TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

SATU MARJOMAA

BUSINESS MODEL FOR MOBILE HEALTHCARE DELIVERY IN CHRONIC DISEASE MANAGEMENT

Master of Science Thesis

Examiner: Prof. Samuli Pekkola
Examiner and topic have been approved at the Council Meeting of the Faculty of Business and Built Environment on October 7, 2015.

ABSTRACT

SATU MARJOMAA: Business model for mobile healthcare delivery in chronic disease management
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Health industry is struggling with ageing population and increasing chronic diseases that result in rising healthcare costs. Use of mobile technologies has potential to provide effective and efficient healthcare while empowering patients for better self-management. However, in many cases mHealth innovations fail to continue beyond successful pilot phase often due to a lack of business model design. Even though business model is the core of any business, business model research in mHealth is scarce, and a reliable and rigorous business model for sustainable mHealth implementation has not yet been developed.

The purpose of this study was to develop a generalisable business model for mHealth services in chronic disease management by using a widely adopted Business Model Canvas as a base framework. The study was conducted as a qualitative business research with theoretical and empirical parts. Theory base was built by reviewing literature on two main topics: mobile healthcare delivery and business model development. The empirical part was conducted as a single-case study with a co-design team in Innovation Lean LaunchPad program where the business model was developed for smartphone-enabled cardiac rehabilitation care model. The data was collected by using creative methods, interviews, and supporting secondary data sources. The interviews were conducted with mHealth stakeholders, including health care professionals, payers and influencers. The developed business model was analysed using a value network to visualise the stakeholders and the value transactions in mHealth ecosystem.

The findings showed six characteristics for a sustainable business model in mHealth. The study also identified common challenges for mHealth adoption and diffusion, and recognised important stakeholders in mHealth ecosystem. In addition, the research clearly demonstrated the importance of business model design for mHealth inventors who need to understand stakeholders, their needs, and their relative influence as well as the existing market environment. In conclusion, focusing on business model design early in the mHealth technology development phase can help researchers and designers to overcome common challenges and create commercially viable mHealth services.

TIIVISTELMÄ

SATU MARJOMAA: Liiketoimintamalli mobiilin terveysteknologian terveyspalveluille kroonisten sairauksien hoidossa
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Avainsanat: liiketoimintamalli, arvonluonti, mobiili terveysteknologia, mHealth, krooninen sairaus

Terveysala kamppailee ikääntyvää väestöä ja kroonisia sairauksia sekä niistä johtuvaa terveydenhuoltokulujen kasvua vastaan. Mobiiliteknologian hyödyntäminen voi tarjota kustannustehokasta hoitoa ja voimaannuttaa potilaita parempaan sairauden itsehallintaan. Monet mHealth-innovaatiot kuitenkin epäonnistuvat jatkamaan menestyksekkään pilottivaiheen jälkeen, johtuen usein puutteellisesta liiketoimintamallin suunnittelusta. Vaikka liiketoimintamalli on minkä tahansa liiketoiminnan ydin, niiden tutkimus mobiiliterveysteknologiassa on vähäistä eikä luotettavaa ja tarkkaa liiketoimintamallia mHealth-teknologian kestävään käyttöönottoon ole vielä ole kehitetty.

Tämän tutkimuksen tavoite oli kehittää yleistettävä liiketoimintamalli mHealth palveluille kroonisten sairauksien hoidossa hyödyntämällä laajasti hyväksyttyä Business Model Canvas –viitekehystä. Tutkimus toteutettiin laadullisena liiketoimintatutkimuksena pohjautuen sekä teoriaan että empiriaan. Teoriapohja rakentui kirjallisuuskatsauksen avulla, joka kohdistui kahteen pääaiheeseen: mobiiliterveysteknologiaan ja liiketoimintamallien kehittämiseen. Empiirinen osio toteutettiin yksittäistapaustutkimuksena suunnitteluryhmän kanssa Innovation Lean LaunchPad –ohjelman aikana, jossa liiketoimintamalli kehitettiin älypuhelinta hyödyntävälle sydänkuntoutuksen hoitomallille. Aineisto kerättiin käyttämällä luovia menetelmiä, haastatteluita sekä sekundääritietolähteitä. Haastattelut toteutettiin mHealth-sidosryhmien kanssa, mukaanlukien muun muassa hoitajat, rahoittajat ja vaikuttajat. Kehitettyä liiketoimintamallia analysointiin arvoverkoston avulla visualisoiden mHealth-sidosryhmät ja näiden väliset arvotransaktiot.

Tulokset osoittivat kuusi ominaispiirrettä kestävälle mHealth-liiketoimintamallille. Tutkimuksessa havaittiin myös tyypillisiä haasteita mHealth-teknologian omaksumiselle sekä tunnistettiin mHealth-toimialan merkittävät sidosryhmät. Näiden lisäksi tutkimus selvästi osoitti liiketoimintamallin suunnittelun merkityksen mobiilin terveysteknologian innovoijille, joiden tulee ymmärtää niin sidosryhmiä, heidän tarpeitaan ja suhteellista vaikutusvaltaa, kuin olemassaolevaa markkinaympäristöä. Yhteenvetona todettiin, että liiketoimintamallin suunnittelu ja sen huomioiminen mHealth-teknologian aikaisessa kehitysvaiheessa voi auttaa tutkijoita sekä suunnittelijoita ratkaisemaan yleiset haasteet sekä luomaan kaupallisesti kannattavia mHealth-palveluita.

PREFACE

Somewhat two years ago, I decided, I want to use my knowledge gained during university studies in information management to improve healthcare. Back then I also had a goal – to do my thesis abroad, in Australia. Since then, my studies and work have become interesting, challenging and rewarding in so many ways.

This study was conducted at CSIRO in The Australian eHealth Research Centre. The empirical research was carried out during Innovation Lean LaunchPad program and I was lucky to be part of the team to facilitate the commercial viability of the developed mHealth technology. I am happy to see the project resulted in the innovation being a part of the research organisation's new acceleration program, and even more excited to continue working in that project to further explore the most viable commercialisation plan.

I would like to express my gratitude to the research centre and my supervisor Dr Mohan Karunanithi for giving me the opportunity to do my thesis in such an inspiring environment and providing me an interesting, yet challenging topic. I would also like to thank my supervisor professor Samuli Pekkola at Tampere University of Technology for your valuable advices and guidance throughout the thesis project. In addition, I want to thank my co-design team for your valuable input and especially Simon, for your continuous support.

I am very thankful for my family and friends, both in Finland and in Australia, who have supported me during the thesis and my studies. Finally, I would like to address my special thanks to my fiancé, Jani – your endless encouragement is the reason why I am here, and I am happy to share this experience with you knowing there are many other adventures waiting for us.

In Brisbane, 25.11.2015

Satu Marjomaa

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ABBREVIATIONS AND NOTATIONS

AEHRC	Australian eHealth Research Centre
BMC	Business Model Canvas
CR	Cardiac rehabilitation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FDA	Food and Drug Administration
iLLP	Innovation Lean LaunchPad
MoTER	Mobile Technology Enabled Rehabilitation
RCT	Randomised controlled trial
STOF	(Business model framework) Service, Technology, Organisation, Financing
TGA	Therapeutics Goods Administration

1. INTRODUCTION

Globally, governments and industry providers of healthcare are facing increasing challenges to meet the demands of the population changes and their needs. One of the major emerging issues is population ageing and the associated increased prevalence in chronic conditions (World Health Organisation 2002; The Commonwealth of Australia 2009, p.62). It is anticipated that by 2020 chronic diseases will account for 7 in 10 deaths in the world (WHO, 2011, p. 9). While chronic conditions require long term health care management, they contribute towards increasing health expenditure (e.g. WHO, 2002, p. 11; Goodman & Norbeck, 2013, para. 11). These issues are confronted not only in developed countries, but also in developing countries (WHO, 2005).

Due to the issues described above, health care sector is under growing pressure to address the use of resources more efficiently. Several policymakers and health care experts share the vision that to solve the problems the health system needs a comprehensive reform and innovative thinking with effective use of information and communication technology (Anderson et al. 2006; The Commonwealth of Australia 2009). From this need, research and development in eHealth and mHealth is emerging to be a growing industry (Black et al. 2011; World Health Organisation 2011b). Over the last decade, vast interest has been focused on utilising mobile technology in chronic care (van Halteren et al. 2004; Mirza et al. 2008; Cole-Lewis & Kershaw 2010). However, even though there is potential to have positive effects on users, clinical outcomes and effectiveness (e.g. Fischer et al., 2006; DelliFraine and Dansky, 2008; Murray et al., 2005), there are challenges to overcome in order to broaden the implementation and use of mobile health devices and services. Often in the technology development process, there is a lack of 'big picture' – inability to find funding, complications with scalability, and uncertainties regarding effectiveness and sustainability (van Limburg et al. 2011; Mettler & Eurich 2012).

"In mobile healthcare, you cannot succeed on your own. Learn how to engage with the broader ecosystem."

– Jitesh Bhatt, General Manager, M- Healthcare, Vodafone India[1]

The statement above is valid pointing the complex partnerships and relationships required to establish mobile healthcare system. In more traditional business world, there is a long legacy of value creation and business model design, which are considered to be in the core of conducting business (See e.g. Vargo et al., 2008; Prahalad and Ramaswamy, 2004; Chesbrough, 2010). In healthcare industry, however, understanding the significance of

[1] Mobile Health Meetup 2014, cited at http://mobile.techsparks.com/?p=559

value lags behind. Only recently, more emphasis has been shifted from physician-centered to patient-centered care, where every stakeholders' interests should be involved in a value-driven dialogue (Laine & Davidoff 1996; Porter 2010; van Limburg et al. 2011). As a result, business model design as well has received the attention it deserves. According to van Gemert-Pijnen and colleagues (2011, p.15), *"integrating persuasive technology design, human-centered design, and business modeling provides the theoretical background for the development, evaluation, and implementation of eHealth technologies".*

Under these circumstances, there is a clear motive to conduct a research that provides insight on the importance of value creation and business model design in mobile health and chronic care delivery. This research aims to address how business model design can assist in implementing sustainable mobile health systems, and what requirements there are for a business model to create value for each stakeholder.

1.1 Research background

With almost 7 billion mobile-cellular subscriptions worldwide, and nearly 3 billion people using Internet (ITU 2014), being connected is more and more becoming part of everyday life. It is only natural that utilising smart devices in health care is also becoming more common. As a result, a number of remote patient monitoring solutions have been developed to support the management of chronic diseases such as diabetes (Cocosila et al. 2004) or heart failure (Chaudhry et al. 2010). In cardiac rehabilitation and follow-up, telephone support and Internet-based remote-monitoring systems have been found to provide a convenient and patient-friendly substitute to time-consuming clinic visits while simultaneously increasing cost-effectiveness (See e.g. Raatikainen et al., 2008; Varnfield et al., 2011). Yet, many eHealth and mHealth pilots are failing to continue beyond the research and development phase, and create value over a long period of time (Obstfelder et al. 2007; Raitoharju & Kontio 2014). One of the reason for this has been the lack of high-quality trials that would show sufficient evidence of the effectiveness of these services (Free et al. 2013). Other reasons behind the lack of success are too engineering-driven solutions with reluctant parties (Spil & Kijl 2009, p.59; van Limburg et al. 2011) or insufficient analysis about the prevailing circumstances for the implementation (Armfield et al. 2014), both resulting in poor uptake. Thus, implementation strategy along with business model development and stakeholder engagement should be all prepared early in eHealth technology development to ensure a satisfying uptake (Valeri et al. 2010; van Limburg et al. 2011, p.3).

Despite the significance of a business model as a means to understand and create value, the concept in academic world is surprisingly young, as it has become common only at the end of the 1990s (Osterwalder et al. 2005, p.6). In healthcare industry, the concept of a business model is naturally even more novel (e.g. Hwang & Christensen, 2008; Duennebeil, Leimeister, & Krcmar, 2012, p. 272), but some specific frameworks have

been developed by utilising the business model frameworks from commercial world, while identifying the unique features of healthcare as an industry (Parente 2000; Valeri et al. 2010). The need for business models in mobile health as well has been identified (Siau & Shen 2006, p.94; De Toledo et al. 2006; Crean 2010), but only little research about the area exists (see e.g. Coye et al., 2009; Chen et al., 2013). This research aims to grasp on this topic, by targeting to create a framework on a specific application area in mobile health. Osterwalder (2004; Osterwalder and Pigneur, 2010) has developed a widely adopted framework, the Business Model Canvas (see figure 1.1), which acts as a base framework for this study. The purpose of the study is to develop a business model solution that creates value for each mobile health stakeholder using the Business Model Canvas and its guiding questions for each component.

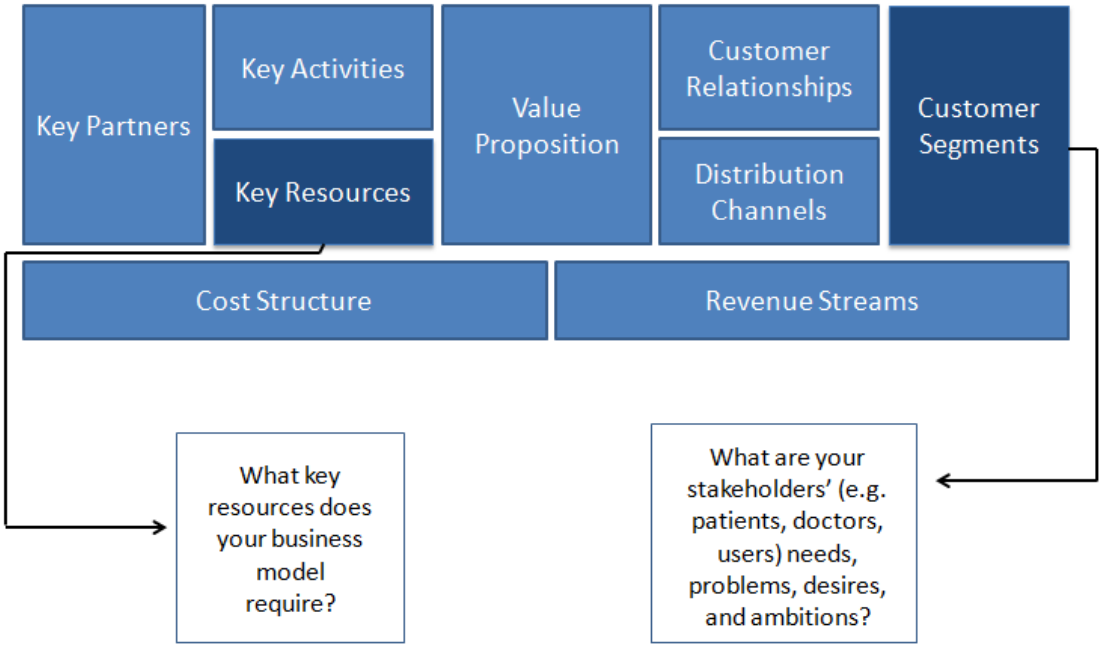

Figure 1.1 *Illustration of Osterwalder's Business Model Canvas and examples of two components (adapted from Osterwalder and Pigneur, 2010)*

To perform the research described in this thesis, the author approached the Australian eHealth Research Centre (AEHRC) in order to use one of their developed platform technologies as an object of study. The AEHRC is a department of Australia's national science agency, the Commonwealth of Science and Industrial Research Organisation (CSIRO), and has expertise in the delivery of healthcare interventions using mobile computing platforms[2]. One of the research outcomes of the research centre is Care Assessment Platform (CAP), a novel technology based home care model for outpatient cardiac rehabilitation (CR) by using smart phones, web-services and other information and communication technology tools (Särelä et al. 2009). The CAP CR delivery model was designed and developed with Queensland Health, and tested in a randomised

[2] See http://aehrc.com/

controlled trial (RCT) in between 2009 and 2011 (Varnfield et al. 2014). Outcomes of the clinical trial demonstrated technology-based home care model was effective in improving the overall cardiac participation and completion, together with improvement in health outcomes in comparison with traditional cardiac rehabilitation delivery in centre-based settings. This hence makes technology based home care model a viable option for optimising the use of CR services (ibid.). Following from results and learnings of the CAP RCT study the mobile health platform was re-engineered and re-developed mobile health platform, called MoTER (Mobile Technology Enabled Rehabilitation) which includes both the mobile application and the corresponding Internet portal. The MoTER platform is currently being implemented within the CR program state-wide in Queensland (The Australian e-Health Research Centre 2013, p.26). Although the MoTER platform itself has been successful in receiving positive response from clinical staff and patients, there is a lack of a business model framework for its implementation in business as usual health care service delivery. This study aims to focus on this; to create a business model for MoTER implementation that could also be generalised to be applicable for other similar mHealth technologies in chronic care delivery. This would therefore facilitate extending MoTER to other chronic disease care services as well, and help other related technology innovations to consider involved parties and their interests for a sustainable and cost-effective solutions.

The empirical data collection and analysis of this thesis is conducted in the context of Innovation Lean LaunchPad program (iLLP), which is CSIRO's initiative to facilitate the commercialisation of research inventions in Australia. The program is an iterative process of hypotheses-validation for business model components that aims to design the most suitable business model for a product or service in development. The process throughout the program is described in chapter 4.5.

1.1.1 Research problem and research questions

Considering the context and the goal of the study, the research question can be formulated as following:

What kind of business model can support the implementation of mobile health care service delivery for chronic disease management?

In support of this main research questions, sub-questions that need to investigate are:

1. How can mHealth improve chronic disease care delivery and what are the challenges in implementing such care models?
2. What kind of ecosystem exists in mHealth?
3. How can business model design be used to create viable and sustainable mHealth systems?

Research questions 1 and 2 are answered through a literature review in chapter 2. Question 3 is answered after empirical research, combining both the existing academic literature reviewed in chapter 3 and insights resulted from iLLP program. The research design for the empirical part is presented in chapter 1.2. The objectives, scope and limitations for the study are discussed more specifically in the next chapter.

1.1.2 Objectives and scope of the research

As stated earlier, healthcare industry lags behind in utilising information and communication technologies in their processes. The complex and varied nature of healthcare delivery makes it difficult to directly transfer business theories from other industries into practice. Still, there are core principles that apply in healthcare field as well: value creation needs to address the health systems' needs, and value created is also for the end users' benefit and experience. The main purpose of this study is therefore to emphasise the significance of a business model that helps in creating the value besides the developed technology itself. The related objective is to demonstrate how business model theory can be used in mobile health. Another important goal is to design a business model that would be usable in real practice of mobile health care service delivery.

The application of this study is in the context of chronic disease management domain of healthcare delivery. As there are lots of different chronic conditions, the focus in this case is in chronic cardiovascular and pulmonary diseases (CVPD), diabetes, and heart failure. The reason behind this is that all of these have similar approach for risk management, which makes it possible to find common stakeholders and other related elements for the model. The service in context is remote patient monitoring (RPM) through mobile devices. Furthermore, the interest in mobile health focuses on smart devices leaving out the early adoptions of mobile technology such as text messaging. Finally, the study is carried out in Australia with the local health system and from a research centre perspective.

1.2 Research design

This study follows pragmatic philosophy, as the relevancy of research finding is in its practical consequences that supports action (Kelemen & Rumens 2008, p.40; Saunders et al. 2012, p.130). Correspondingly, our objective of this study is to design a business model solution for mobile health that supports the implementation of a developed technology.

Research approach considers the reasoning on how we use theory and draw conclusions (Ghauri & Grønhaug 2010, p.15; Saunders et al. 2012, p.143). Inductive reasoning draws conclusions from empirical observations generating new theory, whereas deductive reasoning is based on logic, and conclusions are drawn using existing theory as a foundation (Ghauri & Grønhaug 2010, p.15). Abductive approach collects data to explore

a phenomenon to generate new or modify an existing theory. In this study, we use abduction and induction in combination. We first use abductive reasoning to suggest a business model based on theory and creative thinking, and then inductively advance this model by further observations.

We use a number of qualitative methods to collect the data. The thesis is conducted as a case study, because we want to gain deeper understanding of a complex social phenomena (Yin 2009, p.4). In practice, this means that we need to grasp the motives of each stakeholder in the mobile health value network, and find a solution using multiple sources of evidence. The study is also co-design, because the empirical part is conducted as a team in iLLP program (see chapter 4.5.2). Co-design leverages creativity in the design process or research (Sanders & Stappers 2008, p.6), and we use creative methods at the start of the design. However, we first conduct a systematic literature review to form a theory base for the design. We also collect information from different stakeholders through interviews, which is a core part of the iLLP program. Figure 1.2 illustrates the research methods used in this study.

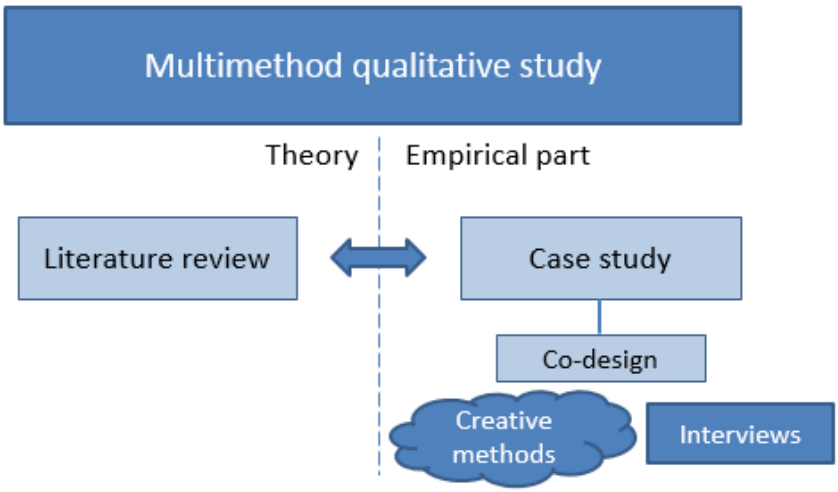

Figure 1.2. *Illustration of research methods*

By creative methods we mean mostly brainstorming and designing tools for business models. Interviews are used to gain in-depth information about relevant stakeholders. Research methods are discussed more in chapter 4.

1.3 Structure of the thesis

The structure of the thesis follows the research questions and is divided into theory part and empirical part. Chapter 2 and 3 comprise of the literature review for mobile health industry and the concept of business model, respectively.

Chapter 4 describes the research methods and the research process. Chapter 5 presents the results and analysis for the empirical part. Chapter 6 discusses the results in relation to the literature, and limitations of the study. Finally, chapter 7 summarises key findings and conclusions, discusses contributions to literature, and presents suggestions for future research.

2. MOBILE HEALTHCARE DELIVERY

Recent advances in information and communication technologies (ICT) have set trends in exploring the use of technology in healthcare (Boulos et al. 2011). Increased prevalence of chronic diseases means there needs to be more focus on the provision of long term care, which is costly with the current health care system. This has aroused debate about how to control growing health expenditure without decreasing health outcomes (Noel et al. 2004; Gaikwad & Warren 2009).

In this chapter we discuss how ICT and especially mobile devices are being considered part of healthcare delivery. First, we present some of the reasons for the increased use of mobile technologies in healthcare. Second, we describe mobile health as a concept and technologies related to it. We then discuss how mobile health can be used in chronic disease management, and what challenges recur in implementing mobile health based interventions. Finally, we study the system environment in which mobile health takes place.

