signing this consent form. The content and meaning of this information have been explained to me. I have been given opportunity to ask questions and am satisfied that they have been answered satisfactorily. I understand that if I do not participate it will not alter my management in any way. I hereby volunteer to take part in this study.

I have received a signed copy of this informed consent agreement.

Participant's name Date

Participant's signature Date

Investigator's name Date

Investigator's signature Date

Witness name and signature Date

VERBAL PATIENT INFORMED CONSENT
Not applicable as such patients who are unable to fill in the journals will be excluded from the study

Appendix F : Faculty of EBIT Ethics Approval

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

27 February 2017

Mr MAP Marufu
Department of Informatics
University of Pretoria
Pretoria
0028

Dear Mr Marufu,

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

The EBIT Ethics Committee has considered your application "Co-creation for service innovation using ICT in the health sector: A design thinking perspective" (EBIT/87/2017).

Aspects of the research work that are within the context of Information and Communication Technology (ICT) have been approved by the EBIT Ethics Committee. However, as the research is within the application domain of health sciences, final approval of the research should be obtained from the Faculty of Health Sciences Research Ethics Committee. Therefore, kindly submit an application to that committee.

Please keep the EBIT Ethics Committee informed about the progress with your application to the Faculty of Health Sciences Research Ethics Committee.

The Committee wishes you every success with the research project.

Prof JJ Hanekom
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

Appendix G : Faculty of Health Sciences Ethics Approval

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.

- FWA 00002567, Approved dd 22 May 2002 and Expires 03/20/2022.
- IRB 0000 2235 IORG0001762 Approved dd 22/04/2014 and Expires 03/14/2020.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences Research Ethics Committee

18/04/2017

Approval Certificate
New Application

Ethics Reference No.: EBIT/87/2017

Title: CO-CREATION FOR SERVICE INNOVATION USING ICT IN THE HEALTH SECTOR: A DESIGN THINKING PERSPECTIVE

Dear Mr Masiya Marufu

The **New Application** as supported by documents specified in your cover letter dated **29/03**/2017 for your research received on the 31/03/2017, was approved by the Faculty of Health Sciences Research Ethics Committee on its quorate meeting of 12/04/2017.

Please note the following about your ethics approval:

- Ethics Approval is valid for 1 year
- Please remember to use your protocol number (**EBIT/87/2017**) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, or monitor the conduct of your research.

Ethics approval is subject to the following:

- The ethics approval is conditional on the receipt of **6 monthly written Progress Reports**, and
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

Dr R Sommers; MBChB; MMed (Int); MPharMed,PhD
Deputy Chairperson of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes, Second Edition 2015 (Department of Health).

☎ 012 356 3084 deepeka.behari@up.ac.za / fhsethics@up.ac.za http://www.up.ac.za/healthethics
✉ Private Bag X323, Arcadia, 0007 - Tswelopele Building, Level 4, Room 60, Gezina, Pretoria

MAP Marufu : Design Thinking Workshop

CO-CREATION FOR SERVICE INNOVATION USING INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN THE HEALTH SECTOR : A DESIGN THINKING PERSPECTIVE

MAP Marufu, University of Pretoria

2017

Overview

The purpose of this workshop is to present the findings of the doctors', nurses and mothers interviews as well as excepts of the mothers' journals as the empathy input into a design journey. Using four design teams each consisting of two nurses, two mobile developers and two mothers; the teams are tasked with developing a Point of View (POV) relating to a problem or a number of problems (related to postnatal care) that they would like to tackle based on the empathy input. Each team is then tasked, after presenting their POVs to the rest of the group, to focus on one problem, unique to the group that they then ideate and build a prototype. As part of the testing, the prototype is presented to the rest of the group, which by this stage will have been joined by doctors who will help evaluate the prototype, with a prize being offered to the winning team to fund the development of a working model.

ICT in Healthcare
A design thinking led workshop

Date
5 August 2017

Venue
Holiday Inn Hotel Harare

Time	Facilitator	Content
08:00 – 08:15	DrMoyo	Introduction
08:15 – 08:45	Manti Grobler	Design Thinking overview
08:45 – 09:45	Alex Marufu	Empathy building
09:45 – 10:00	Tea	
10:00 - 11:00	Manti	Define Creating a POVs
11:30 – 12:00	Alex	Presentation of POVs
12:00 – 12:30	Manti	Ideate Thinking about options
12:30 – 13:30	Lunch	
13:30 – 15:30	Manti/Alex	Prototype Fleshing out selection
15:30 – 15:45	Tea	
15:45 – 16:45	Alex	Test Presentation and judging
16:45 – 17:00	DrMoyo	Awards and Close

Pre-workshop Preparation

The following activities need to be completed two weeks before the workshop

- Developer competition
  - Public Invitation*
  - Shortlisting
  - Workshop Invitation
  - Evaluation criteria**
- Facility Booking
- Workshop Invites
- Facilitator briefing

Materials

The following must be procured or prepared: -

- Pens, charts, stickers, markers, tape, string, sticky stuff, posters, notepads
- Projector, Screen, WIFI, Printer
- Design thinking guides (d.school bootcamp process guide) for each team
- Consent letters for all participants
- Name badges

Post Workshop

- Leanings from the workshop will be captured as part of the author's dissertation and/or articles for publication in peer reviewed journals
- The app that will be developed by the winning team will be made available to Chitungwiza Hospital.

Appendix I : Workshop 2 Output

The following spreadsheets present the output of the second design workshop help as part of the refining of the Technovation Process.

Technovation Project Information [Workshop 2 : The Margaret Project]

Project Name :	The Margaret Project
Date :	5-Sep-17

Objective :	The purpose of this project is to design a set of technology driven processes that can lead to improvements in service delivery in the chosen space. The solution designed must be human centred and must comply with all the rules that impact the target industry

Information

1. This template can be used as part of a design thinking workshop.
2. It is used to guide design teams and to help them generate ideas on how to use technology to solve problems
3. It is based on the ideas of SDL and Technology Capability
4. The process is specially focused on service innovation using technology
5. Design teams are best made up of subject matter experts, designers, developers and users if possible

Instructions

1. Only make changes in the boxes marked in this colour :
2. Information from previous slides in indicated in the colour:
3. Teams must work on the templates starting from left to right, but may return to make adjustments to a previous page if required

This Process was design by MPA Marufu @ University of Pretoria 2017.

Empathy – Definition (1/2) [Workshop 2 : The Margaret Project]

Project Name :	The Margaret Project
Date :	5-Sep-17

	Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
	What services are offered?					
1	Hsp Mother physiological examination	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
2	Hsp Baby Examination	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
3	Hsp HIV Education and counselling	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
4	Hsp Initiation of baby on breast	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
5	Hsp Monitoring mother	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
6	Hsp Monitoring baby	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
7	Hsp Administration of BCG	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
8	Hsp Mother psychological evaluation	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
9	Hsp Mother education	Mother	Midwife, Doctor	Hsp, Clc		Record Keeping
10	Hsp Mother attention	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
11	Hsp Baby Attention	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
12	3D Mother physiological examination	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
13	3D Mother psychological evaluation	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
14	3D Baby Check	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
15	7D Baby Check	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
16	6W Baby Check	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking
17	6W Immunisation	Mother	Midwife, Doctor	Hsp, Clc	Family, Church, Social Media	Record Keeping, Advance Booking

Empathy – Definition(2/2) [Workshop 2 : The Margaret Project] (cont)

Project Name :	The Margaret Project
Date :	5-Sep-17

	Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
	What services are needed and not offered?					
1	Hom Monitoring mother	Mother	Midwife, Doctor, Social Worker	Hsp, Clc	Family, Church, Social Media	Record Keeping, Remote Monitoring
2	Hom Monitoring baby	Mother	Midwife, Doctor, Social Worker	Hsp, Clc	Family, Church, Social Media	Record Keeping, Remote Monitoring
3	Hom Mother attention	Mother	Midwife, Doctor, Pharmacist	Hsp, Clc, Pha	Family, Church, Social Media	Record Keeping, Remote Monitoring
4	Hom Baby attention	Mother	Midwife, Doctor, Pharmacist	Hsp, Clc, Pha	Family, Church, Social Media	Record Keeping, Remote Monitoring
5	Mobile bill payment	Mother	Finance teams	Hsp, Clc, Pha	Family, Church, Social Media	Payments
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Definition – Ideation [Workshop 2 : The Margaret Project]

Project Name :	The Margaret Project
Date :	5-Sep-17

We can improve the life					
ooff	mothers	by (doing)	providing them with easier access to medical services	to enable	to become better mothers

Ideation – Prototype [Workshop 2 : The Margaret Project]