2.1 Changes in healthcare system

Health care needs of patients have changed during the past decades. With changing lifestyles and ageing population, chronic diseases have become increasingly common, and are the leading cause of death and disability worldwide (World Health Organisation [WHO] 2002). Chronic diseases are seen as a major challenge for the health system. Unlike the acute care interventions provided by current health system, chronic disease requires continuous and ongoing care, and systemic approach to treatment (WHO, 2005, p. 35). The approach of a patient-centered care focuses on patient's involvement and their individualisation in care (Robinson et al. 2008, p.600). This means that the patient is seen more as an active subject who can contribute to their own health, and the role of health care provider is then to offer tools for better self-management (van der Eijk et al. 2013, p.926).

However, traditional health systems were not designed to respond this need, which is why many have suggested a reform in health system by significantly changing the focus. Transforming health care from physician-centered to more patient-centered and proactive care has generated new care models, such as Chronic Care Model (Wagner 1998), that emphasise patient self-management. Even though healthcare organisations recognise the need to provide education and support for patients, they do not have the human or financial resources to enable this requirement (Kaufman & Woodley 2011, p.801). As a result, mobile technology has been suggested to be one potential solution in giving the convenient and cost-effective tools for self-management and patient engagement. Most

individuals already have the technology required, including the groups of lower sosioeconomic status (Nundy et al. 2012), and the rapid development of mobile technologies enable more and more advanced applications in healthcare (Honeyman et al. 2014). This has given rise to a new research area, mobile health, which is part of the umbrella term 'eHealth'.

2.2 Evolving mobile health

Mobile health (also written as mHealth or m-health), has been defined by the Global Observatory for eHealth of the World Health Organisation as *"medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices"* (WHO 2011b, p.6). In academic literature, Akter et al. (2010, p.3) addressed the personalised and interactive nature of mobile health service and the objective to provide ubiquitous and universal access to health care and information. Tomlinson et al. (2013) identified also the variety of contexts: *"from the use of mobile phones to improve point of service data collection, care delivery, and patient communication to the use of alternative wireless devices for real-time medication monitoring and adherence support"*. The area of mHealth can be considered as a subfield of eHealth which is an umbrella term for using ICT to improve health care (Eysenbach 2001). Mobile health is also within the spectrum of telehealth (Honeyman et al. 2014, p.228), and the boundaries between these three concepts are often unclear.[3] Figure 2.1 illustrates the relationship between these concepts and summarises working definitions in relation with this thesis.

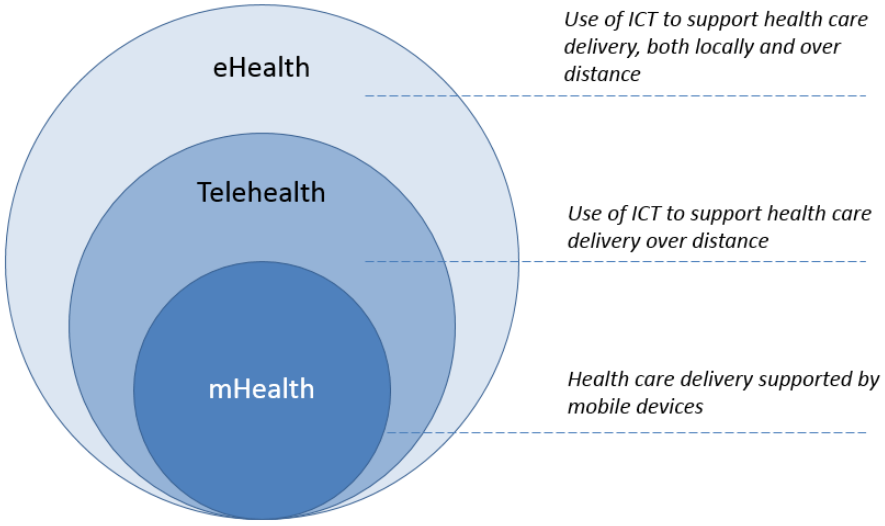

Figure 2.1. *The related concepts of eHealth, telehealth and mHealth (Sood et al. 2007; WHO 2011b; Van Dyk 2014)*

[3] Because of the strong similarities of mHealth, telehealth, and eHealth, we use these concepts somewhat interchangeably during the literature review due to the limited research in mHealth area

While telehealth systems traditionally use internet and medical workstations, mHealth relies on mobile phones and portable healthcare devices which are easier to use, less expensive, flexible, compliant with patients' lifestyle and remotely upgradeable (Honeyman et al. 2014, p.228). Partly due to these advantages, many scholars see mobile phone-based care management promising. First, the prevalence of mobile phones in people's lives enables ubiquitous healthcare where patients can interact with providers "anywhere, anytime" (Boland 2007; Fox & Duggan 2012). This is particularly pertinent in developing regions where healthcare is inaccessible to a vast majority, but yet have high mobile penetration rates (Agarwal & Lau 2010, p.603). Second, from a provider perspective, many believe that using mobile technologies would improve the quality of healthcare by allowing doctors to make more informed choices and providing timely recommendations and care to the patient (see e.g. Agarwal and Lau, 2010, p. 606; West, 2012, p. 3). Remote monitoring services could reduce the number of visits required to the hospital (Agarwal & Lau 2010, p.606) and would therefore reduce health care costs (Fielt et al. 2008, p.270; West 2012, p.3).

2.2.1 mHealth technologies and functions

Recent advances in smartphone technology and ubiquitous computing are leading towards a world, where healthcare is present in most different circumstances and patients have the possibility to take more active role in managing their health and wellness (Milošević et al. 2011). Main functions of smartphone technology that enable its clinical applications are collected in a table below (see table 2.1).

Table 2.1. *Functions of smartphone technology for clinical applications (Honeyman et al. 2014, pp.228–229)*

Application	Functionality
Voice/video calling	Enables remote communication between a patient and a clinician being an alternative to face-to-face consultations
Short message services (SMS) and multimedia message services (MMS)	Provides the ability to transmit text messages and video clips/sound files and thus offers a way to deliver education materials for example about health behaviour
Multimedia functions	Offers an access to receive content from online multimedia servers which can be updated when required
Inbuilt sensors	Include touch, motion and GPS sensors, that can provide clinical assessment by quantifying and classifying physical activities or measuring lifestyle and social activities
Device connectivity	Provides a wireless and automated connection between telemonitoring devices (such as ambulatory ECG and blood pressure monitors) and mobile phones or tablet PCs, which is more practical and less error prone than manual data entry

Internet connectivity	Enables almost ubiquitous access to remotely monitored health data, online education materials, and communication with clinicians

Free et al. (2013) address several key features that give mobile phones the advantage over other information and communication technologies, including portability, continuous uninterrupted data stream, and sufficient computing power to support multimedia software applications. Figure 2.2 illustrates the features and interaction that a smartphone enables.

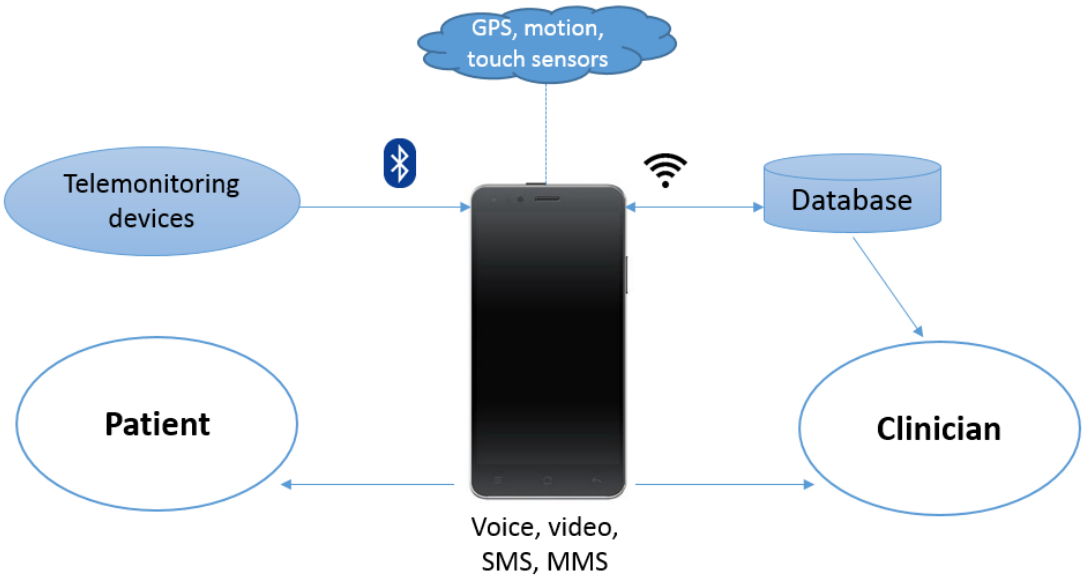

Figure 2.2. *Illustration of smartphone-enabled mHealth system*

While there are simple interventions that rely solely on SMS to send reminders to patients (e.g. Liew et al., 2009), recent achievements in mobile technologies have created the opportunity for complex, smartphone-based interventions (Boulos et al. 2011; Klasnja & Pratt 2012, p.186; Varnfield et al. 2014). These interventions can include following objectives and strategies: 1) Tracking health information; 2) Involving the health care team; 3) Leveraging social influence; 4) Increasing the accessibility of health information; and 5) Utilising entertainment (Klasnja & Pratt 2012, p.186).

Mobile health functions and intervention strategies can be used in several stages of the care journey – from prevention stage to long-term care (see table 2.2).

Table 2.2. *Opportunities of mobile health during an individual patient's care journey (Honeyman et al. 2014, p.230)*

Stage of the care journey	Typical activities by patients	Typical activities by clinicians
Wellness and prevention	• Health improvement applications (measure weight, exercise, and calories consumed) • Health social networking • EMR access • Health information access	• Professional social networking • Screening programs • Public health data analysis
Acute care (pre- and in-hospital)	• Contacting healthcare services • Communication with friends/family • Entertainment	• Decision support • Access to EMRs • ECG interpretation • Communication and expert advice
Subacute care or rehabilitation	• Remote rehabilitation • Education • Home monitoring • Access to care team as required	• Intensive home monitoring • Coordination of care services • Early intervention as required • Updating EMR • Provide services to remote locations
Long-term care	• Access support networks • Long-term rehabilitation and risk factor management • Medication reminders and monitoring • Appointment reminders	• Personalized care planning • Remote monitoring • Video consultation

As seen in the table, mHealth technologies can be used for individual use such as health information access or networking. There are also lots of opportunities to monitoring and consultation.

2.2.2 mHealth in chronic disease management

One of the research areas in mHealth is the use of mobile devices in chronic disease management. Research and mHealth initiatives in this area can be found around the world covering a variety of chronic conditions, such as chronic heart diseases (Salvador et al. 2005; Varnfield et al. 2011), pulmonary disease (van Halteren et al. 2004; del Pozo et al. 2006), and diabetes (Gómez et al. 2002; Farmer et al. 2005; Agarwal & Lau 2010). Many of these studies focus on evidence-based care, and address how care models for chronic

diseases can be supported by mobile health solutions (see e.g. del Pozo et al., 2006; Nundy et al., 2012).

In a systematic review by Gaikwad and Warren (2009, pp.127–128) numerous benefits for telemonitoring interventions in chronic disease management were highlighted. For patients, telemonitoring provides convenience. It can assist in monitoring patients in their homes, thus saving time and cost of travel, and assist to bridge between patients and their health care providers. Moreover, long-term remote patient monitoring of elderly patients offers them independence. For health care professionals in turn, telemonitoring can offer reliable data to supervise patients' progress and support them in making informed decisions. It can also enable proactive patient management by assisting detection of change in normal status of patients and issuing alarms. Finally, telemonitoring can avoid hospitalisations, therefore decreasing healthcare costs, and enabling timely services for those in need. (Gaikwad & Warren 2009.) According to Cocosila and colleagues (2004, p.235), mHealth can provide more effective and efficient care, and save both patients' and clinicians' time.

Despite the positive views on the potential of mobile health in chronic disease management, there are contradicting debate about the actual evidence for efficacy or efficiency in such care interventions. In a comprehensive review, Parè and colleagues (2007) found that the significance of the telemonitoring effects (e.g. decrease in blood pressure, reduced mortality) on patients' conditions remained inconclusive for chronic illnesses: pulmonary conditions, diabetes, cardiac diseases, hypertension. Nevertheless, they concluded that home telemonitoring produces accurate and reliable data, empowers patients, influences their attitudes and behaviours, and potentially improves their medical conditions (ibid.). In another systematic review, Krishna et al. (2009) evaluated cell phone voice and text messaging interventions. Significant improvements were noted for example in compliance with medicine taking, stress levels, smoking quit rates, and self-efficacy. Also quicker diagnosis and treatment as well as improved teaching and training were noted. (ibid.) Moreover, Scherr et al. (2009) found that mobile phone-based telemonitoring has the potential to reduce frequency and duration of heart failure hospitalisations. Similar findings were noted by Purcell et al. (2014) who also concluded that telemonitoring can improve patient outcomes and reduce health costs.

However, some scholars present somewhat conflicting views. In a large randomised controlled trial (RCT) Chaudhry et al. (2010) studied telemonitoring intervention where interactive voice-response system collected daily information about symptoms and weight that was then reviewed by the patients' clinicians. Among patients with recent heart failure, telemonitoring did not improve outcomes even though there were advances in the care (ibid.). Elsewhere, Free et al. (2013) found suggestive evidence of benefits in some areas of chronic conditions, but highlighted the need for additional high-quality controlled trials. All in all, research has shown some evidence of improved health care which is why it is useful to continue developing new mHealth innovations for the

industry. However, more research needs to be done regarding mHealth intervention studies. Burke and colleagues (2015, p.1203) have suggested that more rigorous approach to the analytic methods used, and more diverse samples from demographic perspective are needed. Moreover, sufficient evidence requires both longer-term studies that assess the long-term engagement by the user, as well as more adaptive and diverse methods to test rapidly changing mHealth devices and identify their most effective features early in the development phase (ibid.).

2.2.3 Challenges in mHealth implementation

While there is still lack of sufficient evidence and long-term studies, governments and industries invest in eHealth and mHealth technologies. The increase of smartphones and other mobile devices create new possibilities and initiatives, making it possible to integrate the technology effectively in individuals' lives. However, Chesbrough and Rosenbloom (2002, p.530) point out that *"the inherent value of a technology remains latent until it is commercialized in some way"*. In respect of this, there are recurring problems in deployment of eHealth and mHealth technologies. For example, current financial structures slow down the deployment, and development often focuses strongly on engineering-driven solutions (van Limburg et al. 2011, p.2).

Fielt et al. (2008, p.270) have suggested that there are five type of factors that influence the deployment of new eHealth applications: 1) behavioral, 2) economical, 3) financial, 4) technical, and 5) organisational. For example, the lack of behavioral models limits the understanding of how mobile phone-based programs can support self-management (Nundy et al. 2013). From economical and financial perspective, financial structures that support distribution of costs and revenues lag behind (Broens et al. 2007). Moreover, the regulatory frameworks for mHealth technologies remain immature. Technical barriers can include for example interoperability issues and security concerns. (Honeyman et al. 2014, p.235.) From organisational perspective redesigning healthcare processes is a demanding task (Siau & Shen 2006, pp.94–96).

Besides the general factors that affect the mHealth innovations, the inventor may face challenges when shifting the product from a pilot product to a long-term use. Cho et al. (2009) investigated the paradox between high potential of telehealth innovations and their slow diffusion from this perspective. The authors studied a telehealth innovation in a longitudinal analysis, and recognised a gap between the initial prototype and the subsequent commercial product. Thus, they identified a diffusion chasm as the key challenge to a succesful telehealth innovation. Earlier in technology diffusion research, Moore (1991) identified a chasm between the early adopters and the early majority of adopters – a gap when a product must be made increasingly easier to adopt in order to continue to be successful. Cho and colleagues applied this theory and studied the transition from pilot test to commercialisation. The diffusion process of studied telehealth innovation included both factors that facilitated and challenged the penetration. Some of

the difficulties in this transition are related to the capabilities and constraints of the targeted customers, as well as the requirements for reimbursable healthcare services. (Cho et al. 2009.)

Therefore, the inventor needs to consider the customer and market needs early in technology design phase to overcome the challenges. The authors also suggested that business leadership and skills to prepare commercialisation are needed from early phases in order to build a knowledge base through experimental learning. (Cho et al. 2009.) Similar observations were made by Obstfelder et al. (2007) about the characteristics of successfully implemented telemedical applications. Features included addressing organisational and technological arrangements, collaboration between promoters and users, and considering future operation of the service. All these activities are included in business model design that considers both technology development and economic value creation (Chesbrough & Rosenbloom 2002, p.532).

More specifically, in addition to expertise in seperate domains, one needs to understand how the technical, organisational, and economical areas are integrated and be able to see the ’big picture’. According to Fielt et al. (2008, p.271), the lack of shared vision among all the stakeholders involved is the reason why implementation remains difficult. Next we go through the stakeholders that exist in mHealth environment in order to understand the role each stakeholder plays regarding mHealth inventions for chronic disease management.

2.3 mHealth ecosystem

Understanding the ecosystem in mHealth is important, as it is the way to identify stakeholders who have influence on the mHealth service and its diffusion. In general, health systems are highly complex adaptive systems where technical solutions alone are not sufficient to create significant impact (Plsek, 2003; Atun, 2012). Australia’s health system is no different. In short, there are two main components that make up the Australian healthcare system: public health system administrated by the Australian Government, and the private health system. However, the network of services, providers, recipients, and governance and support mechanisms causes the complexity, and makes it challenging to introduce new innovations in health systems.

Improvements in health systems require systems thinking strategies, including collaboration across disciplines, sectors and organisations, ongoing iterative learning and transformational leadership (Swanson et al., 2012). In mHealth segment, knowing who the stakeholders are, what they want or need, and their relative strength and importance are critical to successful innovations (Malvey and Slovensky, 2014, p. 95). This will enable to design a business model to a given mHealth technology and ensure value is created to each stakeholder. Table 2.3 presents the key players in mHealth sector and the interests they hold for mHealth services.

Table 2.3. *Stakeholders in mHealth and their motives (adapted from Cain and Mittman, 2002, p. 6; Malvey and Slovensky, 2014, pp. 5–6)*

mHealth stakeholder	**Motive**
Patients	Willingness to engage with their care team and have access to health information and options
Health care professionals (doctors, nurses, etc.)	The potential of health information tools for patient education and enhancement
Healthcare providers (hospitals, clinics, etc.)	Public providers: the reducement of costs, improved quality of care Private providers: increased efficiency and productivity
Payers (government/public, private, and employers)	Renstraint in costs, improved efficiency and health outcomes
Technology vendors (devices, software, infastructure, etc.)	New opportunities and markets
Telecommunication services providers	Increase in sales
Influental stakeholder	**Task**
Policymakers and regulators	Evaluate the safety and efficacy of the technology

Patients

Previously we described how chronic disease management requires patient-centered care and tools for self-management. Meantime, people are becoming increasingly health conscious (Kailas et al. 2010, p.58), and there is a growing consumer expectation for more convenient level of health care.

From a demographic perspective, 13 % of Australians live in outer regional, remote, or very remote areas (Australian Bureau of Statistics 2004). This means that they suffer from lack of access to care which increases social inequalities in health. Chronic diseases are most common in age groups 45-64 years and 65+ years with over 64 % of people having one or more chronic conditions (Australian Institute of Health and Welfare [AIHW] 2015). They also occur more often among socioeconomically disadvantaged people (AIHW 2014, p.99).

In general, attitudes towards technology utilisation and telehealth applications are positive, and patients are interested in having control in their own health (Thurmond &

Boyle 2002; Kidholm & Oates 2014, p.45). The expectations of patient-physician relationship are changing, and patients appreciate continuous care, with real-time and virtual service delivery (Malvey & Slovensky 2014, p.14). Overall, major factor in the acceptance of any telehealth system is their usability while ensuring the security and privacy of use (Broens et al. 2007; Malvey & Slovensky 2014, p.14).

Health care professionals

In healthcare industry, physicians and other medical staff have usually been recognised as resistant to the use of information technologies (Cho et al. 2009, p.352). However, Vuononvirta et al. (2009) found health care professionals' attitudes toward telehealth applications to be both positive and negative, and they identified ten types of telehealth adopters. Physicians are hence getting more comfortable regarding mobile devices, but they also want evidence of value to the patient care to be more willing to adopt and also recommend the devices to patients (Putzer & Park 2012; Malvey & Slovensky 2014, p.108). As for themselves, a major value is the possibility to use mobile technologies to collect data in an electronic format and therefore its support for decision-making (Mirza et al. 2008, p.316).

From developer's point of view, it is critical to understand health care professionals' information needs, workflow, and usability requirements in order to enable a facile development and implementation of new technology (Yu et al. 2006, p.181). Health care worker's negative attitude is neither a definite constraint to adoption, but it requires additional attention to find out suitable actions for telehealth adoption (Vuononvirta et al. 2009).

Healthcare providers

As shortly mentioned, healthcare in Australia is provided by both public and private institutions. There are some significant differences about how these two manage and operate their healthcare delivery. In general, public hospitals have an annual budget, whereas private hospitals are revenue driven and seek payment for services as they are offered. Private hospitals seek new markets actively, while public providers try to identify unmet needs and then seek public finance. (Lawson & Rotem 2004, p.122.)

In terms of investing in mHealth, there is no difference. Private institutions compete for health fund reimbursement (Siau et al. 2002), and look for possibilities to open up new sources of revenue and profit (Leslie et al. 2011, p.43). They also try to increase efficiency and productivity. Public providers ask whether mHealth would help them to save costs, achieve more with the available funds, or to improve the quality of care. (Leslie et al. 2011, p.43.)

Payers

Typically, healthcare service is paid by a patient or their family, or the system is funded by private health insurance systems, publically funded health services, or social insurance schemes (A.T. Kearney 2012, p.3). In Australia, public hospitals are funded by the state, territory and Australian governments, but administrated by state and territory governments. Private hospitals are owned and operated by the private sector. Most of their revenue is derived from private health fund reimbursement of patient fees (Lawson & Rotem 2004, p.122.)

Australian Government's funding includes a public health insurance scheme called Medicare. Free or subsidised treatment for public patients are listed on the Medicare Benefits Schedule (MBS). Hospital financing in Australia is largely based on activity-based funding model where services are determined to have a national "efficient price" and cost-weighting for services is based on their complexity and costliness. (AIHW 2014, pp.38–39, 373.)

Payers – governments and health funds – are looking for value for money and system wide benefits when they structure reimbursement policies. Typical benefits are improved clinical outcomes compared to existing solutions, or reduced costs with similar outcomes (A.T. Kearney 2012, p.6). Similarly to other developed countries, healthcare delivery in Australia is based on evidence-based medicine (Craig et al. 2001). This means that clinical evidence is required to support the uptake of new interventions or services. Only when the benefit can offset the cost, will mHealth technology be widely adopted into healthcare delivery (Yu et al. 2006, p.183). Moreover, payers expect sufficient monetary benefits; reduced transport costs are not enough to invest in mHealth, as those are often 'out-of-pocket' expense by patients (A.T. Kearney 2012, p.6). On the other hand, evidence of improved health behaviour or reduced number of hospitalisations would be more valuable for the payers.

Health funds look for similar decrease in health expenditure as governments. As health funds reimburse the patient fees for private providers, it is in their interest to keep individuals as healthy as possible. Leslie et al. (2011, p.43) hence suggest that health funds are potential key buyers and advocates for mHealth services and solutions.