Project Name :	The Margaret Project
Date :	5-Sep-17

	Services	Improvement possible?		Improvement		Capability		Improvement		Capability
	What services are offered?									
1	Hsp Mother physiological examination	Record Keeping	We can make this process	Easier	Through this capability	Knowledge Management	We can make this process	Convenience	Through this capability	Tracking
2	Hsp Baby Examination	Record Keeping		Easier		Knowledge Management				
3	Hsp HIV Education and counselling	Record Keeping								
4	Hsp Initiation of baby on breast	Record Keeping		Easier		Knowledge Management				
5	Hsp Monitoring mother	Record Keeping		Easier		Knowledge Management				
6	Hsp Monitoring baby	Record Keeping		Easier		Knowledge Management				
7	Hsp Administration of BCG	Record Keeping		Easier		Knowledge Management				
8	Hsp Mother psychological evaluation	Record Keeping		Easier		Knowledge Management				
9	Hsp Mother education	Record Keeping		Easier		Knowledge Management				
10	Hsp Mother attention	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
11	Hsp Baby Attention	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
12	3D Mother physiological examination	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
13	3D Mother psychological evaluation	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
14	3D Baby Check	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
15	7D Baby Check	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
16	6W Baby Check	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking
17	6W Immunisation	Record Keeping, Advance Booking		Easier		Knowledge Management		Convenience		Tracking

18	0	0				
19	0	0				
20	0	0				
	0	0				
	What services are needed and not offered?					
1	Hom Monitoring mother	Record Keeping, Remote Monitoring	Easier	Knowledge Management	Convenience	Imaging
2	Hom Monitoring baby	Record Keeping, Remote Monitoring	Easier	Knowledge Management	Convenience	Imaging
3	Hom Mother attention	Record Keeping, Remote Monitoring	Easier	Knowledge Management	Convenience	Tracking
4	Hom Baby attention	Record Keeping, Remote Monitoring	Easier	Knowledge Management	Convenience	Tracking
5	Mobile bill payment	Payments				
6	0	0				
7	0	0				
8	0	0				
9	0	0				
10	0	0				
11	0	0				
12	0	0				
13	0	0				
14	0	0				

Prototype – Testing [Workshop 2 : The Margaret Project]

Project Name :	The Margaret Project
Date :	5-Sep-17

		Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the		Is this service consistent with POV as per definition mode?	
	Services	Benefit:		Actors		Institutions		Networks		POV	
	What services are offered?										
1	Hsp Mother Physiological Examination	Mother	Y	Midwife, Doctor	Yes	Hsp, Clc	Y	0			Y
2	Hsp Baby Examination	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
3	Hsp HIV Education and Counselling	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
4	Hsp Initiation of Bby on Breast	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
5	Hsp Monitoring Mother	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
6	Hsp Monitoring Baby	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
7	Hsp Administration of BCG	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
8	Hsp Mother Psychological Evaluation	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
9	Hsp Mother Education	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	0			Y
10	Hsp Mother Attention	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
11	Hsp Baby Attention	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
12	3D Mother Physiological Examination	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
13	3D Mother Psychological Evaluation	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
14	3D Baby Check	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
15	7D Baby Check	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
16	6W Baby Check	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
17	6W Immunisation	Mother	Y	Midwife, Doctor	Y	Hsp, Clc	Y	Family, Church, Social Media	No		Y
18	0	0		0		0		0			

19	0	0		0		0		0			
20	0	0		0		0		0			
	0	0		0		0		0			
	What services are needed and not offered?										
1	Hom Monitoring Mother	Mother	Y	Midwife, Doctor, Social Worker	No	Hsp, Clc		Family, Church, Social Media	No		Y
2	Hom Monitoring Baby	Mother	Y	Midwife, Doctor, Social Worker	Y	Hsp, Clc		Family, Church, Social Media	No		Y
3	Hom Mother Attention	Mother	Y	Midwife, Doctor, Pharmacist	Y	Hsp, Clc, Pha		Family, Church, Social Media	No		Y
4	Hom Baby Attention	Mother	Y	Midwife, Doctor, Pharmacist	Y	Hsp, Clc, Pha		Family, Church, Social Media	No		Y
5	Mobile bill Payment	Mother	Y	Finance teams	Y	Hsp, Clc, Pha		Family, Church, Social Media	No		Y
6	0	0		0		0		0			
7	0	0		0		0		0			
8	0	0		0		0		0			
9	0	0		0		0		0			
10	0	0		0		0		0			
11	0	0		0		0		0			
12	0	0		0		0		0			
13	0	0		0		0		0			
14	0	0		0		0		0			
15	0	0		0		0		0			

Overall Considerations

Desirability	Yes	Is your solution likely to be accepted by its target users?
Feasibility	Yes	Does the technology required to build this solution exist?
Viability	Yes	Can this solution be built within a reasonable budget?