Technology vendors

Technology vendors have different kinds of interests in mHealth. They seek to position themselves as the technology provider for particular usage scenarios in healthcare delivery. Technology manufacturers may also get involved in clinical trials in order to generate ideas for new devices they can sell. Moreover, software vendors and system integrators may invest in mHealth if they can embed their technologies and methods as standards within mHealth delivery. They seek to complement their product-oriented business models with related services. (Leslie et al. 2011, p.43)

Telecommunication services providers

Mobile network operators have similar drivers for investment than other technology vendors. They seek to increase their market share and discover new business models by stimulating the usage of their networks and services, or by using their networks as platforms for delivering value-adding services that generate additional revenues. (Leslie et al. 2011, p.43.)

Policymakers and regulators

Governments' role is to monitor healthcare providers and ensure equity of access. The regulatory role includes overseeing the safety and quality of therapeutic goods and appliances (AIHW 2014, p.42). The regulation body in Australia is Therapeutic Goods Administration (TGA) which is similar body to that of FDA in the US. In short, any product that is used for a medical purpose or makes a medically related claim may be subject to regulatory approval (A.T. Kearney 2012, p.5).

In terms of mHealth, regulators have identified the potential risk mobile applications could have regarding patient safety. Therefore, medical software products and mobile medical apps are regulated if they are considered as medical devices. (Barton 2012; TGA 2013.) The biggest determinant of whether a product is a medical device, is its *intended use*. That is, if the purpose of the device is for example diagnose, prevent, monitor, treat or alleviate a disease, it falls into a regulated area (TGA 2013; FDA 2015). This may hinder some of the technology and software providers to enter the healthcare market, as it may require a significant endeavor to achieve the regulatory approval (A.T. Kearney 2012, p.5). Moreover, the large amount of unregulated apps makes it difficult for healthcare providers to recommend an app to the patients, as the providers need to be confident about their user-friendliness and helpfulness (Boudreaux et al. 2014).

Other stakeholders

Health services in general are supported by many oher agencies: research and statistical bodies provide health related information and associated policy; consumer and advocacy groups contribute to public discussion and policy development (AIHW 2014, p.43). From mHealth perspective, researchers identify areas of interests and potential collaborators (Malvey & Slovensky 2014, p.14), and also see the collected data from mobile devices as potential for research purposes (Blaya et al. 2010, p.245). Advocacy groups and guideline bodies may find new, more effective health interventions in mHealth, and can hence give their support for such interventions.

Nevertheless, the most influental stakeholders for adoption of mHealth systems are regulators, medical professionals and their representative associations, funders of healthcare and healthcare providers. Although patients as the end users are important

stakeholders, they have less direct influence on adoption of mHealth in reimbursed healthcare systems. (A.T. Kearney 2012, pp.4, 7.)

2.4 Summary

Ageing population and increased chronic diseases are the reason for ongoing healthcare reform. Acute, physician-centered care is now transforming to respond to the different needs for chronic care that requires ongoing, holistic, and systematic treatment. At the same time, the health expenditure has been rising and will soon be unbearable for the universal health system. Use of ICT and mobile technologies has been suggested to improve the preventative care and patient self-management, thus decreasing the costs of care by slowing the progress of disease and avoiding hospitalisations. The benefits of mobile devices include the wide adoption of mobile phones that have become a natural part of individuals' everyday life. Seeing the rapid development in smartphone devices, healthcare industry is able to innovate more complex and advanced interventions that would result more effective and efficient care.

However, there are a number of barriers for implementation and wider diffusion of mHealth innovations. These include a lack of large RCT studies, immature financing structures and regulatory frameworks, and challenges in organisational and technical infrastructure. In addition, the inventors design too technology-driven solutions that do not respond the existing industry structures such as funding models and IT infrastructure. This results in mHealth interventions failing to continue beyond the pilot phase. Considering the economic environment and future operation of mHealth service early in the development phase, and improving collaboration between mHealth stakeholders have been suggested as key drives to successful innovations. This requires understanding the ecosystem in mHealth and acknowledging the needs and motives for each stakeholders.

We identified several stakeholders with varying motives. These include the end users; patients and health care professionals, and healthcare providers who consume and deliver the care; payers and regulators who are key influencers building reimbursement structures and policy requirements; technology vendors and researchers that develop and deliver new, innovative mHealth interventions; and guideline bodies who advovate for effective care models and thus influence the adoption of mHealth. Considering the role of each stakeholder creates a knowledge base for the mHealth inventor to develop a business model that is able to address the requirements in the mHealth marketplace, and thus facilitate the successful implementation and diffusion of mHealth innovations.

3. BUSINESS MODEL DEVELOPMENT

The business model has received increasingly wide attention among both academics and industry practitioners. The business model acts as a tool to commercialise new inventions and technologies – the same technology with different business models can have varying economic outcomes, leading to either success or failure of the innovation.

In this chapter we explain business models and the utility of business model development. First, we study the concept of a business model and the variety of functions it is relevant for. We also examine the relationship between business models and value networks. Second, we describe how business models can be designed and evaluate some of the existing business model frameworks that have been used in eHealth research. We finish the chapter by reviewing business model research in eHealth related areas.

3.1 Business models and their purpose

Since the 1990s and uptake of ICT, the business model concept has received increasing interest both in business practice and research (Krumeich et al. 2012). Globalisation, service business, increasing competition, and rising complexity in organisational networks are also phenomena that are influencing the prominance of the concept. However, the concept is associated with fuzziness, and theories regarding business models are highly diverse (Magretta 2002; Mäkinen & Seppänen 2007; Zott et al. 2011). One reason for this is the multipurpose nature of the concept. That means business models can be used for different functions or objectives. For example, Al-Debei and Avison (2010, p.371) argue that a business model can be a conceptual tool of alignment between business strategy and business processes. Moreover, it can be used for performance measurement, or most commonly, to support the innovation process (Zolnowski & Böhmann 2011, p.4). We will hence review the definition of a business model more closely in order to find a sufficient understanding of the concept for this study.

3.1.1 The definition of a business model

The importance of a business model is well summarised by Chesbrough (2010, p.355):

> *”a mediocre technology pursued within a great business model may be more valuable that a great technology exploited via a mediocre business model”*

Even though scholars agree on the value of a business model (Chesbrough & Rosenbloom 2002; Teece 2010; Zott & Amit 2010), there are various ways to look at the concept and its purpose. Chesbrough and Rosenbloom (2002, p.532) see the business model as a *”focusing device that mediates between technology development and economic value*

creation". Osterwalder et al. (2005, p.4) on the other hand, explain business model simply as *"the blueprint of how a company does business"*. In the literature, there is no generally accepted definition for a business model, and there are lots of diversity and confusion in the formed definitions (Morris et al. 2005, p.726; Zott et al. 2011, p.1020). According to Linder and Cantrell (2000, p.2), authors may mean different things when they speak about business models. These can be components of business models, types of business models, change models, or concrete real world instances of business models (Linder & Cantrell 2000, p.2; Osterwalder et al. 2005, p.8).

Due to the large variety of different definitions, some authors have done systematic review of these definitions in attempt to find common elements and unified perspective (Morris et al. 2005; Zott et al. 2011). Morris et al. (2005, pp.726–727) identified three general categories for the definitions found in literature. These categories are economic, operational, and strategic, constructing a hierarchical levels that become more comprehensive as one moves from the economic to the operational to the strategic level. In conclusion, they form an integrative definition: *"A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competetive advantage in defined markets"*. (ibid.) On the other hand, later review by Zott et al. (2011, p.1020) found that business model literature is divided into silos, and the main interest areas in research are 1) e-business and the use of ICT; 2) strategic issues such as value creation and competitive advantage; and 3) innovation and technology management. Therefore, they suggest that employing more precise labels could be established, presenting business model archetypes; business model as activity system; and business model as cost/revenue architecture, as cases in point (ibid., p. 1036).

Further, Osterwalder et al. (2005, pp.8–11) believe that business models can be classified in three different categories or levels that can be hierarchically linked to one another, and that they must be distinguished conceptually in order to achieve a common understanding of business models (see table 3.1).

Table 3.1 . *Three levels of business models (adapted from Osterwalder et al., 2005, pp. 8–11)*

Conceptual level	Business Model Concept	Consists of **definitions** (e.g. Timmers, 1998) of what a business model fundamentally is, and **meta-models** (e.g. Osterwalder, 2004) that conceptualise them.
	Business Model Type	Consists of **taxonomies**, i.e. several types or meta-model types of business models that are generic but contain common characteristics. The models can be a sub-class of an overarching business model concept. Business model taxonomies can apply to specific industries, such as banking (DeYoung 2005) or mobile business (Camponovo & Pigneur 2003).

Instance level	”Real world” Business Model	Consist of either **concrete real world instances**, or conceptualisasation, representations, and descriptions of real world business models (e.g. Chesbrough and Rosenbloom, 2002).

According to Osterwalder and colleagues’ (2005, p.17) definition, business model is amongst all *”a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm.”*.

While trying to form a unified definition for business model has been proven to be a difficult task, we can acknowledge that the business model concept in commercial world cannot be transferred directly into healthcare. This is because of the complex environment and different kind of marketplace of health industry (Tseng & Chen 2007, p.36). First, business model is often defined as how company makes money (Stewart & Zhao 2000; Chesbrough & Rosenbloom 2002, p.529; Magretta 2002, p.4). However, Valeri et al. (2010, p.14) recognize that in healthcare context, one must consider both intangible internal and external elements, as well as the financial return. Second, one of the reasons eHealth projects tend to fail is their inability to receive funding after the pilot (Cho et al. 2009, p.352), meaning they fail to demonstrate the concrete value to different stakeholders. Therefore, it is reasonable to use Fielt’s (2011, p.15) proposed definition as a working definition for this thesis:

> *”A business model describes the value logic of an organization in terms of how it creates and captures customer value.”*

According to Fielt, the definition is based on Osterwalder and Pigneur (2010), and is well aligned with Chesbrough (2006), Johnson (2010), and Teece (2010) – all of them addressing value creation. The definition also leaves out the different elements (such as revenue model or value proposition) of a business model, which are more seen as parts of the business model framework (see chapter 3.2). However, to better understand different dimensions a business model holds, it is also worthwhile to present more detailed and operational definition by Chesbrough and Rosenbloom (see table 3.2).

Table 3.2. *A detailed and operational definition for a business model (Chesbrough & Rosenbloom 2002, pp.533–534)*

The functions of a business model
• Articulate the *value proposition*, i.e. the value created for users by the offering based on the technology
• Identify a *market segment*, i.e. the users to whom the technology is useful and for what purpose, and specify the revenue generation mechanism(s) for the firm

• Define the structure of the *value chain* within the firm required to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain
• Estimate the *cost structure* and *profit potential* of producing the offering, given the value proposition and value chain structure chosen
• Describe the position of the firm within the *value network* linking suppliers and customers, including identification of potential complementors and competitors
• Formulate the *competitive strategy* by which the innovating firm will gain and hold advantage over rivals

In addition to the difficulty in defining a business model, there is various arguments over the extent in which business model and strategy are related (Magretta 2002; Seddon et al. 2004; Casadesus-Masanell & Ricart 2010). Some see business model as a reflection or implementation of the firm's strategy (Osterwalder 2004, p.17; Casadesus-Masanell & Ricart 2010). Elsewhere, scholars differentiate these concepts based on the focus, which the strategy has on competition and value capturing, whereas the business model emphasises customer-focused value creation, cooperation, and partnership (Chesbrough & Rosenbloom 2002, p.535; Magretta 2002, p.6). Finally, even though business model is not a strategy, it includes a number of strategy elements (Morris et al. 2005, p.727), and can be a source of competitive advantage (Zott et al. 2011, p.1032).

In summary, a business model has a variety of functions, purposes and research areas, and it is easily mixed with complementary concepts. The core logic of a business model, however, lies in organisation's value proposition to the customer, and the mechanisms to capture value (ibid., p. 1034).

3.1.2 Value creation and value networks

Previously we discussed the complex ecosystem in mHealth and the number of stakeholder with various needs (see chapter 2.3). It is important to understand how value is created in such networks. In academic literature, there is large debate over value creation[4]. Few decades ago, Porter (1985, p.38) defined value as *"the amount buyers are willing to pay for what a firm provides them."*. This was the time when economics was highly based on manufacturing industries, and the development of ICT was still in its infancy. Over time, the concept of value has shifted from traditional goods-dominant logic, "value-in-exchange", into service-dominant logic, which sees value as "value-in-use" (Vargo et al. 2008, p.146). From this perspective, value is always co-created in interactions by a combination of actors in the network through resources and competences

[4] Term "value creation" produced 148 000 results by online search engine (search made on Google Scholar on 15.01.2015)

(Peppard & Rylander 2006, p.133; Vargo et al. 2008, p.146). Similarly, the concept of value chain with linear value flow has gradually been superceded by the value network (Allee 2000; Peppard & Rylander 2006) and the new discipline of service science emerged (Chesbrough & Spohrer 2006; Maglio et al. 2006; Rai & Sambamurthy 2006).

Stabell & Fjeldstad (1998, p.414) state that value network models firms that create value by facilitating a network relationship between their customers using a mediating technology. Indeed, ICT plays an important role providing the ability to link and coordinate activities between and across different actors (i.e. different entities and stakeholders) within the value network (Basole & Rouse 2008, p.65). However, Biem & Caswell (2008, p.3) have a broader view, and they see value network as a *"set of economic entities connected through transfer of offerings that yields a structural network whose purpose is to deliver common value proposition to a specified end-consumer or market"*. Economic entities mean actors such as firms, business units, or individuals. Offerings on the one hand refer to transferable that could be a manufactured product, a service, knowledge or brand. (ibid., p. 4.) Allee (2002, p.6) points out that value created can be both tangible and intangible.

So how do value creation and value network specifically appear in a business model? Chesbrough and Rosenbloom (2002, p.534) addressed that the first function in a business model is articulating a *value proposition* latent in the new technology. Subsequently, *value creation* is defined by identifying how an organisation works with customers and suppliers to create and deliver the service. Finally, the organisation needs to understand how to *capture value*, i.e. ensure the profit that occurs from the business model. Figure 3.1 illustrates these concepts in relation with the business model.

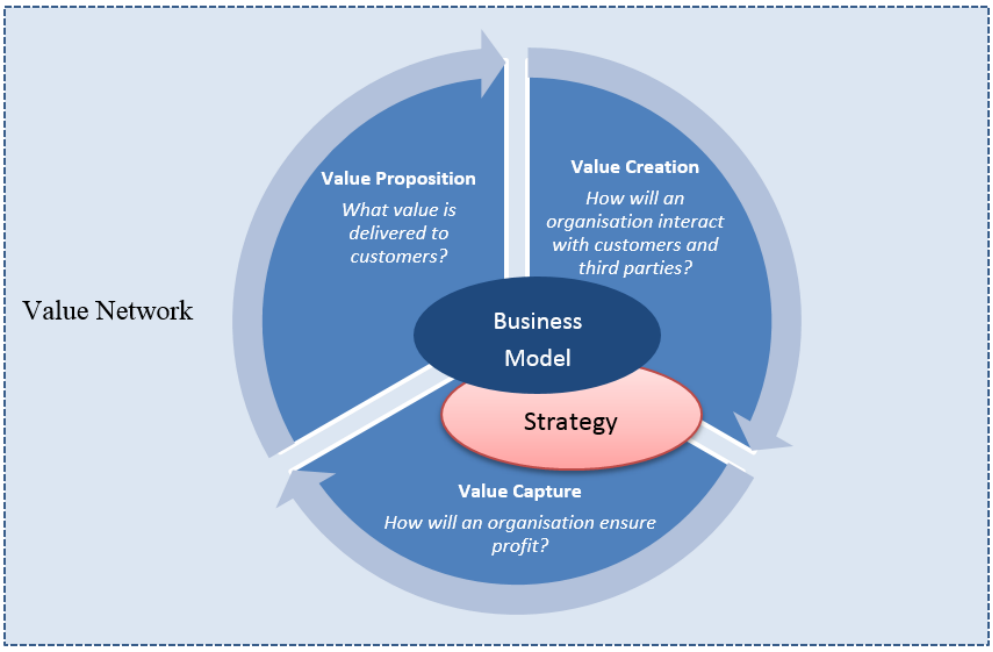

Figure 3.1. *Value proposition, value creation, and value capture in relation with a business model and strategy*

As the illustrated in the figure, the value network is around a given business, and shapes the role that suppliers, customers and other parties play in influencing the value created and captured from commercialisation of an innovation. (Chesbrough & Rosenbloom 2002.) The strategy element demonstrates its emphasis on competition and value capturing.

3.2 Business model design

The business model definition by Chesbrough and Rosenbloom (2002) (see chapter 3.1.1) addresses clear functions of a business model. When developing a particular business model one can discuss the concept of ’business model design’ or ’business model development’[5] (Johnson et al. 2008; Zott & Amit 2010). Corresponding concept is also ’business model innovation’ (Chesbrough 2007; Frankenberger et al. 2013) especially when associated with novel ways to create and capture value.

Zott and Amit (2010) see business model design from an activity system perspective. According to them, this approach provides a language and a conceptual toolbox to the creative design process and encourages systemic, holistic thinking. (Zott & Amit 2010.) Scholars have developed numerous other ways to design and articulate a business model. These are known as ’business model frameworks’. However, similarly to the concept of a business model, scholars may mean different things when explaining a business model framework. Chesbrough (2007, p.13) debates that business model framework is a model that sequences possible business models from very basic models to far more advanced models. On the other hand, Fielt (2011, p.3) suggests that business model frameworks enable designers to specify a business model in a systematic way by describing the different elements included such as value proposition and value economics. Krumeich et al. (2012, p.1) discuss business model framework in a similar way, and point out that no uniform business model framework has been established so far.

Hence, we present two relevant business model frameworks for this study: Business Model Canvas and STOF (Service, Technology, Organisation, Finance) model. We also describe the differences and suitability of each framework.

3.2.1 Business Model Canvas

The Business Model Canvas (Osterwalder & Pigneur 2010) is one of the most adopted business model frameworks in several industries, and widely used as an official tool for startup formation and technology commercialisation. It is based on Osterwalder’s (2004) research on business model ontology and nine building blocks: 1) customer segments, 2) value proposition, 3) channels, 4) customer relationships, 5) revenue streams, 6) key

[5] Sometimes referred also as *business modeling*, which is however more seen as *business process modeling* (see Osterwalder et al. 2005)

resources, 7) key activities, 8) key partnerships, and 9) cost structure. These building blocks cover the four main areas of a business: customers (’who’), offer (’what’), infrastructure (’how’), and financial viability (’how much’) (Osterwalder & Pigneur 2010, p.15). Rather than only describe each component, it is important to understand the relationship between the different elements (Osterwalder et al. 2005, p.20). Table 3.3 describes the purpose of each building block and how they are related with each other.

Table 3.3. *The 9 Building Blocks (Osterwalder & Pigneur 2010)*

Building block	Description
Customer Segments	The starting point of the model, “For whom are we creating value?” Organisation must define who are the most important customer segments and then understand the specifics of customer needs.
Value Propositions	An array of products and services that create value for a specific customer segment by solving or satisfying a customer need. Value can be quantitative (e.g. price) or qualitative (e.g. customer experience).
Channels	Defines how the value proposition is delivered to customers – through communication, distribution, and sales channels. Plays an important role in the customer experience.
Customer Relationships	Describes what kind of relationships an organisation wants to establish with each customer segment, how to maintain them, and how they are integrated with the rest of the business model.
Revenue Streams	Represents the revenues an organisation generates from the value proposition delivered to customers.
Key Resources	The most important assets required to deliver the other elements of the business model. These can be physical, financial, intellectual, or human, and they can be owned by the organisation or acquired from key partners.
Key Activities	As the previous building block, this describes the most important things an organisation must do to make the business model work. These can be categorised as production, problem solving, and platform/network.
Key Partnerships	Describes the network of suppliers and partners that are required to for example acquire resources or optimise the allocation of activities.
Cost Structure	Describes the costs that incur from delivering other elements like maintaining customer relationships. Costs can be defined after defining key resources, key activities, and key partnerships.

These building blocks form the basis for the Business Model Canvas. As Osterwalder and Pigneur's approach is design- and innovation-oriented (Fielt 2011, p.18), the Canvas was created to be a hands-on tool that *"fosters understanding, discussion, creativity, and analysis"* (Osterwalder & Pigneur 2010, p.42). The authors address various design techniques and tools: Customer Insights, Ideation, Visual Thinking, Prototyping, Storytelling, and Scenarios. For example, visualizing the model with different tools such as pictures, sketches, diagrams, and Post-it™ notes can enhance in capturing the 'big picture'. (ibid., p. 125, 148.) Figure 3.2 illustrates the Business Model Canvas template and how its elements can be filled to achieve a visual representation of the business model.

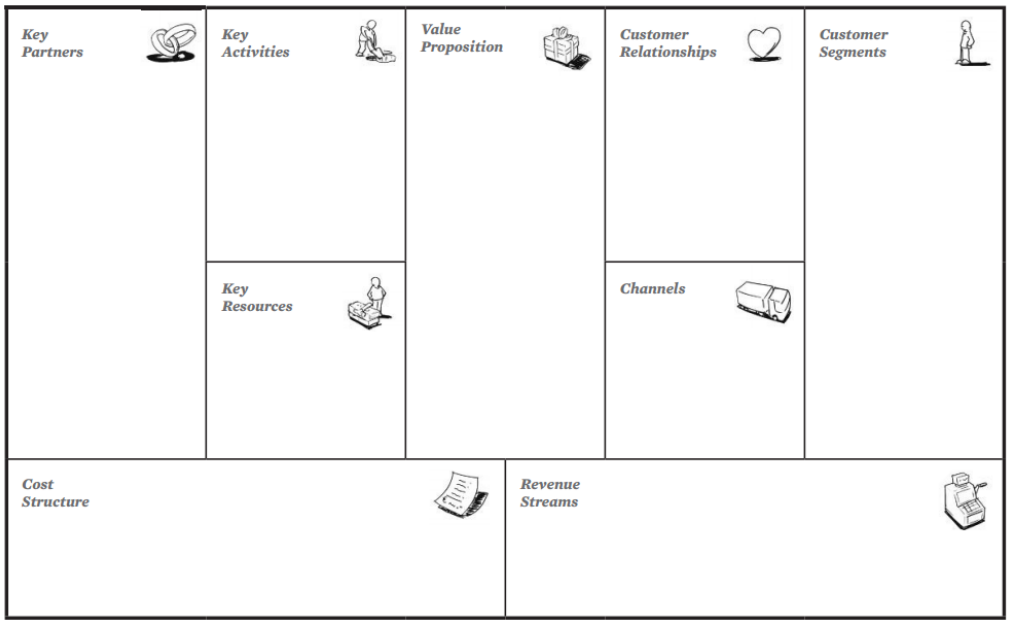

Figure 3.2. *The Business Model Canvas (under a Creative Commons 1.0 Generic License, originally in Osterwalder & Pigneur 2010, p.44)*

The Canvas can be printed out on a large surface where a group of people can jointly sketch and discuss the elemets with Post-it™ notes.

3.2.2 STOF model

Another, more service-oriented approach is the STOF model (Bouwman, Faber, Haaker, et al. 2008), which consists of four domains: Service, Technology, Organisation and Finance. It is especially focused on service innovations and considers the important elements around mobile services in particular (Bouwman, De Vos, et al. 2008). Figure 3.3 describes the four interrelated domains.