Industry Rules

Legislation	Yes	Does your solution comply with relevant legislation?
Ethics	Yes	Is your proposed solution ethical?
Standards	Yes	Does your solution meet standards relevant to your industry?

Appendix J : Workshop 3 Output

Empathy – Definition (1/2)

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
What services are offered?					
Vaccination	Baby	Midwives	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Infant health checkup	Baby	Midwives	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Information dissemination	Mother	Midwives	Hosps, Clinics	IF, EF, NF, RG	Remote communication.
Day to day advice	Mother	IF, EF, NF, RG	Hosps, Clinics	IF, EF, NF, RG	Communication
Child day care	Mother, Baby	Father, IF, EF, NF	Hosps, Clinics	IF, EF, NF	Education
Baby feeding	Mother, Baby	Mother, Father, IF, EF		IF, EF, NF	Education
Diagnosis	Baby	Midwives, Doctors, IF, EF, NF	Hosps, Clinics	IF, EF, NF, RG	Record keeping
Medication	Mother, Baby	Midwives	Hosps, Clinics, Pharmacies	IF, EF, NF, RG	Record keeping
At birth medical examination	Mother, Baby	Midwives	Hosps, Clinics	IF	Record keeping
At birth psychological and risk evaluation	Mother, Father	Midwives	Hosps, Clinics	IF, EF, RG	Record keeping
At birth counseling	Mother, Father	Midwives	Hosps, Clinics	IF, EF, RG	
Emergency healthcare at major hospitals	Mother, Baby	Doctors, Nurses	Hosps	IF, EF, NF, RG	Record keeping, Training
Birth Records	Mother, Baby	Midwives	Hosps, Clinics, RG office		Provision on discharge, Electronic record

Project Name :	Post-natal Healthcare Reloaded	Empathy – Definition (2/2)
Date :	12-Sep-17	

Services	Beneficiaries	Actors	Institutions	Networks	Improvement possible?
What services are needed and not offered?					
home visits	Mother, Father, Baby	Midwives, Community health workers	Hosps, Clinics	IF, RG	
On demand advice	Mother, Father	Midwives, Community health workers	Hosps, Clinics, Pharmacies	IF, EF, NF, RG	
Appropriate Transport	Mother, Baby	Transport service providers	Ambulances, Taxis	IF, EF, NF	
Financing	Mother, Father	Mother, Father, IF, EF	Government, NGOs	IF, EF	
Psychological health monitoring	Mother, Father	Midwives, Doctors, IF, EF, NF	Hosps, Clinics	IF, EF, NF	
Reporting/Feedback	Mother, Father	Midwives	Hosps, Clinics	RG	
Training of primary health support system (friends and family)	Mother, Father, IF, EF, NF, RG	Midwives, Community health workers	Hosps, Clinics	IF, EF, NF, RG	
Counseling	Mother, Father, IF, EF, NF, RG	Midwives, Community health workers	Hosps, Clinics, NGOs	IF, EF, NF, RG	
Direct communication between hospital and patient	Mother, Father	Midwives, Community health workers	Hosps, Clinics	IF, EF, NF, RG	
Support system education	IF, EF, NF, RG	Midwives, Community health workers	Hosps, Clinics	IF, EF, NF, RG	
Medication Adherence monitoring	Mother, Baby	Midwives, Community health workers	Hosps, Clinics	IF, EF, NF, RG	
Medical record sharing across health service providers	Mother, Baby	Midwives, Community health workers	Hosps, Clinics		
Prioritization and streamlining of resource allocation	Mother,	Midwives, Community health workers	Hosps, Clinics		
Educational outreach	Mother, Father, IF, EF, NF, RG	Midwives, Community health workers	Hosps, Clinics, NGOs		
Healthcare outposts	Mother, Baby	Midwives, Community health workers	Hosps, Clinics		
Hospital call centers	Mother, Father, IF, EF, NF	Midwives, Community health workers	Hosps, Clinics		
Child day care (alleviate mother's duties and allow her to rest)	Mother	Father, IF, EF, NF	Hosps, Clinics		
Remote diagnostics	Mother, Father, IF, EF, NF	Midwives, Community health workers	Hosps, Clinics		

Accessible communication channels	Mother, Father, IF, EF, NF	Midwives, Community health workers	Hosps, Clinics, MNOs		
Remote appointment system or similar outpatient wait time limiting system	Mother, Father, IF	Midwives, Community health workers	Hosps, Clinics		