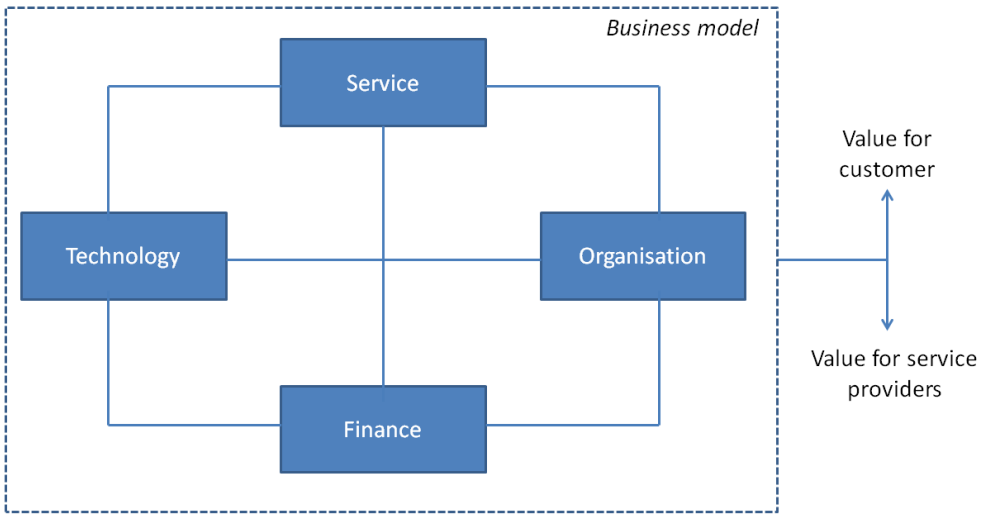

Figure 3.3. *The STOF model (adapted from Bouwman et al., 2008, p. 36)*

Service domain considers especially creating value. Similarly to the Business Model Canvas, the focus is on provider's value proposition, and service design describes intended value, delivered value, expected value, and perceived value (Bouwman, Faber, Haaker, et al. 2008, p.43). The authors also discuss more specifically the value of mobile services and different factors affecting the user experience, such as personalisation and context-awareness (ibid., p. 39).

Technology domain is guided by service design. In the context of mobile services it describes following technological considerations: technical architecture, infrastructure, access networks, service platforms, devices, applications, data, and technical functionality. The service design guides the technical design. (Bouwman, Faber, Haaker, et al. 2008, p.48.)

Organisation domain considers the resources related to technology, marketing and finance that have to be made available to enable the service. This means describing the value network that consist a number of actors with certain resources and capabilities, and how they interact to create value for customer and realise their own strategies and goals. (Bouwman, Faber, Haaker, et al. 2008, pp.49, 56.)

Finance domain basically describes how the value network intends to generate revenues from the service offering (Menko et al. 2013, p.109). This outlines the description of profits, investments, costs, risks and revenue sources, and how they are devided among the actors (Bouwman, Faber, Haaker, et al. 2008, p.63).

Every domain is described in detail via a descriptive model. Simultaneously it describes how the domains are related. For example, how the concepts of the technology domain affect on the service domain, and what domains from the service domain put requirements on other domains. (Fielt, 2011, p. 21.) Bouwman and colleagues (2008) also argue that the design choices that are made in each domain need to be balanced to realise viability

and feasibility. As a result they introduce Critical Design Issues (CDIs) and Critical Success Factors (CSFs) that were derived from the different applications and case studies of the STOF model in the mobile area (ibid.). In comparison with the Business Model Canvas, it can be noticed that STOF model is more abstract. However, whereas the BMC offers a hands-on tool for designing a business model, STOF model offers a step-by-step approach – the STOF method (De Vos & Haaker 2008). The STOF method consists of four steps: 1) Quick Scan – an initial sketch of the business model, 2) Evaluation with CSFs – the viability of the Quick Scan is assessed, 3) Specification of CDIs – the initial business model is refined, and 4) Robustness check of the business model (see De Vos and Haaker, 2008, pp. 116–132).

3.2.3 Critique

As Fielt (2011, p.24) points out, there is great overlap between the Business Model Canvas and STOF model. The major distinction is focus: Business Model Canvas is more product oriented whereas STOF model is developed (mobile) service innovations in mind. This results in that an organisation concerned is more seen as a part of the network instead of a single organisation. (ibid.) Hence, STOF as a framework is more aligned with Chesbrough and Rosenbloom's operational definition of a business model (see chapter 3.1.1). Heikkilä et al. (2014, p.73) share this view pointing out that the Business Model Canvas considers only little the networked nature of service business by identifying partners as key component of a business model. Zolnowski et al. (2014) have grasped this deficit and proposed Service Business Model Canvas (SBMC) as an extension to the Business Model Canvas. They separate the canvas into three different perspectives – partner, company, and customer (see figure 3.4). According to the authors, this enables a detailed analysis of any actor of a service and hence service specific aspects can be considered.

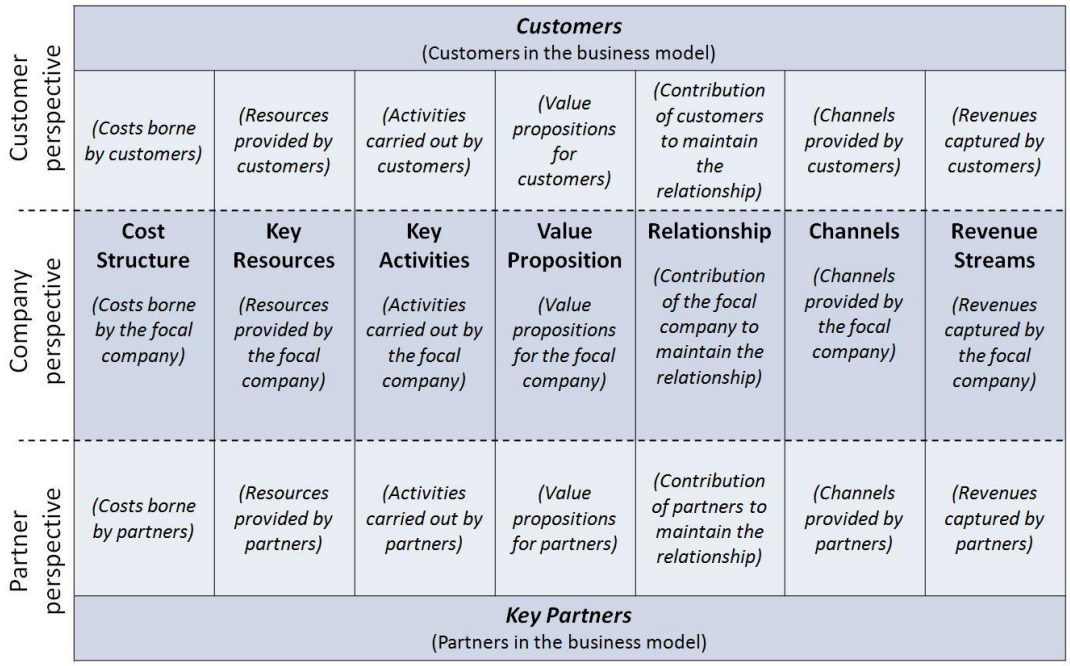

Figure 3.4. *Service Business Model Canvas (adapted from Zolnowski et al. 2014)*

However, they point out that when representing networked based service business models, the complexity of the SBMC rises significantly. (Zolnowski et al. 2014, pp.720, 726.) This would be especially true in healthcare context due to the large number of stakeholders.

From design perspective, STOF model is much more abstract in comparison with the BMC. As a hands-on tool the Business Model Canvas offers an easily approachable method, and is proven to enhance perceived collaboration (Eppler et al. 2011, p.1332). However, the Business Model Canvas receives critique from Simonse (2014, p.69) who argues that the Canvas does not model the business model – the standardised elements are not connected by transactions, and the canvas lacks the visualised model structure that uniquely identifies the business model. We therefore suggest that while the Business Model Canvas is suitable for changing ideas between people in the early phase of a business model development, it would also be beneficial to visualise the structural and integrated nature of the business model. This is included in STOF model's Organisation domain but there are several tools to describe and visualise the value network in a detailed and even in strategic level (Gordijn et al. 2000; Allee 2002; Biem & Caswell 2008). Next we review the literature of eHealth related business model research and ground the approach this study will take regarding the business model design.

3.3 Business model research in eHealth/mHealth

Malvey and Slovensky (2014, p.12) argue that *"no one has yet developed a robust and reliable business model that shows how to make mHealth a successful venture on a large and sustainable scale"*. In literature, there are some attempts to approach this complex

area with the focus on eHealth and telehealth. One of the earliest efforts for business model research in eHealth is Parente's (2000) taxonomy of eHealth business models. Parente describes a business model of e-commerce, and how it has successfully been used for healthcare delivery, presenting also the barriers for eHealth (ibid.). Since then, most notable studies have been conducted only during recent years with varying purpose and approach (see table 3.4).

Table 3.4. *Business model research in eHealth*

Research area	Author(s)	Purpose of the study	Business model framework
Demonstrate the use of a framework	Fielt et al., 2008	Design a business model for remote patient monitoring case	STOF
	Kijl et al., 2010	Design a business model for telerehabilitation case	STOF
	Menko et al., 2013	Combine a business model framework, innovation process, and relevant success factors for a business model approach	STOF
Business model design in general	van Limburg et al., 2011	Describe the importance of business model design and important factors in design process	Business Model Canvas
	(van Meeuwen et al. 2015)	Frame the essential building blocks for business model design of any eHealth service	N/A
Evaluate and analyse business models	Spil and Kijl, 2009	Evaluate eHealth pilots from traditional business model perspective	STOF
	Valeri et al., 2010	Evaluate existing successful business models and identify socio-economic and financial challenges for eHealth	Business Model Canvas
	(Peters et al. 2015)	Develop an analysis framework for service business model in telemedicine	N/A
Business logics	Mettler and Eurich, 2012	Business logic for different eHealth services	N/A
Performance measurement	Heikkilä et al., 2014	Combine business model design with performance evaluation	Business Model Canvas

As seen on the table, we can identify five research areas. Most of the studies use a business model framework (STOF or Business Model Canvas) on their background. One purpose is to **demonstrate the use of a framework** to design a business model for a particular case or technology (e.g. Fielt et al., 2008; Kijl et al., 2010; Menko et al., 2013). Menko et al. (2013) use STOF as a base framework and combine it with innovation process and success factors to improve design approach.

Some studies focus on **business model design in general**, and address the important factors to be considered in designing process. Van Limburg et al. (2011) address context asessment, stakeholder participation, openness, and the identification of value drivers and critical success factors to be considered in designing process. Similarly, van Meeuwen et al. (2015) identify important building blocks that contribute to the convenience and quality of an eHealth service. These include for example continuous interaction between the health care professional and the client (i.e. patient or an individual), social interaction among the clients, and the involvement of a health care professional in the development of an eHealth service. The authors emphasise also visual design in business model development.

Another research area is **evaluating existing business models** in eHealth (Spil & Kijl 2009; Valeri et al. 2010) using a business model framework. Peters et al. (2015) developed an analysis framework for service business model in telemedicine, and found three types of typical business model: enablers, supporters, and patient-centered innovators. According to the authors, the framework allows service providers to identify the type of their business model and help analyse the competitiveness of the business model.

Mettler and Eurich, (2012) have yet another distinctive approach, the focus being on **conceptualising common business logics** of eHealth services. They identified a number of business model design patterns, including eHealth as freemium, eHealth as multi-sided market, and crowd-based eHealth (ibid.).

Similarly to van Limburg et al. (2011), Heikkilä and colleagues (2014) discuss business model design, and emphasise the openness and collaboration in design process. While they find business model frameworks useful for innovation process, they address that business model should also be measured with **performance indicators**. This helps to evaluate and improve the developed business model. (ibid.)

In conclusion, there is a large variety in research areas. Studies that have demonstrated a use of business model framework have only utilised STOF framework. Even though the Business Model Canvas is generally the most adopted framework, research in eHealth and mHealth lacks a systematic use and demonstration of the Business Model Canvas to design a business model that would support sustainable implementation. There is also a

lack of attempt to generalise the developed business model to be applicable beyond the particular case.

This study aims to expand the research area which demonstrates the use of a business model framework. Instead of using the STOF model, we demonstrate the use of the Business Model Canvas as it is widely adopted and would therefore be more applicable in real life commercialisation. However, we complement the framework by using value network analysis in order to capture and visualise the interactions between stakeholders.

3.4 Summary

The business model is a multi-purpose concept that can be used for instance to align business strategy and business processes, or measure performance of the business. However, it is the most commonly used method to support the innovation process and commercialisation of new technologies. As a definition, the business model describes the value logic of an organisation in terms of how it creates and captures customer value. Value creation and value capture occur in a value network with a number of stakeholders and value transactions.

Over years, researchers have developed frameworks to identify the elements in the business model and these frameworks can be used in business model design. One of the most adopted frameworks is Alex Osterwalder's Business Model Canvas which in general level describes the customer, offer, infrastructure and financial viability of the business model. Another business model framework that has been used in eHealth business model research is STOF model which was developed to be more service oriented. From design perspective, there are benefits for each framework: the Business Model Canvas is particularly suitable for early phase business model development to facilitate collaboration. STOF model on the other hand, considers better the networked nature of services.

In eHealth and mHealth industry, no one has yet developed a rigorous and reliable business model to show the sustainability of these services. There is only scarce literature on business models for eHealth related technologies with varying research focus. One of the research areas in eHealth business models demonstrates the use of a business model framework in this industry. However, the research in this area has been limited only to the use of STOF model and without an attempt to generalise the developed business model. To close this gap, we aim to create a generalised business model for mHealth in chronic disease management, using the widely adopted Business Model Canvas as a framework, and therefore contributing to this particular research area. Next we describe the research methods that are used in the business model design on top of the Business Model Canvas.

4. RESEARCH METHODS

This chapter presents the research methodology for the empirical part of the study where we design the business model for a particular technology in mHealth. First, we discuss how the chosen research methods are applied in the study. We then describe the context in which the research takes place and the research process.

4.1 Case study

Case study is *"an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context"*. Case study also uses data triangulation which involves using multiple data souces to increase credibility and validity of the results. (Yin 2009, pp.18, 116.) Case study research allows the exploration and understanding of complex issues and is particularly useful when the study requires a holistic investigation

In this study, we can define the case to be mobile health service delivery as an industry. The context of the case is chronic disease care in Australian health care system. The study is conducted as an embedded single-case design, as the case is a representative (Yin 2009, p.48) example of a mobile health service in chronic disease management. Business model components represent the units of analysis (see figure 4.1).

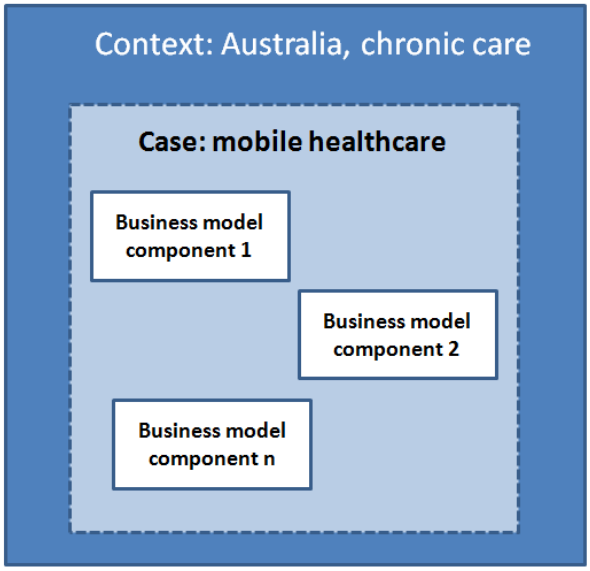

Figure 4.1. *Illustration of case study design (adapted from Yin, 2009, p. 46)*

In case studies, the most commonly used data sources are documentation, archival records, interviews, direct observations, participant-observation, and physical artifacts (Yin 2009, p.101). Among these we use interviews as the main data collection method and supplement these with archival records.

4.2 Co-design

The empirical study of this thesis is conducted as co-design. Co-design, or sometimes referred as participatory design (see e.g. Spinuzzi, 2005), encompasses user involvement through numerous methods such as contextual inquiry, participant observation, open-ended qualitative interviews and various workshops (Bødker & Iversen 2002, p.11; Bason 2012, p.313).

During the design process, we use creative methods and design tools together with researchers from different backgrounds with the guidance of iLLP program mentors. Brainstorming and the use of visualisation techniques are common instruments in idea generation (Bason 2012, p.313), and they will be used to design an initial business model. The business model is developed further based on the insights from external stakeholders, customers and users. These insights are collected through a co-design method, qualitative interviews, to clarify the requirements that are relevant for the business model.

4.3 Interviews

Interview is the most important source for case study information. In case studies, interviews are often unstructured or semi-structured, where they will be *"guided conversations rather than structured queries"*. (Yin 2009, p.106.) Unstructured, or in-depth, interviews are informal and they are used to explore a general area of interest in depth (Saunders et al. 2012, p.375). The interviewer can ask respondents about the facts of a matter as well as their opinions. In such interviews, the respondent becomes more as an informant who can also suggest other persons to be interviewed. Semi-structured, or focused, interviews go often a shorter period of time, but open-ended questions in a conversational manner are still common. (Yin, 2009, p. 107.)

In this study, we use semi-structured or focused interviews for a number of reasons. First, we want to use open-ended questions to gain more accurate information from the respondent's point of view. Second, the setting of this study follows the iLLP program (see chapter 4.5.2) and requires interviews from a large number of stakeholders with varying theme. For this we are using one-to-one interview technique when possible to avoid groupthink (Ghauri and Grønhaug, 2010, pp. 134–135). Third, we are not confident about the most appropriate persons for interviews so we use snowball sample (Biernacki & Waldorf 1981; Marshall 1996, p.523) to allow respondents to suggest other interviewees.

4.4 Supporting data sources

To produce more comprehensive account, we use data triangulation and secondary data to complement the data collected through the interviews. In case study, there are two sources for secondary data: documentation and archival records (Yin 2009, pp.101–106).

From these we utilise archival records such as government reports and third party submissions to find specific facts regarding funding, readmission statistics and legal information.

When secondary data and archival records, it is worthwile to acknowledge that the information may have been produced for a specific purpose and a specific audience, and might affect the usefulness and accuracy of the data (Yin 2009, p.106). This will be considered when evaluating the validity and reliability of this study.

4.5 Conducting the research

As mentioned in chapter 1.1, this study is conducted in Australia as part of the iLLP program organised by CSIRO. Broadly, the purpose of the iLLP is to find a way to commercialise some technologies developed in CSIRO. Mobile health technology developed by the researchers in AEHRC is called a Mobile Technology Enabled Rehabilitation (MoTER), a home-based care model for cardiac patients. Before the iLLP program, the co-design team developed the first business model for MoTER using the Business Model Canvas and its guiding questions as a framework.

Next we describe the MoTER care model which acts as the case example in this study. We then present the background and purpose of the iLLP program. Finally, we describe the research process in detail.

4.5.1 Case study of the MoTER platform

MoTER was initially developed to improve the delivery of cardiac rehabilitation. In Australia, cardiovascular disease is one of the largest contributor to burden of disease and health expenditure (AIHW 2014, p.91).

The best care for cardiovascular diseases are prevention and self-management which can improve health outcomes and therefore reduce the cost of care. Prevention can reduce the likelihood of developing a disease or disorder (primary prevention), or prevent the progress of the disease or disorder (secondary prevention). (ibid., pp. 102, 344.) Cardiac rehabilitation (CR) is secondary prevention care that is delivered after a cardiac event, such as a heart attack. The objectives of CR are to help people with heart disease to return to a fullfilling life and minimise the risk of further cardiac events (National Heart Foundation of Australia [NHFA], 2004, p. 1). Secondary prevention consists of three phases (see figure 4.2).

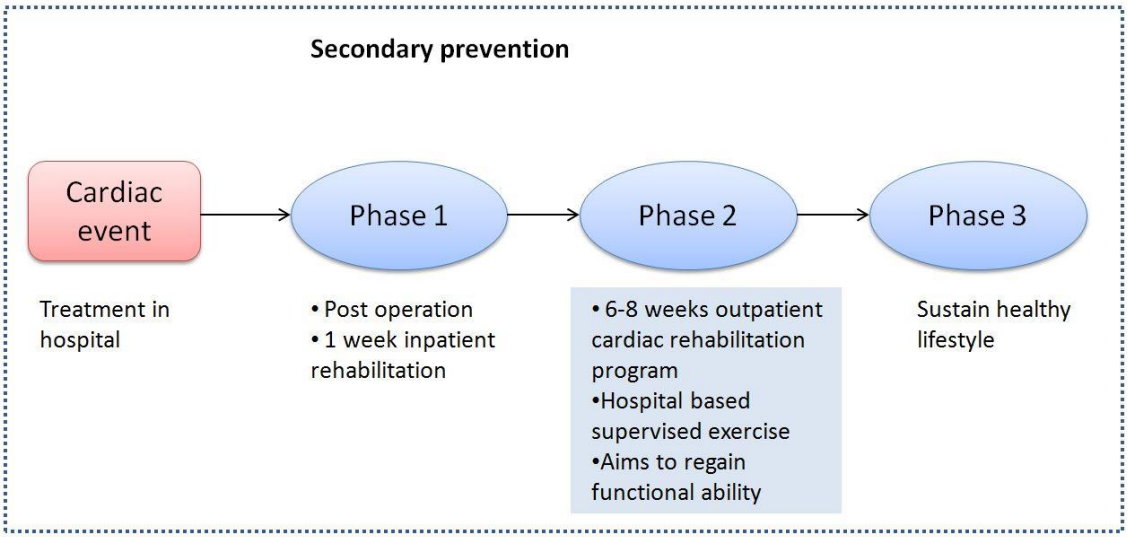

Figure 4.2. *The three phases in secondary prevention of cardiovascular disease (adapted from (Varnfield 2014, p.45)*

Phase 1 consists of inpatient rehabilitation that provides patient basic information, appropriate discharge planning and referral to outpatient CR. The main objective of Phase 2 and outpatient CR is to empower the patient to adopt self-management strategies. Outpatient CR can be provided in various settings such as hospital-based, community-based or home-based settings. This phase includes rehabilitation elements, such as individual assessment, group training and guidelines for daily excercise, education about healthy eating, and counselling about psychological issues (e.g. depression). Phase 3 focuses on ongoing management of behaviour change. (NHFA, 2004, pp. 4–10.)

Body of evidence have shown CR provides health benefits to those at risk or recurrence of CVD, including decrease in blood pressure, cholesterol, smoking rates, excess weight and reduction in cardiac mortality (Leon et al. 2005; Williams et al. 2006; AIHW 2011, p.162; Varnfield 2014, pp.46–47). However, despite the effectiveness of outpatient CR programs, the uptake of traditional hospital or community based programs is poor and patients find it difficult to attend these programs (Jolly et al. 2007, p.3; Varnfield et al. 2011, p.15). Biggest barriers to patient attendance are work commitments, transport difficulties and pressure of other duties. In addition, health care professionals do not always refer eligible patients to CR programs major reason being the absence of local CR provider. (Scott et al., 2003, p. 343.)

To overcome some of these barriers, home-based CR programs were developed. As Varnfield (2014, pp.55–61) reviewed, home-based CR programs were shown to be as effective and overcome some barriers of uptake, and is thus considered as a viable option for CR. However, a better exploitation of ICT is suggested to overcome some of the remained barriers (Varnfield et al. 2011) such as access to care, motivational issues and

staff shortages while decreasing the costs of care (Jolly et al. 2007, pp.5–6; Kaufman & Woodley 2011, p.801; Varnfield 2014, p.61).

The target in developing MoTER was to utilise smartphones as they are becoming more and more common in people's lives. MoTER uses smartphone as the communication medium through which a mentor of the care team provides mentoring and goal setting, daily motivational messages, educational videos and relaxation audios (see figure 4.3). Correspondingly, the patient enters self-observations and measurements to the health diary application. (Varnfield, 2014, p. 139.)

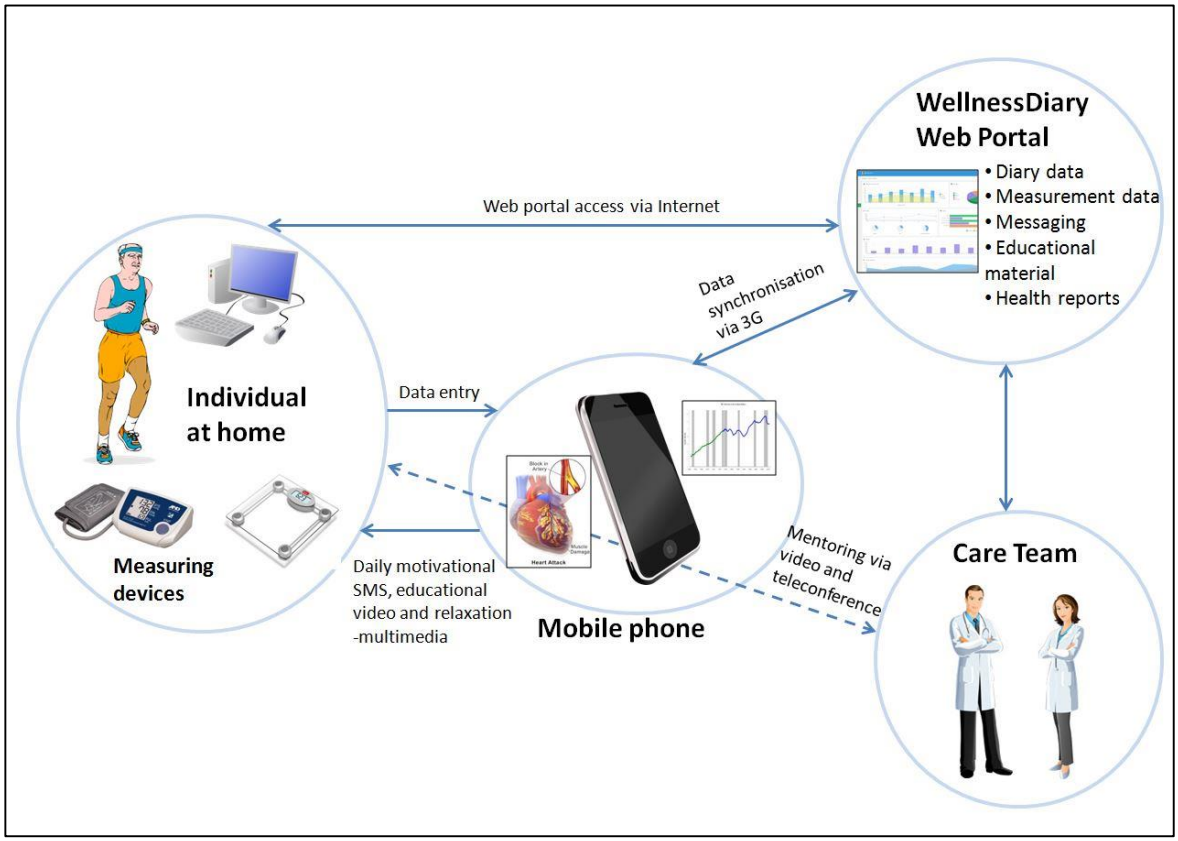

Figure 4.3. *MoTER platform (adapted from Varnfield, 2014, p. 139)*

Compared to traditional CR program, MoTER offers a variety of tools that bring particular advantages[6]. Patients can for example excercise anywhere and anytime carrying the mobile phone during excercise, and they can observe their own progress against goals set by the mentor, leaving them feel more empowerd and motivated to change behaviour. Mentors receive timely information via the web portal and they can check on patient's progress, revise targets and provide feedback accordingly. (Varnfield et al., 2011, p. 16.)

The RCT study was recently conducted for MoTER care model which suggests positive outcomes in comparison with traditional CR program (Varnfield et al. 2014).

[6] See Varnfield et al. 2011 for a detailed description of the technology and its advantages

Smartphone-based care CR had significantly higher uptake, adherence and completion rates than traditional CR. It was also equally effective in improving physiological and psychological health outcomes, and can thus be considered as a viable option in improving CR services. (ibid., p. 1.)

Currently, MoTER is being implemented in some of the Queensland hospitals and it has aroused wide interest in other CR providers around Australia and UK. There are also some indications of cost benefits. However, going through the iLLP program and business model design process would make MoTER a more solid and attractive care model that could be provided in a sustainable way.

4.5.2 iLLP program

The iLLP is based on Steve Blank's Lean LaunchPad®, a class for entrepreneurship students that was launched in 2011 (Blank 2010). As the name implies, Lean LaunchPad leverages lean thinking in order to confirm the product-market fit early in the development process. The core tool in Lean LaunchPad is Osterwalder's Business Model Canvas that is used to design, test, and pivot business models. A key concept is also Customer Discovery (Blank 2005), where students go outside in the field to obtain critical information trough customer and partner interviews. Lean LaunchPad curriculum was subsequently adopted by the National Science Foundation in the United States for their Innovation Corps (I-Corps) program to facilitate the commercialisation of technologies (Blank 2011). Whereas entrepreneur students study how to build start-ups, researchers extend their focus beyond the laboratory, and thereby strenghten the innovation ecosystem (National Science Foundation 2014). Following the promising results of the increased number of funded projects, Lean LaunchPad method is now being adopted in Europe (Newsroom 2014) and Australia.

From a research point of view, one could argue that Lean LaunchPad and Customer Discovery are rooted in the scientific method (Maurya 2012, p.11; Constable 2014, p.81), as the core idea is to test hypotheses around the different components in the Business Model Canvas (Blank & Dorf 2012). The insights either validate or invalidate the hypotheses, and create new assumptions (see figure 4.4).

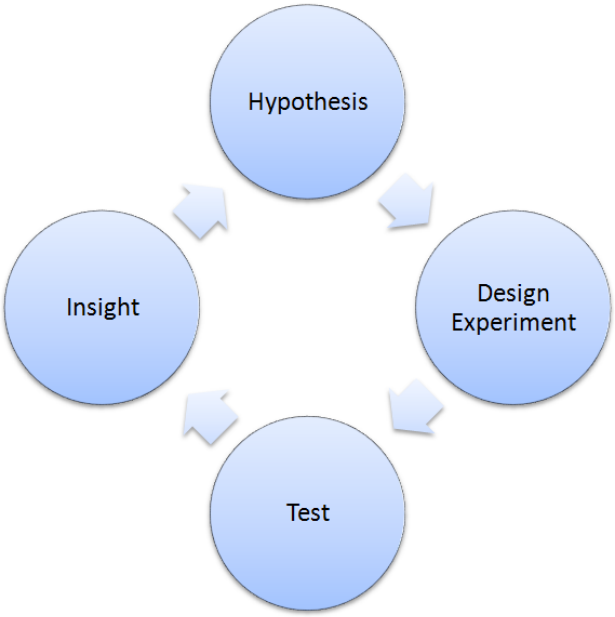

Figure 4.4. *Customer Development Insight Cycle (adapted from Blank and Dorf, 2012, p. 38)*

This cycle continues until the business model is validated (or invalidated), and has ensured that the product-market fit exists. Next we describe the overall research process of this study, and how the empirical data collection is conducted within the iLLP Australia program.

4.5.3 Research process and data analysis

The empirical part of the study was a two-step process. First, an initial Business Model Canvas was filled by the co-design team to unfold each component based on the assumptions the team had. The business model was then modified and developed further during the iLLP program (see table 4.1) utilising previously described data collection methods. After the program, the author developed the final business model based on the analysis and findings from the interviews.

Table 4.1. *iLLP program schedule*

Date (2015)	Session topic
April 10	Session 1: Customer Development interview strategies
April 24	Session 2: Value Proposition and Customer Segments
May 8	Session 3: Channels and Customer Relationships
May 22	Session 4: Key Activities and Key Resources
June 5	Session 5: Partners (and Minimum Viable Product)
June 19	Session 6: Costs and Revenue Model
June 26	Session 7: Final presentations

As described in table 4.1, the iLLP program consisted of seven 'In Class' sessions where teams presented their business model progress gathered from previous session. In between these sessions, each team targeted to interview 10-15 customers or partners and updated the Business Model Canvas based on the insights. A core element during the program was the discussion in iLLP sessions facilitated by experienced business development experts. The author of the study guided the team and the process through iLLP program and delegated interviews to be conducted by team members.

The nine components in the Business Model Canvas (see chapter 3.2.1) were filled by the team using guiding questions from Business Model Generation (Osterwalder & Pigneur 2010, pp.20–41) as a tool. During the development process, the team also used other tools to facilitate the design (see table 4.2) that were part of the iLLP program.

Table 4.2. *Guiding questions and tools in business model development process*

Business Model Canvas component	Guiding Questions	Tools
Value Proposition	What value do we deliver to the customer? Which problems are we helping to solve?	Value Proposition Canvas[7]
Customer Segments	For whom are we creating value? Who are our most important customers?	
Channels	Through which channels do our customers want to be reached? How are we integrating them with customer routines?	
Customer Relationships	What types of relationships do our customers expect us to establish? How are they integrated with the rest of our business model?	'Get, Keep, Grow' funnel[8]
Key Resources	What resources do our value proposition require? Our distribution channels? Customer relationships? Revenue streams?	
Key Activities	What activities do our valur proposition require? Our distribution channels? Customer relationships? Revenue streams?	
Key Partners	Who are our key partners and suppliers? What resources and activities are we acquiring from them?	

[7] See http://www.businessmodelgeneration.com/canvas/vpc
[8] See http://www.slideshare.net/sblank/lecture-5-customer-relationships-120411

Cost Structure	What are the most important costs inherent in our business model? Which resources and activities are most expensive?	
Revenue Streams	For what value are our customers really willing to pay? For what do they currently pay? How are they currenly paying? How would they prefer to pay? How much does each revenue stream contribute to overall revenue?	
Business Model Canvas		Business Assumptions Exercise[9]

The design started with drafting an initial Business Model Canvas for MoTER through a brainstorming session using guiding questions presented in the table above. Following this, the team did the Business Assumption Exercise (see Appendix 1) where the team identified critical assumptions regarding the business model in order to find the priorities for the interviews. The team also utilised Value Proposition Canvas (see Appendix 2) to increase understanding of value proposition to each customer segment. Another tool, 'Get, Keep, Grow' funnel, was used in customer relationship component in order to think how to create demand (see Chapter 5.1.2).

After the initial Business Model Canvas and Business Assumptions Exercise, the team put together an initial customer contact list for interviews based on mHealth stakeholders (see chapter 2.3) and leveraging existing connections. Other interviewees were found using a snowball sample technique, i.e. asking advice from each interviewee for other suitable contacts. Interviews were conducted as semi-structured interviews with relevant questions for each stakeholder type. An interview template and an example of interview questions for a particular stakeholder are in Appendix 3.

There were five interviewers in the project team with some conducting more interviews than others. Interviews were conducted in English as the research was carried out in Australia. Most of the interviews were face-to-face and conversation-like over a duration of 30-min, and were recorded by taking notes. The notes were documented in internal wiki by using a pre-design template (see Appendix 3) which included key information about the interview. The interviews were carried out during the three month iLLP program, from April to June 2015. After the program, the author contacted some of the interviewees with an interview summary and requested their consent to use the results in de-identified manner. These interviewees were selected and included as part of this study because of their relevance and contribution to the developed business model. Table 4.3

[9] Constable, G., 2014. *Talking to Humans*. Available at http://www.talkingtohumans.com/

summarises the interviewees and stakeholder types. The author was involved in six of the chosen interviews.

Table 4.3. *The interview record*

Interviewee	Association	Number of interviews
CR coordinators	CR provider in public sector	2
CR clinicians	CR provider in public sector	3
Senior Manager	State department of health	1
Chief Marketing Officer	Private Health Insurer	1
Project Manager	Body for telehealth support and guidance	1
Enterprise Architect	Hospital and Health Service	1
Advisor	Guideline body for cardiovascular disease management	1
Regulatory specialist	Consulting body	1
Total		**11**

The Business Model Canvas was updated during the iLLP program according to analysis and insights from the interviews. At the end of the data collection, the author used the interview notes and team discussions to determine what should be in the final Business Model Canvas. The author complemented some of the business model components by searching secondary data and supporting facts from e.g. Government reports and websites. For example, the cost estimates and benefits for healthcare provider (see chapter 5.1.5) were estimated by the author by using secondary data.

After the co-design activities, interview findings and business model development, the author analysed the developed business model using a basic value network diagram to visualise the most important value transactions and the general network structure.

5. FINDINGS

This chapter presents the results that were gathered using research methods described previously. First we present the Business Model Canvas as whole, and the business model components are then analysed in subchapters. Finally we analyse the value network of the designed business model.

5.1 Business Model Canvas for MoTER

Applying Business Model Canvas through the iLLP program, the delivery of smartphone-enabled CR program through the MoTER platform would have key players and attributes as detailed in figure 5.1. The canvas is colour-coded to visualise elements that are related to each other. For example convenience and accessibility as value proposition (marked with green) is directed to patients.

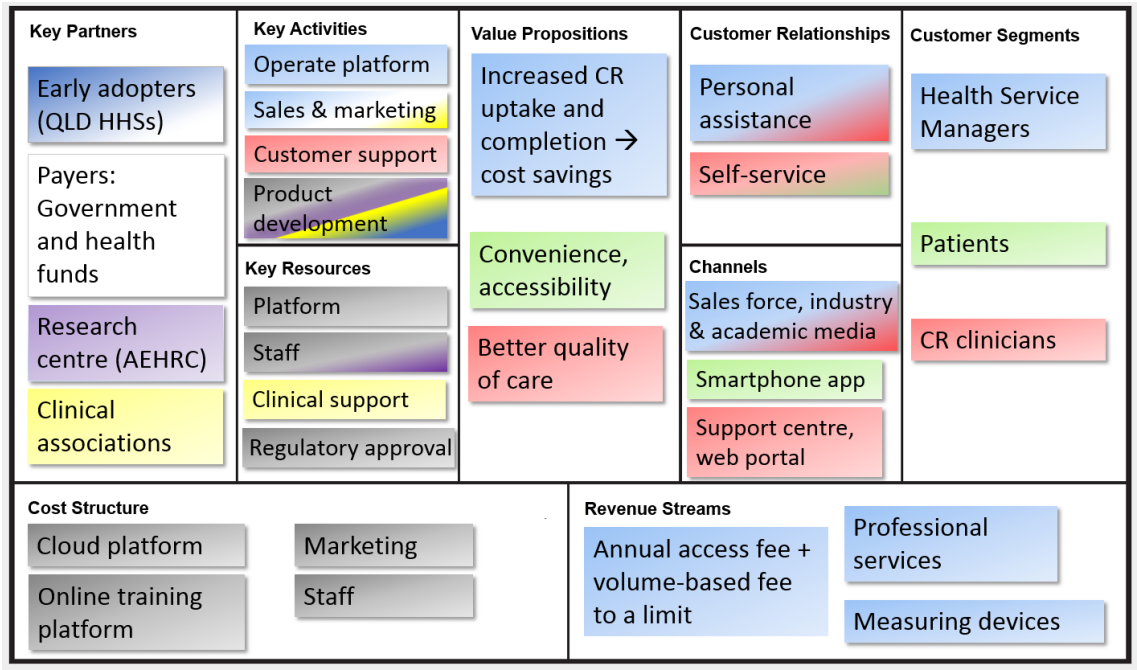

Figure 5.1. *Business Model Canvas for MoTER*

The product or the service is a smartphone-enabled CR care model which is offered to health care providers as a Software as a Service (SaaS). As stated by a Senior Manager of State department of health:

> *"The healthcare industry is moving into a direction where it is possible for the healthcare provider to use a third party and Software as a Service approach for telehealth solutions."*

SaaS solution is thus a viable option for health care providers if they are considering new telehealth technologies as a part of their healthcare delivery. The service operates in a multi-sided market that has different types of customer segments with their own value proposition. Details on each of the components on the Business Model Canvas (later on referred as BMC) were derived through guiding questions from Business Model Generation book, insights from the interviews, and guidance of the iLLP program facilitators. The order of the chapters is based on the iLLP program workshops.

5.1.1 Value proposition and customer segments

The main customer segments are Health Service Managers in healthcare providers who deliver cardiac rehabilitation, and end users. There are two types of users: patients who have been referred to cardiac rehabilitation and cardiac clinicians who act as their mentors and interventionists. The main service offering is a smartphone-based CR model which is delivered for Health Service Managers as a Software as a Service. This includes a web portal for the clinicians and a smartphone app for the patients. Value proposition for each customer segment are summarised in table 5.1.

Table 5.1. *Value proposition for customer segments*

Product/Service	Value proposition	Customer segment
Smartphone-enabled CR care model as SaaS	Increased uptake, adherence and completion of CR that result in cost savings	Health Service Managers
Smartphone app	Convenience and better accessibility to care	Patients with cardiac conditions
Web portal	More personal and better quality of care	CR Clinicians

Key aim of the smartphone-enabled CR is to address the underutilisation of CR programs. Only minority of eligible patients (< 30 %)[10] undertake cardiac rehabilitation. Patients who participate in cardiac rehabilitation significantly lower their risks of another cardiac event or readmission. Therefore, increasing the uptake of CR would bring cost savings for healthcare providers by reducing costly readmissions. For example, at national level,

[10] Scott, I.A., Lindsay, K.A. & Harden, H.E., 2003. Utilisation of outpatient cardiac rehabilitation in Queensland. Medical Journal of Australia, 179(7), pp.341–345.
Wenger, N.K., 2008. Current Status of Cardiac Rehabilitation. *Journal of the American College of Cardiology*, 51(17), pp.1619–1631.

increasing uptake of CR from 25 % to 65 % would potentially reduce emergency cardiac admissions of 30 %, equating to potential savings of nearly AUD $55 million[11].

The key customer who buys the service is therefore the Health Service Manager who makes the decisions regarding CR delivery. However, most of the funding for cardiac rehabilitation comes from either the Government or private health funds. As public and private health care sector act in a different logic, there are differences between public and private CR providers: Normally, uptake among private CR providers is much higher because health funds give patients incentives to complete the CR program. Nevertheless, private providers are generally interested in better workflow management and more efficient ways to deliver care. There is also a possible interest to extend the current offering of CR care delivery. In terms of CR, private providers might be willing to deploy technology-enabled care models that do not for example require investments in expensive gym equipment or centre-based activities. Private sector could be more agile for adopting new services and changes in workflows but could also be more difficult to incentivise:

> *"Regarding the differences between public and private sector when providing the care model as SaaS, private sector is a possible market but the biggest issue would consider how to incentivise health care professionals."* (Senior Manager of State department of health)

Because of the existing relationships with public CR providers, the business model design in this study was more focused on public sector.

In terms of answering patients' needs, there are two major reasons how MoTER can affect the uptake of CR. First, patients often are not referred to CR in the first place for one reason being the absense of local CR program[12]. As MoTER can be delivered as home-based care, doctors could be more willing to refer the patient to CR. Second, the interviews addressed similar barriers for patient participation that had been found in previous research:

> *"Major reasons why patients drop out from the CR program is because of work commitments or lack of transport. Also getting sick or living far away are reasons for drop outs. Home-based CR such as MoTER could be a viable option to reduce these kind of barriers to uptake."* (CR clinician)

A CR coordinator said key barriers to be *"problems with accessibility and motivation."* The co-design team therefore stated the value proposition to be better accessibility and convenience of care. Convenience means that smartphone app enables patients to do

[11] Heart Foundation – Cardiac rehabilitation factsheet. Available at: http://www.heartfoundation.org.au/SiteCollectionDocuments/HF-Fact-sheet-01-Cardiac-Rehabilitation.pdf

[12] Scott, I.A., Lindsay, K.A. & Harden, H.E., 2003. Utilisation of outpatient cardiac rehabilitation in Queensland. Medical Journal of Australia, 179(7), pp.341–345

cardiac rehab anywhere, anytime and grants access to CR when otherwise not possible. It is therefore more ”real life” rehabilitation. Based on the previous experience of the co-design team members, it is important not to replace the effective centre-based CR but to offer more flexibility and options for patients, and thus ”increase the pie” of patients who attend and complete CR (see figure 5.2).

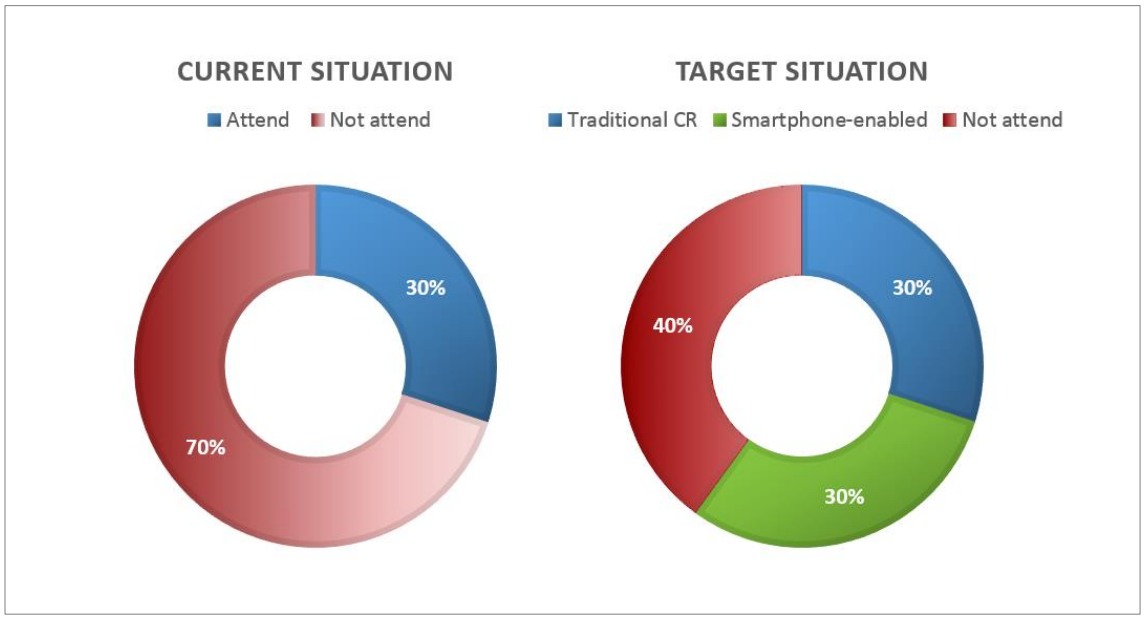

Figure 5.2. *Current attendance rates in CR program and target rates with smartphone-enabled CR*

Therefore, MoTER CR would be targeted to technology-savvy patients and younger in demographic who cannot access centre-based care:

> *”It [home-based CR] would suit especially for younger patients such as working men or self-employed people who do not have time to attend the centre-based CR.”* (CR clinician)

The value proposition for CR clinicians follows the value for patients, as clinicians want to give patients an opportunity for improved quality of care:

> *””Real life” rehab and ”real life” activities with monitoring possibility [...] would be more valuable than a weekly check during CR sessions. [...] It could also increase the Quality of Life for patients.”* (CR clinician)

Automatic data transfer from patient’s smartphone to clinician’s web portal enables more timely data, which can help in decision-making and redefining intervention targets. However, health care professionals can be reluctant to use new technology if it does not fit well in their workflow or takes unnecessary time from the patient care. Thus, the co-design team decided the clinician archetype to also be technology-savvy and open-minded for new types of care delivery.