Definition – Ideation (1/1)

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

We can improve the life					
of	Jane and her family	by (doing)	1. Providing a unified electronic health record for her newborn baby, that can be shared and used by many different health practitioners. 2. Improve access to information on post-natal care. 3. Improve ability for mothers to communicate with Midwives.	to enable	her to receive better healthcare from the health system

Ideation – Prototype (1/2)

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

Services	Improvement possible?		Improvement		Capability		Improvement		Capability		Improvement		Capability	What Technology can make this happen
What services are offered?														
Vaccination	Record keeping	We can make this process	Convenience	Through this capability	Knowledge Mgt	We can make this process	Easier	Through this capability	Geographica l	We can make this process		Through this capability		Firebase cloud storage, Mobile app
Infant health checkup	Record keeping		Convenience		Mobility		Flexibility		Mobility		Faster		Sequential	Firebase cloud storage, Mobile app
Information dissemination	Remote communication		Convenience		Geographical		Less Redundancy		Automation					Firebase cloud messaging, Mobile app, SMS
Day to day advice	Communication		Less Redundancy		Automation		Convenience		Mobility		Easier		Artificial Intelligence	Firebase cloud messaging, Mobile app, SMS
Child day care (	Education		Cheaper				Easier							Mobile app, Scheduling system
Baby feeding	Education													Firebase cloud storage, Mobile app
Diagnosis	Record keeping		Faster		Artificial Intelligence		Convenience		Geographica l		Cheaper		Imaging	Chat bot, Wit.ai, Mobile app, smartphone camera
Medication	Record keeping		Cheaper		Knowledge Mgt		Convenience		Geographica l					Firebase cloud messaging, Mobile app, SMS
At birth medical examination	Record keeping		Convenience		Knowledge Mgt									Firebase cloud messaging, Mobile app
At birth psychological and risk evaluation	Record keeping		Convenience		Knowledge Mgt									Firebase cloud messaging, Mobile app
At birth counselling	0													
Emergency healthcare at major hospitals	Record keeping, Training		Faster		Knowledge Mgt									Firebase cloud messaging, Mobile app
Birth Records	Provision on discharge, Electronic record		Convenience		Knowledge Mgt		Flexibility		Cloud computing					Firebase cloud storage, Mobile app, SMS

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

Ideation – Prototype (2/2)

Services	Improvement possible?	Improvement	Capability	Improvement	Capability	Improvement	Capability	What Technology can make this happen
What services are needed and not offered?	0							
home visits	0	Convenience	Geographical	Convenience	Mobility			Firebase cloud messaging, Mobile app
On demand advice	0	Convenience	Geographical	Easier	Mobility	Faster	Artificial Intelligence	Firebase cloud messaging, Mobile app, SMS
Appropriate Transport	0	Cheaper						
Financing	0							
Psychologial health monitoring	0	Privacy	Digital security					Mobile app
Reporting/Feedback	0	Privacy	Digital security	Convenience	Mobility	Convenience	Disintermediation	Firebase cloud messaging, Mobile app, SMS
Training of primary health support system	0	Easier	Sequential	Convenience	Geographical			Firebase cloud messaging, Mobile app, SMS
Counselling	0	Privacy	Digital security	Convenience	Geographical			Firebase cloud messaging, Mobile app, SMS
Direct communication with patients	0	Convenience	Disintermediation	Convenience	Geographical	Convenience	Mobility	Firebase cloud messaging, Mobile app, SMS
Support system education	0	Convenience	Geographical					Firebase cloud messaging, Mobile app, SMS
Medication Adherence monitoring	0	Easier	Mobility	Convenience	Geographical			Firebase cloud messaging, Mobile app, SMS
Medical record sharing	0	Faster	Knowledge Management	Convenience	Cloud computing			Firebase cloud storage
Prioritisation and streamlining of resource allocation	0	Faster	Sequential	Faster	Analytical			Firebase cloud messaging, Mobile app, SMS
Educational outreach	0	Cheaper	Social Mediation	Faster	Geographical			Firebase cloud messaging, Mobile app, SMS
Healthcare outposts	0	Choice	Geographical					
Hospital call centres	0	Convenience	Geographical					Firebase cloud messaging, Mobile app, SMS
Child day care	0	Easier	Social Mediation					Firebase cloud messaging, Mobile app,