One additional need for the service was identified. According to a Project Manager in telehealth support, *"there is a need for data about the patient participation and completion of the CR program."* Currently, there are no national or state-wide data on episodes of outpatient CR. A detailed information on demographics, completion, and drop outs could be valuable for data analysis and improvements. However, this was not investigated further.

Many of the interviewees identified some barriers for adopting a smartphone-enabled CR care model to complement centre-based CR delivery. For example:

> *"The biggest barriers when putting through a new telehealth initiative are firewall issues and shared records. Health care providers have different legal structures, and the legal opinion for exchanging data is an issue that needs to be considered."* (Project Manager in a body for telehealth support and guidance)

Staffing resources were also considered as a possible barrier:

> *"Regarding MoTER as another option to deliver CR for patients, it would be difficult to expand the offering due to staff availability."* (CR clinician)

On the other hand, one CR coordinator saw that *"telehealth would free up face-to-face time for staff delivering information session for patients"*. Another CR coordinator stated that deploying the service would mainly depend on the cost, and *"financing staff would need some evidence that the model would be cost-effective."* Thus, a critical task is to demonstrate the value for health care providers in public sector that would require a full cost-effectiveness analysis. This was beyond the scope of this study, but according to a recent study, a similar smartphone app for CR reduced emergency room visits and hospital readmission by 40 %[13]. The paying incentives and funding models are discussed more in Chapter 5.1.5. Other barriers and their influence for business model components are discussed next.

5.1.2 Channels and customer relationships

The SaaS solution is delivered to health care providers directly. This requires direct sales to Health Service Managers who deliver CR. Health professionals (both managers and clinicians) are also influenced by industry and academic media so they will be reached through these channels. This can be achieved through publication in journals and conference presentations, and by contacting clinical associations who develop guidelines for health professionals. For example guideline bodies for cardiovascular disease management *"endorse practices and clinical networks to take up alternative care models that have shown evidence of effectiveness"*. The Project Manager from telehealth support

[13] See http://mobihealthnews.com/31580/mayo-clinic-study-finds-app-reduces-cardiac-readmissions-by-40-percent/

and guidance body had also experienced that *"collaboration or contacts with clinical network is valuable, as it gives a possibility to talk with influencers."*

The service provider will be indirectly contact with patients as a smartphone app is part of the SaaS solution. This is convenient for the patients, as smartphones have become a natural part of people's everyday life. The app will be provided to patients through clincians with their guidance. Many of the interviewees stated that usability of the app is crucial as many individuals easily give up if they do not instantly know how to use the technology. Other possible requirements are providing a tablet solution for elderly patients, as they often do not have smartphone but instead a tablet with more convenient user interface. However, this would require changes to the model as one of the current product feature is a built-in accelerometer to monitor exercise, enabled only by smartphones.

For clinicians, the SaaS solution includes a web portal that enables the connection between clinicians and patients. Clinicians also require a trouble-free system, so an easy access to service provider support is necessary if clinicinas face any technical problems with the portal. Previously we identified the customer archetype for the clinicians to be tech-savvy and willing to change the existing ways of deliver care. We also mentioned staff availability as a possible problem when complementing centre-based CR with smartphone-enabled care model. Thus, the web portal could be integrated with health care provider's routines by dedicating one or more clinicians that match with the target archetype to deliver only smartphone-enabled CR.

When operating in business-to-business healthcare industry, long-term relationships are common. In terms of interacting with Health Service Managers, the co-design team identified the relationship to be personal assistance. The service provider's customer representative will communicate with Health Service Manager and help them to plan a business case during the sales processes and will work to maintain the customer relationship.

Personal assistance is also provided to the clinicians for initial training of the care model and web portal, and for technical support through a help desk service. The support is partly self-service, as clinicians are also provided with a web-based support centre that includes training and trouble shooting content.

The relationship with patients are based on self-service. The service provider is not therefore directly in contact with patient, but offers them a manual for technical support. However, a CR clinician indicated that *"patients should also have an easy access to support if they experience any problems with technology"*. Therefore, finding out sufficient material for training, either manual or help desk, requires further validation as well as specifying the patient archetype.

Designing customer relationships is also about making strategic decisions to ensure a scalable and repeatable business model. Based on brainstorming, interviews, and mentoring, the co-design team developed following demand creation strategy (see figure 5.3).

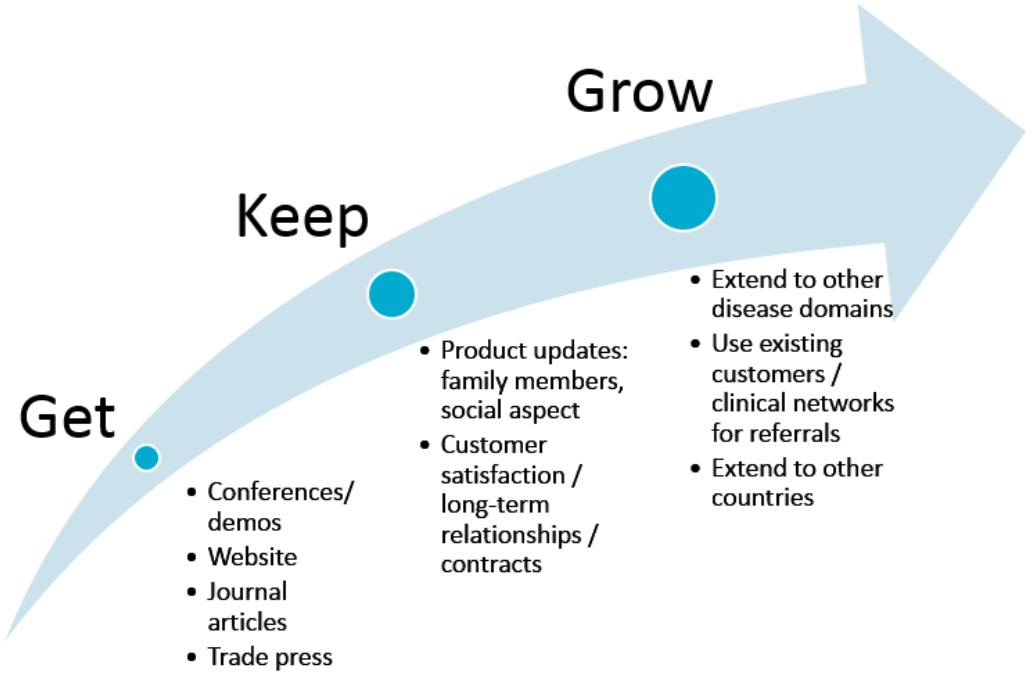

Figure 5.3. *'Get, Keep, Grow' funnel for MoTER*

The first step in customer relationships is raising awareness of the service offering which is highly related to channels. Besides on creating relationships directly with key customers, *getting* customers requires interaction with influencers and payers, including government bodies and health funds. Further steps require high customer satisfaction and pathways to scalability. The challenge is to keep the patient motivated:

> *"With products like fitbit, there is a big fall off utilisation after an initial period. Engagement with the app in regular meaningful ways is important to utilisation and retention."* (Chief Marketing Officer in Private Health Insurer)

Not only the patient satisfaction is important but also the satisfaction for decision-makers who want to avoid fragmented use of different solutions. Related to these issues, one of the interviewees suggested the following:

> *"Scalability could be increased by extending the platform to similar disease domains such as diabetes where lifestyle factors are important in managing the disease. Step-wise changes would also be recommended, such as extending the app to carers, adding a social aspect, or include gamification."* (Senior Manager of State department of health)

To generate sufficient revenues for sustainability, the service provider can also scale the service by extending the marketplace to other countries since chronic diseases are a global problem.

5.1.3 Key resources and key activities

There are four types of resources that other business model components require: physical, intellectual, human, and financial. Main physical resource is the platform, including web portal and a smartphone app. In customer relationships we identified product updates and extending the app to other disease domains to be important to ensure the scalability of the service which is why flexibility of the platform is crucial. To overcome previously identified barriers for telehealth deployment, interoperability of the web portal is important. The Project Manager in telehealth support body stated that *"optimal would be to integrate MoTER platform with Electronic Health Records".* However, the transition from paper based medical records into EHRs in Queensland is only in its infancy. The integrated electronic Medical Record (ieMR) [14] solution has been rolled out only in six hospitals out of 170 hospitals in Queensland[15].

Regarding the smartphone app, it needs to work on most common mobile operating systems such as Google Android and iOS. Usability of the app is critical. Inherently, the care model also requires a smartphone and measuring devices, a blood pressure monitor and a scale, to measure vital signs and weight. Finally, another physical resource is the online training platform for clinicians that helps them to learn to use the system.

A strong business model requires intellectual resources, including required know-how, proprietary knowledge, and partnerships. Intellectual property rights were not investigated much further, but a patent would probably not be applicable in this case. However, clinical credibility and evidence-based research are resources that are important regarding health professionals as a customer segment. In addition, regulatory approval from TGA needs to be considered. For this reason, a regulatory specialist was interviewed:

> *"In general, regulatory body for healthcare is struggling with regulating medical apps. [...] Now with proliferation of apps the regulator has not quite caught up. In terms of regulating MoTER, it probably does not require TGA approval at this stage. [...] However, as soon as the data which is collected is manipulated for the purpose of clinical assessment or treatment, it becomes more likely that it will move into a space where TGA approval is required."*

In addition to physical and intellectual resources, human resources are crucial part of the business model. mHealth as an industry is knowledge-intensive, and long-term customer

[14] EHR in Queensland is called ieMR
[15] See https://www.health.qld.gov.au/clinical-practice/innovation/ehealth/default.asp

relationships demand skilled sales force and customer support. Operating in complex health care environment is demanding: understanding evicence-based medicine, best practices, the end users' needs, health systems' infrastructure, and regulatory environment requires therefore diverse skills set. Based on the other elements in the business model, the co-design team identified at least following staff members and skills: IT Engineer for coding the platform, Sales Manager for repeatable sales processes, Marketing Manager for planning customer strategy, Customer Support Specialist for helping users in troubleshooting, Product Development Manager for understanding customer needs and improving the product, Research Scientist for conducting evidence-based research, Legal Advisor for understanding regulatory environment, and System Integrator to assist healthcare providers after buying. In addition, clinical expertise is needed to understand the guidelines of care delivery. However, the service provider does not necessarily have to have all the skills in their organisation, but can acquire for example clinical knowledge and legal advises from key partners or consulting bodies.

Some level of financial resources are also required before the business model can become self-sustaining. These could be for example a stock option pool for hiring key employees described above or initial revenues for costs from external funders.

In terms of activities, the most important activity the business model requires is continually operate and develop the SaaS platform. To start, this means integrating the platform with health care provider's IT systems. This is challenging as the platform has to have ongoing availability to interoperability for existing and planned systems. For example, some of the Queensland Hospital and Health Services (HSS) are currently looking for vendors for an EHR. The upcoming EHR would signficantly change the IT environment and therefore the requirements for the SaaS platform. Otherwise, the platform needs to meet other requirements for SaaS vendor:

> *"The non-functional requirements for SaaS vendors would be based on Health Department's (in State Government) quality requirements for IT vendors. Specific requirements would also emerge during contract negotiation."* (Enterprise Architect in HSS)

Service delivery as an activity was not fully investigated. As mentioned earlier, the care model requires a smartphone, a scale and a blood pressure monitor, raising a question who provides or pays for the devices. One of the interviewees discussed the usefulness of providing the equipment, stating that *"models with all of the equipment such as a smartphone provided may give less effecive use."* It could also add another level of complexity and be less effective to deliver the service and care. Thus, the co-design team concluded that the patient should already have a smartphone. This should not be a decisive issue as most of the people already have a smartphone. However, regarding the measuring devices, finding the right solution is more problematic. A CR clinician expressed following views on the matter:

> *”Lots of patients already have measuring devices (a scale and a blood pressure monitor), although withouth Bluetooth. However, if patients were asked to pay for these services in order to attend the home-based CR, many would be reluctant to do so.”*

One of the options for CR providers could be lending the devices for the patient. Accordingly, the service provider would acquire the devices from a technology vendor and deliver them to a health care provider as part of the SaaS package. However, it was unclear whether lending measuring devices would be approved by the Infection Control in healthcare. Another issue besides the devices is the cost of data transfer. The patient should have a phone plan with Internet connection to enable the data transfer between a smartphone and a web portal. Again, it is unclear who would pay for this. Assumingly, this would be paid by the patient. In any case, the service delivery regarding required devices requires further investigation.

Previously we suggested the best way to create demand in the business model. Raising awareness by selling and marketing is an activity itself but notable is that there are other parties that need to be considered besides only the customers. Health care providers and professionals often rely on clinical associations’ guidelines that provide information on approaches of effective and evidence-based care interventions. Therefore the service provider needs to target marketing also to these players. Moreover, Governments and private health funds are influencers because they reimburse the health services provided in public and private sector. For example, government bodies review possible telehealth solutions and new health care interventions they will invest. Similarly, the Chief Marketing Officer in a private health insurance company said that health funds look for investing in health related programs that have *”demonstrated health benefits and an opportunity to engage individuals’ membership and to develop their loyalty”*. However, it remained unclear what kind of interaction there would be with private sector insurance companies and private healthcare practitioners.

In customer relationship component we also identified important factors for keeping and growing customers, which needs strong focus on product development. This activity is co-creation that requires multiple stakeholders for evidence-based results. Extending the platform to other similar disease domains will also increase the likelihood for regulatory approval. As the regulatory specialist stated:

> *”It is important to consider the development trajectory of this sort of product. If it is envisaged that future developments and enchancements of the product would be likely to take it in the direction of TGA approval, then getting systems and processes of development in place early is key to minimising the disruption of the regulation process.”*

In summary, the key activities require lots of attention to legal, IT, and usability issues. Moreover, to make the service attractive, clinical evidence of the care delivery model is critical.

5.1.4 Key partners

In the designed business model, many of the key resources and activities require partnerships. A major key partner in the business model is the AEHRC. Close collaboration with organisations who possess research facilities enables effective and meaningful product development. This is necessary when the aim is to extend the product to other service domains and rely on evidence-based health care interventions. Product development requires also other partners; clinical associations for clinical advising, and early adopter health care providers for research and customer environment. The ultimate payers of healthcare can also be considered as partners, as it requires collaboration and marketing to find reimbursement for new healthcare interventions.

If the service delivery model includes delivering measuring devices to healthcare providers, the service provider needs a supplier for the devices. This would be a medical technology vendor such as TaiDoc or Spengler.

5.1.5 Cost structure and revenue model

Costs

After defining key resources, activities and partnerships, it is possible to estimate the costs occured for the service provider. The business model in this case is more value-driven than cost-driven. A challenging healthcare environment with varying customer needs requires highly personalized service. Thus, operation of the platform, product development and staff generate most of the costs.

The operation and development of the platform can be costly if the product requires a TGA approval. One interview unfolded this area:

> *"If TGA approval is required, it [MoTER] will only be class one device*[16] *which has $0 application fee and a yearly $60 maintenance fee. The real cost if such registration is required is in ensuring that the quality control processes for software development are in place. These need to be formally documented quality control with design specifications and verification that the product meets those standards."* (Regulatory specialist)

[16] TGA Classification: Class 1 IVD Level of risk: no public health risk or low personal risk. See https://www.tga.gov.au/node/5311

In summary, quality control and product development along with sales process and customer support are the most expensive activities that require skilled staff.

Other costs include marketing the product and operation of the online training platform. Ordering measuring devices would also generate costs if they were delivered to the health care providers. These costs would be variable costs as they depend on a volume of the devices ordered from the supplier.

The costs were not estimated numerically in the design process. However, this would be an important part of the business model development to estimate the break-even point, i.e. the moment when the costs and revenues are equal.

Revenues

Previously we described the value proposition for healthcare providers. Healthcare providers have scarce resources to deliver care. Having more patients to participate a CR program would bring indirect savings due to reduced readmissions which could be reinvested in rehabilitation. Full cost-benefit analysis was out of the scope of this study. However, we can use some of the available numbers to estimate the cost savings for healthcare providers.

According to an interview with a CR coordinator, the average cost of CR per patient is approximately $1200. The cost of readmission for a new heart attack, in turn, can be as high as $17,600[17]. One evidence shows that participation in CR program after a heart attack results in significant reduction in all-cause 60-day hospital readmission rates. The readmission rate for patients undergoing CR was 6.7% while for others the rate was 23%.[18]

Using these numbers we can roughly calculate the costs of CR and readmissions when the uptake of CR is the current average of 30%. Similarly, if we assume that providing smartphone-enabled CR would increase the overall uptake of CR we can calculate the costs and possible savings for healthcare providers that result from reduced readmissions. Table 5.2 demonstrates the costs and benefits for healthcare providers when 500 patients are referred to their CR in a year. We assume that the uptake rate would increase from 30 % to 60 % and the cost of MoTER for healthcare providers would be the same $1200 per patient.

[17] Stranges et al. 2012. Readmissions for Heart Attack, 2009. See http://www.ncbi.nlm.nih.gov/books/NBK109195/

[18] Lam et al. 2011. The effect of a comprehensive cardiac rehabilitation program on 60-day hospital readmissions after an acute myocardial infarction. *Journal of the American College of Cardiology*, 57(14), E597.

Table 5.2. *Cost savings for healthcare providers with 500 referrals if CR uptake rate would increase from 30 % to 60 %*

Uptake rate 30 % (only face-to-face CR)		
	Patients	**Costs ($)**
Participate CR program	150	180,000
Readmissions for patients in CR program	10.05	176,880
Readmission rates for others	80.5	1,416,800
	Total	**1,773,680**
Uptake rate 60 % (face-to-face + MoTER)		
	Patients	**Costs ($)**
Participate CR program	300	360,000
Readmissions for patients in CR program	20.1	353,760
Readmissions for others	46	809,600
	Total	**1,523,360**
Savings for healthcare providers: $1,773,680 - $1,523,360 = $250,320		

Note that the readmission rates and cost of readmissions are secondary data so the costs and benefits for a particular healthcare provider might differ. There is also a possibility that smartphone-enabled CR could be delivered at lower costs which would bring more savings for healthcare providers.

In healthcare, the buying customer i.e. the healthcare provider is not the ultimate payer. Reimbursement for healthcare delivery comes either from the Government, private health funds, or patients. In public sector cardiac rehabilitation is reimbursed by the Government and the patient pays only a small co-payment fee (approx. $30). In Queensland, 34 of the largest public hospitals are funded through Queensland Activity Based Funding (ABF) funding model, which sets prices at a disaggregated level for each type of public hospital

service.[19] For cardiac rehabilitation this is Tier 2 Clinic price 40.21 with new assessment price $655 and following reviews $433.[20]

According to the interviews, it is unclear how the smartphone-based CR would be funded. Government and health insurance as well as patient co-payment were suggested. Ongoing pilot projects of MoTER receive State Government's innovation funding but this is not ideal in future. Instead, long-term funding would be preferrable. The co-design team therefore assumed that similarly to centre-based CR, healthcare providers who offered MoTER could be reimbursed through ABF rate for cardiac rehabilitation. However, this proved to be inapplicable, since the occasion of care in cardiac rehabilitation covers only face-to-face assessment. Furthermore, reimbursement for remote patient monitoring is currently immature in Australia. There is an MBS item for telehealth but the definition of telehealth is limited only to video consultations.[21] Therefore, it seems that so far the only way for the Government to fund smartphone-enabled CR is ad hoc funding.[22]

If suitable funding arrangements for remote patient monitoring were in place, the team made some assumptions in terms of how the service provider would charge the healthcare provider for MoTER. The revenue strategy would be an annual subscription fee. The pricing tactics would follow both fixed and dynamic pricing mechanisms. The team first assumed that volume-based pricing where the price would be lower after a particular number of patients would be applicable. The interviews gave some contradicting results regarding this. According to the Project Manager in telehealth support body, revenue model could not be volume-based because budget for healthcare providers needs to be anticipated. On the other hand, the Senior Manager of State department of health suggested that volume-based funding could be possible when states are moving from ABF towards population-based funding. In terms of professional services (i.e. integration support) and measuring devices, the team assumed dynamic pricing would be applicable where the price is based on enterprise need, size, and degree of support. The revenue model with key players and pricing tactics is illustrated in figure 5.4.

[19] Queensland Health – Purchasing and funding models. See https://www.health.qld.gov.au/system-governance/health-system/managing/funding-model/default.asp
[20] Queensland Health – Health funding principles and guidelines 2014-2015, Appendix 6, p. 3/4
[21] Department of Human Services: MBS and telehealth. See http://www.humanservices.gov.au/health-professionals/services/mbs-and-telehealth/
[22] Medical Technology Association of Australia – 2013-2014 Pre-budget Submission: Reimbursement for telehealth in Australia, p. 3

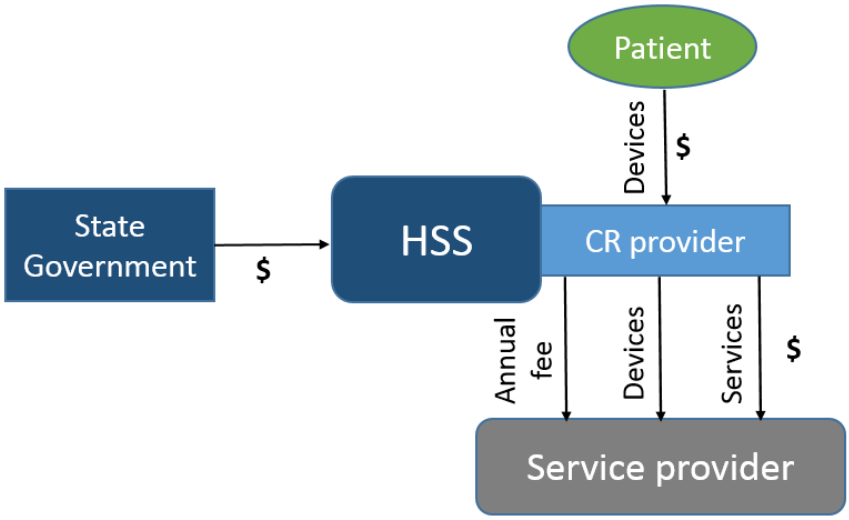

Figure 5.4. *Key players in revenue model for public CR provider*

CR provider is part of Queensland's Hospital and Health Services (HSS). These hospital networks receive funding from the Government but make the decisions of how to spend the money largely by themselves. The service provider's SaaS offering is consisted of the subscription fee and dynamic pricing for integration services and possible measuring devices. These are negotiated with a CR provider and put in a business case form which is then proposed to financing staff in HSS. Previously it was suggested that CR providers could either lend or rent the measuring devices to patients. Medical Technology Association of Australia (MTAA) also proposes some level of patient co-payment for measuring devices and services. This would be based on a patient's capacity to pay.[23] Subscription fee and professional services would contribute most to the revenue streams, and selling devices would be only a minor source of the overall revenues.

Nevertheless, the revenue model was not fully validated. Without finding sustainable funding arrangements it is not guaranteed that offering MoTER only for cardiac rehabilitation would generate sufficient revenues for the service provider. Developing platform scalable for similar disease domains is hence important.

In terms of private sector, the co-design team did not investigate the options for a revenue model during the interviews. According to MTAA report[24], telehealth services are not commonly funded by private health insurers in Australia. However, there is an incentive for health plans to fund telehealth programs to keep members healthy in order to avoid expensive hospitalisations. Examples of such programs are "My Health Guardian", home telemonitoring service for people with chronic conditions[25], and the COACH program

[23] Medical Technology Association of Australia (MTAA) – 2013-2014 Pre-budget Submission: Reimbursement for telehealth in Australia, p. 11
[24] MTAA – 2013-2014 Pre-budget Submission: Reimbursement for telehealth in Australia, p. 10
[25] See https://www.hcf.com.au/more-for-members/my-health-guardian/chronic-conditions/

that involves regular phone contact with qualified dietitian[26]. In general, private sector might be more agile and ready for changes in their healthcare delivery. According to the interviews, if telehealth solutions have potential to demonstrate health benefits and cost benefits, health plans could be willing to reimburse such programs while private practitioners could generate more revenues due to increased level of service.

5.2 Value network

The value network in figure 5.5 provides an overview of the developed business model and visualizes the transactions that are delivered between the service provider, customers, partners, and other parties. It follows the colour coding used in the Business Model Canvas (see figure 5.1). Dashes in transaction arrows indicate the elements that were not thourughly validated during the design process.

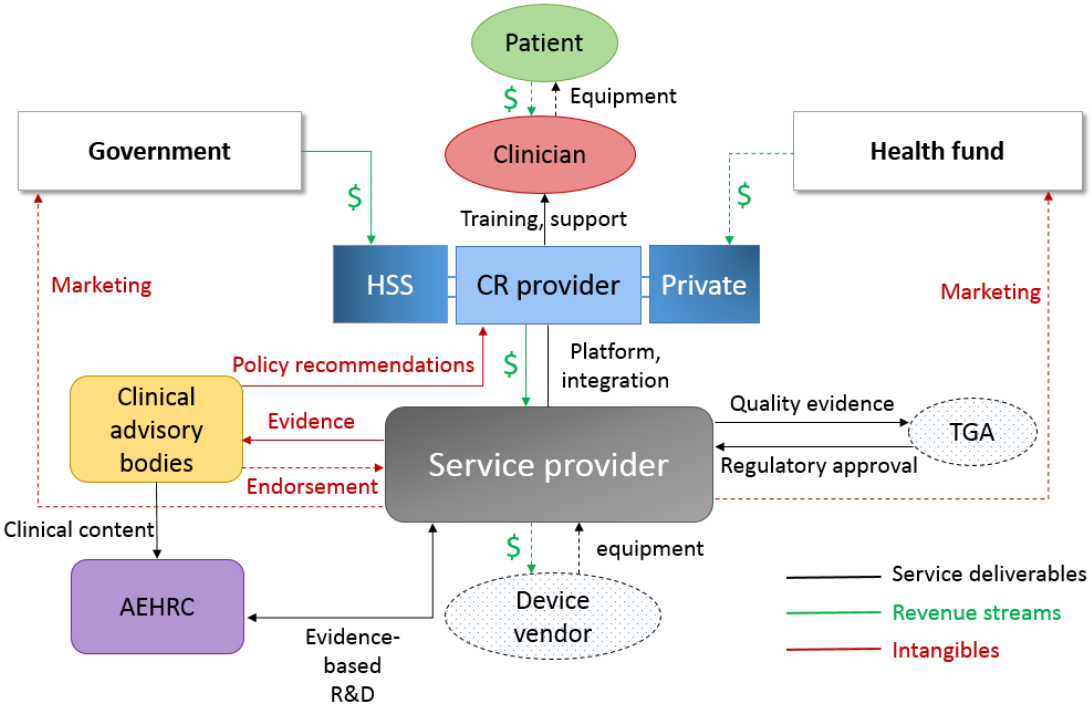

Figure 5.5. *Value network for MoTER with value transactions and revenue streams*

As described earlier, the service provider delivers the platform, including the web portal and smartphone app to CR providers. Service support, including training, integration, and customer support is critical part of the service delivery. The purchaser of the service is the CR provider who receives reimbursement either from the State government or health funds depending on whether it is a public or private provider.

Marketing MoTER to Government bodies and health funds is hence important but the level of interaction was not investigated further. Another important component is

[26] See http://www.bupa.com.au/health-and-wellness/programs-and-support/member-support-programs/the-coach-program

collaboration with the AEHRC and clinical advisory bodies who develop guidelines for cardiac rehabilitation. The service provider would work closely with the AEHRC to develop the product further and do evidence-based research which is important considering extending the platform to other disease domains. This evidence will be then informed to clinical associations who can include alternative and effective care models in their care recommendations.

When the product is developed to monitor patients remotely and help in decision-making, it will need regulatory approval. The service provider will provide evidence for the safety and effectiveness of the product as well as the quality control documentation that is needed for the approval from TGA.

Service delivery model was not fully validated but there were suggestions of providing measuring devices to CR providers who could then either lend or rent them to patients. The devices would be then ordered from the supplier and delivered to CR provider depending on their needs.

6. DISCUSSION

In this chapter we discuss the most important findings and aim to generalise them in the light of the literature, i.e. what similarities and differences we found during the study compared to previous findings. We first debate the key characteristics for sustainable mHealth business models. We then identify benefits and common challenges of mHealth, and present key actors in this industry. Finally we discuss how business model design can overcome existing challenges in mHealth implemention.

6.1 Characteristics of mHealth business models

In empirical part we used Osterwalder's Business Model Canvas as a base framework for developing a business model for a particular mHealth technology. The business model is thus a description of a "real world" business model (Osterwalder et al. 2005, p.10). We aim to generalize the model to a conceptual level by finding common characteristics in the business model that are applicable in mHealth industry specifically regarding chronic disease management.

To start, we discovered two basic elements regarding the nature of the business model. Firstly, the mHealth business model in chronic disease management is a multi-sided market with multiple customer segments where the target customer is different from the end users. Moreover, the buying customer is different from the one who ultimately pays for the service. Thus, value creation in the multi-sided market is based on the interaction among involved parties (Mettler & Eurich 2012, p.81). Secondly, the results showed that mHealth technology is possible to deliver as a Software as a Service with a third party service provider. This is aligned with the previous literature where the service provider plays a focal role in the business model (Fielt et al. 2008, p.276; Kijl et al. 2010, p.346; Peters et al. 2015, p.1300).

The value proposition in mHealth business model is seemingly strong. First, patients value the increased convenience and continuous care (Malvey & Slovensky 2014, p.14), and clinicians the support for decision-making (Mirza et al. 2008). Decreased number of readmissions that results in reduction of healthcare costs is inherently valuable to the payers. However, strong value proposition is not suffiecient for the right business model, and there are important factors in other BMC components. In addition to the general nature of the business model, we can identify six main findings in the business model that act as key characteristics for sustainable mHealth care delivery. Each finding is linked with the BMC components they are related to in order to find a pattern for the business model. The related BMC components are illustrated in figures using dark blue colour.

Finding 1: Sustainability requires scalability and reliability

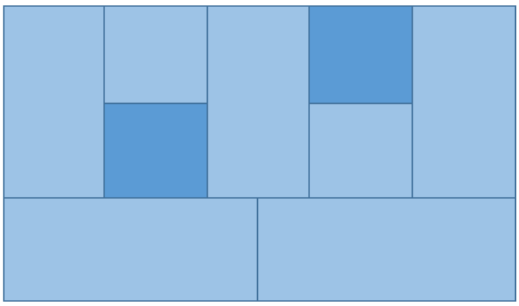

Figure 6.1. *Related BMC components: Customer Relationships and Key Resources*

Scalability is related to the 'Get – Keep – Grow' funnel: how to create and increase the demand of the service. Scaling the service is required to generate sufficient revenues for sustainability, and this can happen by extending the platform to similar disease domains or growing the marketplace to other countries. The initial platform should also be scaled by increasing the functionality, usefulness, and desirability of the app. After solving the initial need for the patient, tracking of vital signs and behavioral changes, the service provider needs to consider the life cycle of the product to satisfy the additional needs of the user. This means adding social and motivational features into the product such as interaction with other users or family members (van Meeuwen et al. 2015, p.12), and gamification possibilities (Klasnja & Pratt 2012, p.186). The product itself needs to be flexible and solidly grounded (Peters et al. 2015, p.1297) to ensure scalability and meet the health providers' requirements. In addition to flexibility and interoperability, a reliable platform requires patient security, privacy and usability (Broens et al. 2007; Malvey & Slovensky 2014, p.14), as well as support services that are available when needed.

Finding 2: The role of regulatory approval

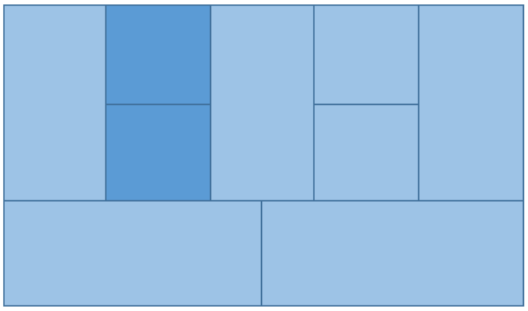

Figure 6.2. *Related BMC components: Key Resources and Key Activities*

Regulatory bodies are slowly catching up with regulating mHealth innovations. This means technology innovators need to scope the regulatory environment in their target market in order to avoid developing solutions that cannot be used because they do not meet the policy standards. Health industry has lots of standards to ensure patient privacy

and safety (see chapter 2.3). The level of clinical decision-making support of the product determines the regulatory requirements for the mHealth service. Considering legal issues as key design dimensions can facilitate successful diffusion (Cho et al. 2009, p.363), and doing this early in the development minimises the disruption of the regulation process.

Finding 3: Early adopters as key partners

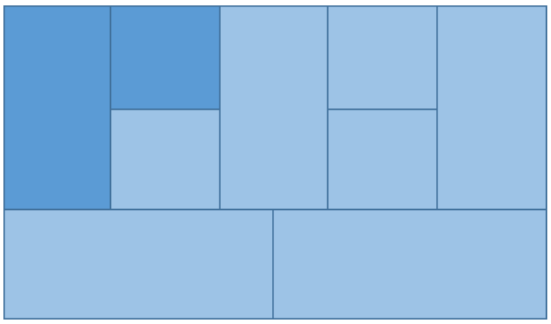

Figure 6.3. *Related BMC components: Key Activities and Key Partners*

Product development requires early adopters that can act as pilot organisations. Understanding clinical workflow is crucial when implementing mHealth solutions in practice, and early adopters help to develop the product and refine the process around it. However, it is important to notice that the early adopter might not be the ”true” customer in a marketplace (Cho et al. 2009, p.361) because of the existing financial or organisational structures that do not support long term implementation. In this case, the early adopters were in public CR providers due to the pilot studies, but proved to be challenging long term customers because of immature reimbursement models in public health sector. Besides having an early adopter acting as a partner, one of the key factors is to find the right long term customer segment and design the rest of the business model to match their needs.

Finding 4: Clinical credibility and evidence-based medicine as key success factors

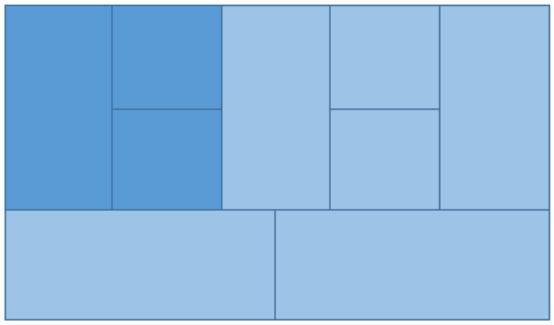

Figure 6.4. *Related BMC components: Key Resources, Key Activities and Key Partners*

Healthcare industry relies greatly on evidence-based medicine (Craig et al. 2001) that is used to create best practices and care guidelines. The results showed that clinical advisory bodies advocate for care models that are proven to be effective, and health insurance companies invest in health programs that have demonstrated positive health outcomes. In addition to this, the literature suggested that health care professionals are more willing to adopt mHealth services if there are evidence of value to the patient (Putzer & Park 2012; Boudreaux et al. 2014). Clinical credibility is therefore a success factor that can also bring competive advantage. Creating collaborative partnerships with medical R&D organisations (Kijl et al. 2010, p.346; Burke et al. 2015, p.1167) and early adopters is therefore a critical part of the business model in order to conduct high-quality clinical studies. In addition, the support of opinion leaders (Menko et al. 2013, p.113) or medical champions (Cho et al. 2009, p.362) is one of the key drivers in successful implementation.

Finding 5: Reimbursement and funding structures as key determinants

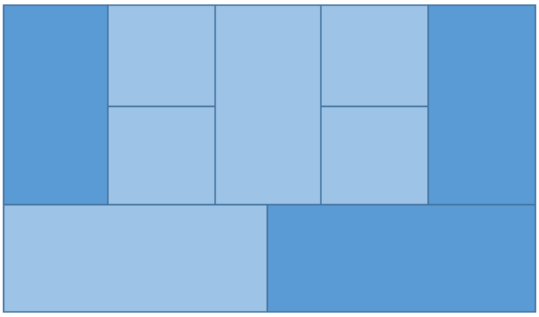

Figure 6.5. *Related BMC components: Customer Segments, Revenue Streams and Key Partners*

Related to *Finding 3*, funding models play an important role in business model design. Even though the end users are willing to adopt the product, they are not the final decision-makers whether to implement the product or not. Healthcare has complex and varying funding (see chapter 2.3); if increased offering of cardiac rehab leads to higher costs, there are no incentives for healthcare providers to adopt the service if it is not reimbursable by the government. In this study, we found that government bodies are eager to invest in mHealth innovations as they have a possibility to decrease the readmissions (Gaikwad & Warren 2009) and thus health expenditure. Nevertheless, this investment has thus far been ad hoc type of funding which is not the sustainable way to implement mHealth services as it does not bring recurrent revenues for the service provider. Therefore, the mHealth system should either be developed to meet the requirements of reimbursable telehealth (Cho et al. 2009, pp.358, 361) or find a private sector payer, such as employers (Kijl et al. 2010, p.352) or private health funds who benefit from the service. Early design of the recurrent revenue streams is important as this also affects other components in the business model. In order to influence the payers and funding structures, there needs to be evidence of real cost benefits for the payer (Yu et al. 2006, p.183).

Finding 6: The varying role of the service provider

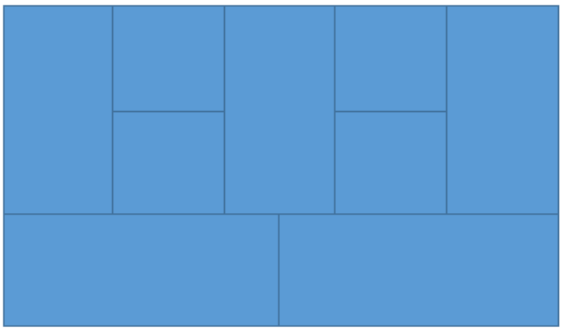

Figure 6.6. *The role of the service provider affects every component in the BMC*

In this study, we did not fully validate the responsibilities of the service provider. For example some providers may focus only on delivering the service and outsource the integration and support services (Kijl et al. 2010, p.352). Moreover, we assumed that the service provider is a third party organisation with a sole business purpose to deliver the mHealth solution for the providers as a Software as a Service. However, the service provider can be a different type of party in the mHealth ecosystem. Fielt and colleagues (2008, pp.277–278) presented possible scenarios for the service provider actor: 1) Demand-Side Scenario that includes healthcare providers or health insurers to take on the role of the service provider; 2) Supply-Side Scenario where health solution providers or telecommunication providers want to invest in new service offering; 3) Outside Investor Scenario including for example a venture capitalist who can invest in the start-up who will take on the role of the service provider; 4) Mixed Scenario that is a combination of the other scenarios. Based on these scenarios, this study was designed from the Outside Investor's perspective. The type of the service provider naturally affects each components in the BMC, but the key characteristics (findings 1-6) are still instrumental in the business model.

Based on the key findings, we can conclude that there is a strong emphasis on the left side of the BMC which includes most of the key challenges for sustainable implementation (discussed in next chapter). Figure 6.7 illustrates the emphasis of each business model component in the BMC based on the six findings. The tone of the colour indicates the level of the emphasis (dark blue has the most emphasis).

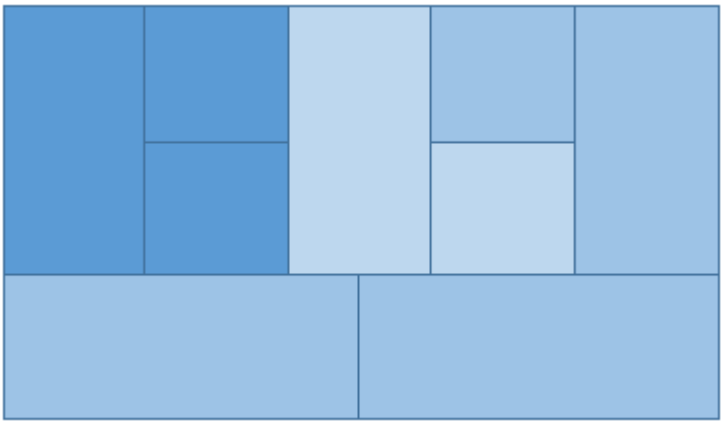

Figure 6.7. *The emphasis of key findings in the context of Business Model Canvas components*

Resources and activities play important role in the business, and creating a partnership strategy to deliver these activities has large influence on the success of the implementation. In addition, to achieve recurring revenues, the service provider needs to understand the funding models to find out the right customer for long term mHealth deployment. Finally, quantitative analysis of the business model is required to show the cost-effectiveness of the mHealth service.

6.1.1 Benefits and challenges of mHealth

During business model design, we identified a value proposition for the key customers segments. In general, mHealth services can increase the accessibility and convenience of care for the patients. While this improves self-management of chronic diseases and decreases the risk for secondary events, it leads to reduced number of costly readmissions therefore decreasing the overall healthcare costs for the payers. For clinicans more timely and accurate information about the patients vital signs and progress enables reliable and informed decisions leading to improved quality of care. These value propositions is well aligned with the literature (Gaikwad & Warren 2009; Purcell et al. 2014) that has investigated the benefits mHealth care delivery provides.

The business model and its components contain also risks that are translated into barriers for mHealth implemention. During the business model design we found different types of challenges that are aligned with literature. For example the value proposition for patients is only valid if a patient finds the product useful. Understanding the additional needs of the patients can be challenging which is partly because of the lack of behavioral models (Nundy et al. 2013). Social aspects such as the influence of family and carers can be decisive aspect in terms of how long the patient continues to use the device after the initial exitement.

There are two big challenges in the clinical environment. First, in results we discovered that referrals have a major impact on the utilisation of CR services. Thus, the service provider needs to understand the patient journey and related points that affect the service.

In this study the referral rates for CR were low partly because of the lack of nearby CR centres. Being aware of patient journey stages that have influence the overall utility and benefit of the service may be difficult to external service providers who do not have the experience of health care processes. Second, implementing a new type of care model requires redesigning clinician workflows that may also be challenging to understand by a person without clinical experience. Introducing new processes can also cause resistance to change by the clinicians. The results also showed that staff availability can be an issue when the healthcare provider is considering new mHealth services as the additional care delivery model would need staffing. On the other hand, using technologies have a possibility to reduce the workload of the clinicans by reducing time for home visits (Cocosila et al. 2004, p.235) which could then be then reallocated to mHealth care delivery.

In addition to the organisational challenges in healthcare, technical and legal issues were recognised as possible barriers. These include mainly the IT infrastructure in healthcare provider organisations, system security, and regulatory requirements. Different healthcare providers have different IT systems in use, as well as different legal structures. Moreover, the industry is going through a constant reform and increased utilisation of IT systems. Designing the mHealth service to fit the existing systems and flexible to change is a major challenge for the developers. Similarly, the regulatory requirements for mHealth services are becoming more rigorous and the developers need to have a long-term plan for the early phase technology in able to design the technology and its development processes to align with regulatory needs. Regulatory requirements also vary between countries so strategic decisions also affect the technology development.

In empirical part of the study we discovered that one of the biggest risks is around funding of mHealth. We found that funding in Australian public healthcare is largely activity based which means the hospitals receive funding for people in hospitals but not for keeping people out of them. The value is therefore only realised for the Government or private health insurers who benefit from preventative care and decreased readmissions. As long as the Government does not have incentives for public providers to provide remote patient monitoring that decrease readmissions, the value proposition might not be relevant for the providers. Moreover, current health funding principles for telehealth do not include reimbursement for remote patient monitoring which makes it difficult for the service provider to provide the SaaS in a sustainable way. This is also the case in Europe where consultants call for modernisation of the reimbursement systems (Newsroom Editor 2015, p.21). These findings confirm that existing funding models are one of the biggest challenges in mHealth implementation (Broens et al. 2007; Fielt et al. 2008; van Limburg et al. 2011). Under these circumstances, it seems that private sector could be easier to operate in. Health insurance providers are more agile to restructure their funding, but on the other hand, the results indicated that private practitioners could be difficult to incentivise. However, private providers compete for health fund reimbursement (see

chapter 2.3) so there is an opportunity to create value for private providers by offering them new, cost-effective care models.

Related to reimbursement and incentives for payers and providers, the challenge is to prove the stakeholders that the new mHealth system is cost-effective. This is difficult because often the new system has large implementation costs at the beginning, and the benefits and savings are only realised in long-term. The savings should not also occur at the expense of patient health outcomes, so the service provider should have rigorous evidence for both, the improvement in health outcomes (Free et al. 2013) as well as the cost savings (Burke et al. 2015, p.1190).

During the business model design, the co-design team explored that many of the assumptions that were made before the interviews turned out to be false and there were many unknown facts about the healthcare industry related issues. Only the interviews unfolded underlying motives of the stakeholders, existing public healthcare funding structures that hinder the long-term adoption, or the organisational challenges that affect the platform design. This demonstrated well the literature, where the lack of interaction between different organisations and stakeholders was recognised to be one of the key challenges (Fielt et al. 2008, p.271).

6.1.2 Actors in mHealth

During business model design we identified the actors or stakeholders in mHealth value network. The BMC (see figure 5.1) illustrated the complexity of the network with different types of customer segments and partners. As Malvey and Slovensky (2014, p.95) suggested, knowing the motives, the relative strength and importance of the stakeholders is critical to successful innovations and their implementation. Previously we acknowledged that funding structures and reimbursement are the key drivers in the business model, and determine the target customer regarding the type of the healthcare provider. Payers have therefore the biggest strenght as influencers, and the benefits of mHealth solutions should be outlined clearly in order for them to restructure reimbursement policies. Other strong influencers are regulatory bodies who can inhibit the mHealth care delivery if it does not meet the required standards. We also identified clinical advisory bodies as key stakeholders as they advocate for effective care delivery models, and healthcare providers are thus influenced by them. Research organisations or facilities act as a means to provide evidence of clinical effectiveness of the mHealth service. Health care professionals and patients are the end users, but have limited influence on the adoption of mHealth service. However, considering the motives and needs of the end users can facilitate the adoption and diffusion of the service (Vuononvirta et al. 2009).