														SMS
Remote diagnostics	0		Flexibility		Imaging		Convenience		Geographical		Less Redundancy		Artificial Intelligence	Firebase cloud messaging, Mobile app, SMS, AI, Image Processing
Accessible comms channels	0		Convenience		Mobility		Convenience		Geographical					Internet, SMS, Mobile App
Remote appointment system	0		Faster		Automation		Convenience		Geographical					Firebase cloud messaging, Mobile app, SMS

Prototype – Evaluation (1/2)

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

	Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the	
Services	Benefit:		Actors		Institutions		Networks	
What services are offered?								
Vaccination	Baby	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Infant health checkup	Baby	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Information dissemination	Mother	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Day to day advice	Mother	Y	IF, EF, NF, RG	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Child day care (watching a child while mom is resting or incapacitated)	Mother, Baby	Y	Father, IF, EF, NF	Y	Hospitals, Clinics	Y	IF, EF, NF	Y
Baby feeding	Mother, Baby	Y	Mother, Father, IF, EF	Y	0	Y	IF, EF, NF	Y
Diagnosis	Baby	Y	Midwives, Doctors, IF, EF, NF	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Medication	Mother, Baby	L	Midwives	L	Hospitals, Clinics, Pharmacies	L	IF, EF, NF, RG	L
At birth medical examination	Mother, Baby	Y	Midwives	Y	Hospitals, Clinics	Y	IF	Y
At birth psychological and risk evaluation	Mother, Father	Y	Midwives	Y	Hospitals, Clinics	Y	IF, EF, RG	Y
At birth counselling	Mother, Father	L	Midwives	L	Hospitals, Clinics	LIM	IF, EF, RG	L
Emergency healthcare at major hospitals	Mother, Baby	Y	Doctors, Nurses	Y	Hospitals	Y	IF, EF, NF, RG	Y
Birth Records	Mother, Baby	Y	Midwives	Y	Hospitals, Clinics, RG office	Y	0	Y

Prototype – Evaluation (2/2)

Project Name :	Post-natal Healthcare Reloaded
Date :	12-Sep-17

	Does the Proposed solution		Does the solution provide functionality for		Does the solution provide a link/API to?		Does the solution address the concerns of the	
Services	Benefit:		Actors		Institutions		Networks	
What services are needed and not offered?	0		0		0		0	
home visits	Mother, Father, Baby	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	IF, RG	Y
On demand advice	Mother, Father	Y	Midwives, Community health workers	Y	Hospitals, Clinics, Pharmacies	Y	IF, EF, NF, RG	Y
Appropriate Transport	Mother, Baby	L	Transport service providers	L	Ambulances, Taxis	L	IF, EF, NF	L
Financing	Mother, Father	L	Mother, Father, IF, EF	L	Government, NGOs	L	IF, EF	L
Psychologial health monitoring	Mother, Father	Y	Midwives, Doctors, IF, EF, NF	Y	Hospitals, Clinics	Y	IF, EF, NF	Y
Reporting/Feedback	Mother, Father	Y	Midwives	Y	Hospitals, Clinics	Y	RG	Y
Training of primary health support sysytem (friends and family)	Mother, Father, IF, EF, NF, RG	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Counselling	Mother, Father, IF, EF, NF, RG	Y	Midwives, Community health workers	Y	Hospitals, Clinics, NGOs	Y	IF, EF, NF, RG	Y
Direct communication between hospital and patient	Mother, Father	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Support system education	IF, EF, NF, RG	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Medication Adherence monitoring	Mother, Baby	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	IF, EF, NF, RG	Y
Medical record sharing across health service providers	Mother, Baby	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	0	Y
Prioritisation and streamlining of resource allocation	Mother,	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	0	Y
Educational outreach	Mother, Father, IF, EF, NF, RG	Y	Midwives, Community health workers	Y	Hospitals, Clinics, NGOs	Y	0	Y
Healthcare outposts	Mother, Baby	L	Midwives, Community health workers	L	Hospitals, Clinics	L	0	L
Hospital call centres	Mother, Father, IF, EF, NF	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	0	Y
Child day care (alleviate mother's duties and allow her to rest)	Mother	Y	Father, IF, EF, NF	Y	Hospitals, Clinics	Y	0	Y
Remote diagnostics	Mother, Father, IF, EF, NF	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	0	Y
Accessible communication channels	Mother, Father, IF, EF, NF	Y	Midwives, Community health workers	Y	Hospitals, Clinics, MNOs	Y	0	Y
Remote appointment system or similar outpatient wait time limiting system	Mother, Father, IF	Y	Midwives, Community health workers	Y	Hospitals, Clinics	Y	0	Y

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