In terms of the service provider, there can be different types of stakeholders to adopt this role. In the empirical part of the study, we designed the business model from a third party

perspective where providing mHealth service to healthcare providers would be their sole business purpose. However, the service provider can also be a technology vendor or telecommunication service provider (Leslie et al. 2011, p.43), or a health insurer or healthcare provider who complement their business models with related services (Fielt et al. 2008, p.277). Different scenarios for the value network are presented below (see figure 6.8).

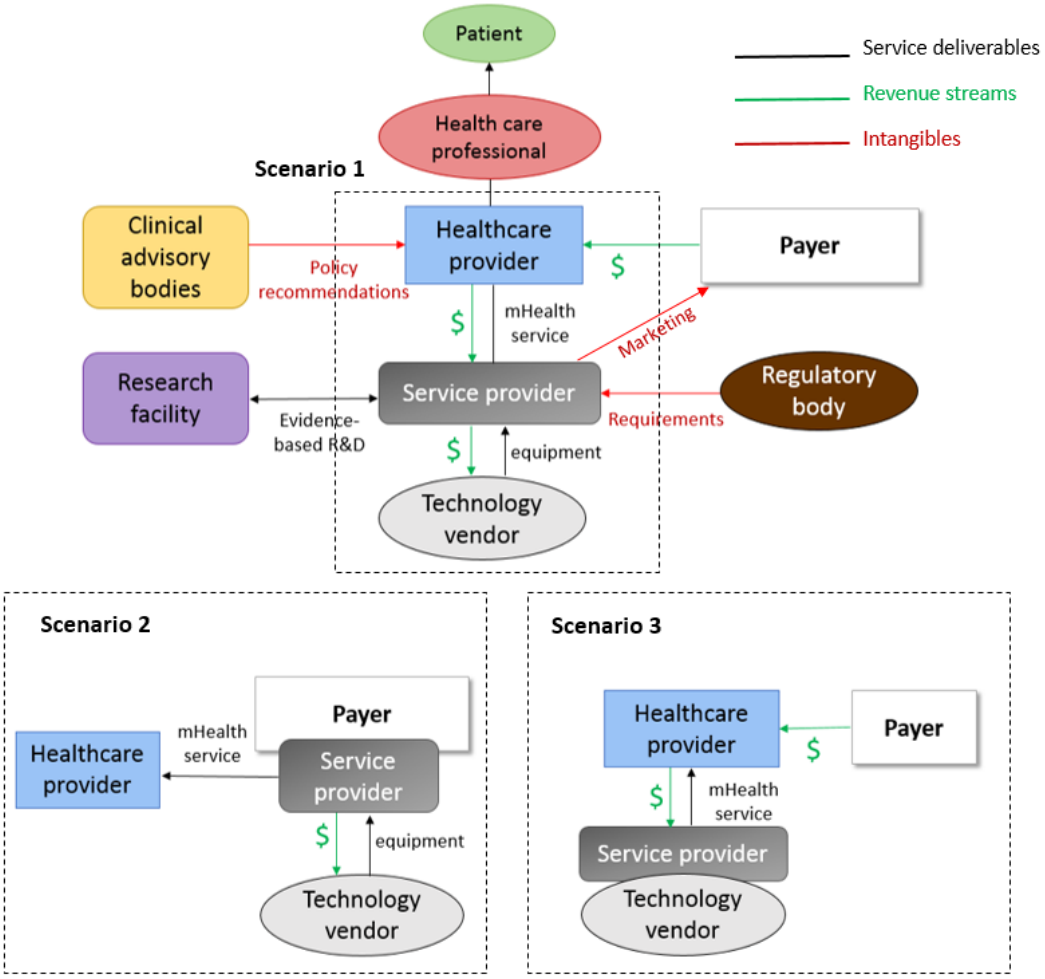

Figure 6.8. *Value network and service provider scenarios in mHealth care delivery*

Scenario 1 is the outside investor, scenario 2 the demand-side senario, and scenario 3 is the supply-side scenario. As Fielt (2008, p.277) suggested, the value network can also be a mix of these scenarios.

6.2 Business model design in mHealth context

The empirical part of this study allowed us to observe some of the benefits of business model design. The business model demonstrated how all the challenges and mHealth stakeholders can be found in the Canvas, so the business model enables the designers to see the ’big picture’ as suggested in previous research (van Limburg et al. 2011).

The business model as a framework therefore helps designers to consider what elements need addressing and what resources are needed to take account when implementing mHealth services for a long time period. For example, the co-design team consisted of researchers who were not previously familiar with reimbursement and funding structures in healthcare, and the business model design process forced the researchers to consider these elements that affect the mHealth innovation. The business model also guides designers to think about the customer in a comprehensive way. In healthcare, this includes the clinical workflow, IT infrastructure, legal environment, staff shortages, funding arrangements, and future plans that may affect the service design. When the product or service truly reflects customer needs, rest of the business model will follow. Importantly, the design process demonstrated the critical role of resources and activities that are required early in the development phase – if these are not considered from the beginning, it can lead to innovations that are not viable for commercialisation and do not meet external forces including technological, regulatory and reimbursement requirements.

The most important issue is around the assumptions for the business model that were either validated or invalidated during the design process. At the beginning, the co-design team made a conscious decision to focus on public healthcare sector because of the existing relationships and ongoing implementations in Queensland Hospital and Health Services. However, during the interviews and design process it turned out that at this stage it is nearly impossible to generate recurring revenues which is important in enabling creation of sustainable mHealth services. Existing funding structures do not reimburse remote patient monitoring care models so the service provider would have to rely on ad hoc funding. This demonstrated earlier findings in literature (Kijl et al. 2010, p.352) that an initial business model and value network is not necessarily the right one. It is therefore important to invalidate or validate the first assumptions and search alternative business models to find the one that creates value to all the stakeholders while bringing revenues for the service provider.

The design process also led the team to explore, what requirements there are for the service in order to cross the diffusion chasm (Cho et al. 2009), i.e. to move from a pilot product to a commercial product. When the service provider shifts from a research centre to an external provider and the marketplace becomes bigger, the value-added services (Cho et al. 2009, p.361) must be in place. Therefore, the key characteristics for a sustainable business model can help to cross the chasm (see figure 6.9).

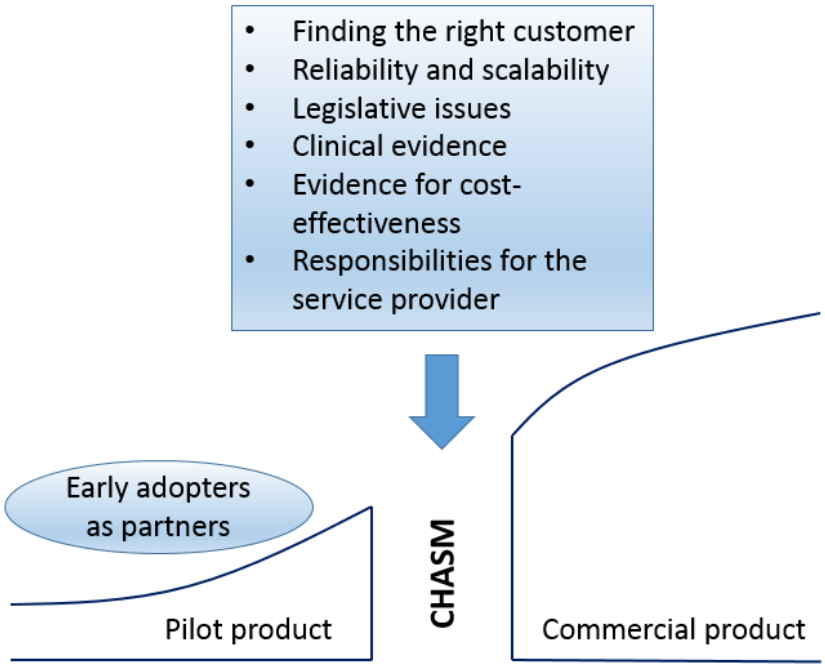

Figure 6.9. *Requirements for a commercial product and a sustainable mHealth system*

As illustrated in the figure, early adopters in pilot phase are key partners who help to develop the product. During the product development, business model design enables to discover the true customer and consider the resources and activities that are needed to develop the commercial product.

The co-design team also observed that in healthcare, there are lots of surrounding elements in the value network and the product development is influenced by the future circumstances such as policy and regulatory changes. Thus, the set of all feasible business models is not foreseeable in advance (Chesbrough & Rosenbloom 2002, p.550), and business model design is a dynamic process (Spil & Kijl 2009).

In terms of business model frameworks, the BMC is useful to give an overall picture of the business model and its elements. Nonetheless, the co-design team experienced some difficulties during the design due to the complex nature of healthcare. This might be because the team was forced to think ”within” the given domains of the canvas, which might therefore hinder the creativity of the developed business model (Eppler et al. 2011, p.1335). For example the service model, i.e. how to actually deliver the service for the provider and the end users, did not receive sufficient attention. The service model as a concept is scattered across the BMC elements, including key resources, key activities, channels and customer relationships which making it difficult to comprise the overall picture of the model and its transactions. Therefore STOF model could work better when designing the service model, as the organisation domain includes actors with certain resources and capabilities and how they interact with each other (Bouwman, Faber, Haaker, et al. 2008, pp.49, 56). In addition, the BMC led us to include only the CR providers and end users in customer segments, all who have limited influence on the

adoption of mHealth service. It could therefore be argued whether health insurers, government and guideline bodies who were identified as most important influencers, should be in customer segment component so that they would get more attention regarding customer relationships and channels amongst all.

Nevertheless, the BMC is a highly relevant tool for the early development because it is easy to comprehend and universally well adopted, and is therefore easy to communicate to others facilitating collaboration across disciplines (Swanson et al. 2012). However, other business model tools may be more useful for visualisation (van Meeuwen et al. 2015) and understanding the value transactions, and can be used to complement business model design.

We discovered that the co-design team consisted of research-oriented people with limited business skills. During the design process, the team became more familiar with the marketplace in healthcare and the industry forces. Related to this, both Steve Blank's Lean LaunchPad method and literature (Chesbrough & Rosenbloom 2002, p.551) suggest that technology founders cannot rely on others in the organisation to experiment alternative business models, but instead, they must themselves become acquainted on these issues. Business model design plays an important role requiring technology developers to create processes to explore the economic domain more thoroughly (Chesbrough & Rosenbloom 2002), and thus aids to design the mHealth system to meet the market needs.

6.3 Limitations

This thesis provides general characteristics for a business model that are needed for a sustainable mHealth techonology implementation. The study covered many important stakeholder interviews and supporting documents that contributed to the results, and the findings were often aligned with previous literature. However, there are several limitations related to the research methods and results.

As for the results, we previously observed that using the BMC as a framework was somewhat challenging, and identifying a viable service delivery model for instance remained unsolved. In addition, we were not able to provide clear insights for the revenue model or private sector. There are also other ways to design a business model using different business model frameworks such as STOF model as a base framework which could have provided diverging results.

The quality and trustworthiness of the study can be evaluated using validity and reliability as measures. Construct validity of this study was increased by using multiple sources of evidence: co-design methods, interviews and supporting data. However, the interview data was limited and for example patients and Health Service Managers were not interviewed. Another way to increase the validity is to establish chain of evidence, for

which we kept notes and BMC versions in internal wiki. The iLLP sessions acted as frequent debriefing sessions (Shenton 2004) that allowed us to discuss alternative approaches to the business model development, and test our ideas and interpretations thereby enhancing the construct validity.

External validity refers to the extent to which the findings can be generalised to other situations (Yin 2009). In general, a single-case study is more difficult to generalise but the representative nature of the case in this study justifies this approach (Yin 2009, p.48). Nevertheless, even though mHealth technologies share a common set of characteristics, it is important to take into account the unique contexts in which they unfold (Cho et al. 2009, p.364). It is also worth to notify that the study was carried out in Australia, but there are different kinds of health systems in other countries with divergent stakeholders and funding models. In single-case studies, the external validity of the study can be enhanced by using theory in research design (Yin 2009, p.41) which in this study confirmed some of the findings.

Reliability of the study refers to the certainty that a later investigator followed the same procedures would arrive at the same findings. In this study, the reliability may be negatively influenced by having a co-design team and various interviewees which affects the case study protocol. To increase the reliability, we used an interview template and a set of common questions for the interviews. We also kept continuous notes during the business model design to make the research progress transparent.

7. CONCLUSIONS

”There’s not a single business model ... There are really a lot of opportunities and a lot of options and we just have to discover all of them.”

– Tim O’Reilly, CEO, O’Reilly[27]

This study explored the business model for a mobile health care service delivery in chronic disease management. As many mHealth solutions fail to continue beyond the pilot phase, there is a need for business model design to ensure the sustainability of the service. In general, we were not able to find a fully generalised business model, as the components of the business model depend on the target customer, existing funding models, the role of the service provider, and the context of a health system. Even though we did not find a rigorous and general business model, the study allowed us to identify generalisable characteristics for sustainable mHealth business model.

Overall, the mHealth service needs to be flexible and reliable. This enables the scalability for other disease domains and increases customer satisfaction. Regulatory requirements may obstruct the adoption of mHealth service which is why the inventor needs to scope the regulatory standards for a particular technology and create good quality development processes early on. To ensure product development and suitability for clinical environment, the mHealth inventor needs early adopters and research facilities as key partners. These partnerships are also the way for clinical credibility. Reimbursement of mHealth services is the key driver for sustainability of the business model. Therefore the inventor needs to consider the target customer and also provide the evidence for cost savings. Finally, we recognised that there are multiple options for the service provider, including an outside investor, health insurance company or a technology vendor as cases in point which influences the other components in the business model.

As for the opportunities of mHealth in chronic disease management, it has the potential to improve self-management and convenience of care, enable more timely care and decision-making support, improve health outcomes, and reduce healthcare costs. Major challenge is to transfer the pilot product into a commercially viable mHealth service. Barriers for this include redesigning clinical workflows, technical and regulatory requirements, immature funding structures, and the lack of large RCT studies and cost benefit analyses to provide sufficient evidence. In addition, there is a lack of interaction between different stakeholders. In mHealth ecosystem, there are many stakeholders with different level of influence, and mHealth inventors need to identify the stakeholders and their needs.

[27] In book Business Model Generation: A Handbook For Visionaries, Game Changers, And Challengers

We conclude that business model design is useful in mHealth development as it enables mHealth designers to understand all the elements that affect the mHealth service and thus consider what resources and activities are needed to overcome the challenges in implementation. Business model design also facilitates the interaction between stakeholders resulting in better understanding of the marketplace and possible future changes.

This study offers two academic contributions. First, our study expands the scarce literature of business models in mHealth. We agree that there is a lack of a robust and realiable business model that would make mHealth services sustainable (Malvey & Slovensky 2014, p.12). So far, research in this area has been diverse (Fielt et al. 2008; Spil & Kijl 2009; van Meeuwen et al. 2015), but only few studies have used the Business Model Canvas in their study (Valeri et al. 2010; van Limburg et al. 2011; Heikkilä et al. 2014), even though it is the most adopted business model framework around the world. This study demonstrates the use of the Business Model Canvas by complementing the approach with Lean LaunchPad method. While we acknowledge that this study does not provide a fully robust business model, we offer applicable key characteristics for the business model to facilitate sustainable implementation of mHealth innovations. Second, this study contributes to broader theories of business model design to further demonstrate how the diffusion and adoption of a technology is largely dependent on its business model (Chesbrough & Rosenbloom 2002; Zott & Amit 2010). Technically viable and medically useful mHealth innovation can often fail to move beyond the pilot phase (Obstfelder et al. 2007; Cho et al. 2009) if it does not meet the realities of the marketplace, often related to reimbursement and organisational issues (van Limburg et al. 2011; Mettler & Eurich 2012). We demonstrate how the assumptions that mHealth technology designers have regarding the marketplace and business model components may be invalidated after talking to customers and partners.

As some of the business model components in this study remained unclear, more research should be conducted to validate the service delivery model and best ways to generate recurrent revenues. It would also be interesting to investigate the differences between public and private sector business models, or between the roles of different kinds of service provider scenarios. Moreover, studying multiple mHealth innovations in various health systems would provide more holistic picture of the area and would more likely provide better generalisability of a sustainable business model. In terms of business model design approach, it would be beneficial to examine different ways to develop a business model to discover best practises for the design. In this study we used iLLP program and individual stakeholder interviews, whereas another approach would be to carry out workshops with representatives from each stakeholder. Finally, this study emphasised the importance of business model design in mHealth technology development. Thus, mHealth research in general would benefit from studies that provided insights on how to include business model design in everyday research and product development.

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APPENDIX 1: BUSINESS ASSUMPTIONS EXERCISE

From Giff Constable 2014. *Talking to Humans*, pp. 69-71

My target customer will be?
(Tip: how would you describe your primary target customer)

The problem my customer wants to solve is?
(Tip: what does your customer struggle with or what need do they want to fulfill)

My customer's need can be solved with?
(Tip: give a very concise description / elevator pitch of your product)

Why can't my customer solve this today?
(Tip: what are the obstacles that have prevented my customer from solving this already)

The measurable outcome my customer wants to achieve is?
(Tip: what measurable change in your your customer's life makes them love your product)

My primary customer acquisition tactic will be?
(Tip: you will likely have multiple marketing channels, but there is often one method, at most two, that dominates your customer acquisition — what is your current guess)

My earliest adopter will be?
(Tip: remember that you can't get to the mainstream customer without getting early adopters first)

I will make money (revenue) by?
(Tip: don't list all the ideas for making money, but pick your primary one)

My primary competition will be?
(Tip: think about both direct and indirect competition)

I will beat my competitors primarily because of?
(Tip: what truly differentiates you from the competition?)

My biggest risk to financial viability is?
(Tip: what could prevent you from getting to breakeven? is there something baked into your revenue or cost model that you can de-risk?)

My biggest technical or engineering risk is?
(Tip: is there a major technical challenge that might hinder building your product?)

And then answer the following open-ended question. Be creative and really examine your points of failure.

What assumptions do we have that, if proven wrong, would cause this business to fail?

1.

2.

3.

4.

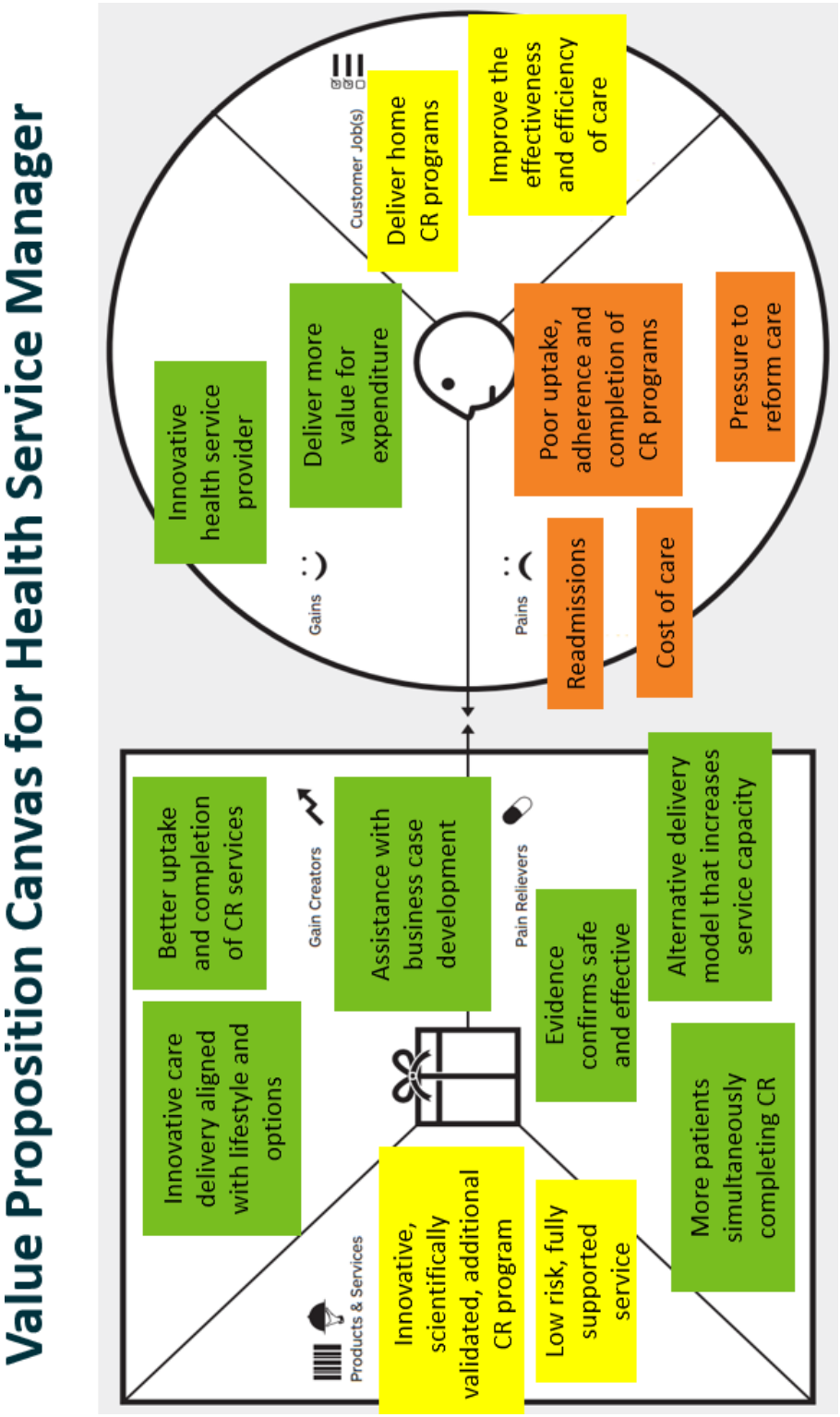
5.

6.

After you have looked at your business holistically and also answered the broad final question, mark the assumptions that would have a large impact on your business and feel highly uncertain.

APPENDIX 2: VALUE PROPOSITION CANVAS

Example of a Value Proposition Canvas for a Health Service Manager



APPENDIX 3: INTERVIEW TEMPLATE

Name of the interviewee(s):

Company / Institution:

Affiliation / Position:

Date:

Interviewer(s):

Purpose:

In-person or videoconference:

Duration of the interview:

Example of interview questions:

Asked	Questions	Sub-questions	Notes
	What kind of telehealth services would you like to see in use?	What are the biggest benefits expected from funding telehealth initiatives?	
X	What are the biggest barriers when putting through a new telehealth initiative?	What do you see as the most important actors to overcome these barriers?	
X	What kind of differences there are between public and private sector regarding telehealth services and their implementation?		
X	What does it require from a third party service provider to be a viable solution?	In what pricing model it would be included? (e.g. annual fixed fee vs. quarterly fixed fee)	
X	Short brief of MoTER	In what level should the service be integrated with existing systems?	
	Who else could we talk to?		