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Commercialisation of eHealth Innovations in the Market of UK Healthcare Sector: A Framework for Sustainable Business Model.

Abstract

Demographic trends with extended life expectancy are placing increasing pressures on the UK state-funded healthcare budgets. EHealth innovations are expected to facilitate new avenues for cost effective and safe methods of care, for enabling elderly people to live independently at their own homes and for assisting governments to cope with the demographic challenges. However, despite heavy investment in these innovations, large scale deployment of eHealth continues to face significant obstacles and lack of sustainable business models (BM) is widely regarded as part of the greatest barriers. Through various empirical methods which include facilitated workshops, case studies of relevant organisations and user groups, this paper investigates the reasons the private market of eHealth innovations has proved difficult to establish and it develops a framework for sustainable BMs that could eliminate barriers of eHealth innovation commercialisation. Results of the study suggest that for sustainable commercialisation to be achieved, BM frameworks and innovation diffusion characteristics are complements but not substitutes.

Keywords

eHealth innovations, business model, telecare, telehealth, telemedicine.

1 Introduction

Life expectancy has continued to increase around the world as a result of advances in science and technology as well as general improvements in social and environmental conditions (DPH, 2011; Lewin et al., 2010; Oderanti & Li, 2016). The need for healthcare increases with age – four times as many people aged 85 years and over need daily care compared to those aged 65–74 years (Botsis & Hartvigsen, 2008). Also, it is unlikely that in the near future there will be enough medical practitioners to provide adequate care to these elderly people.

Population ageing is profound, having major consequences and implications for all facets of

human life, including health and social care sectors and indeed, as we age, the incidence and prevalence of chronic diseases continue to increase (Lewin et al., 2010). Therefore, the demanding task of elderly healthcare, especially for those suffering from chronic diseases, cannot be solved solely by conventional methods; other alternatives and more cost-effective technological solutions must be considered (Botsis & Hartvigsen, 2008). The latter could also offer new opportunities to improve the wellbeing and quality of life for the elderly, not just maintaining the existing standards of care.

Information and Communication Technology (ICT) enabled healthcare (i.e eHealth) innovations are expected to facilitate new avenues for cost effective and safe method of care for enabling elderly people to live independently at their own homes; and for helping governments to cope with the challenges of the increasing ageing population. These innovations are also expected to help governments to cope with the growing pressure (brought by the ageing population) on health and social care budgets. However, several items of evidence have shown that while there are many technologies and services in these areas, the levels of user uptake of these innovations are very low at the moment and that the deployment of eHealth innovations into the mainstream health and social care sectors (Figure 1) are currently facing significant barriers (Urueña, Hidalgo, & Arenas, 2016; Zanaboni & Wootton, 2012).

Driven by demographic changes, and the consequent growth in people with long term health conditions (chronic heart disease, chronic obstructive pulmonary disorder, type II diabetes and dementia) significant investment are been made in technology research and development, but the key challenges are not technological, but in the social sciences (Worsley, 2009). Among these key challenges are strategies for sustainable commercialisation for delivering these services from providers to end users (Oderanti & Li, 2016; van Gemert-Pijnen et al., 2011). According to Lin et al (2010), advanced technology, products or services

by themselves are not guarantees of market success, and therefore, new technology needs an appropriate business model to survive in the market (Lin et al., 2010).

The economic, financial and business aspects of eHealth innovations have been poorly researched (Davies & Newman, 2011; Lin et al., 2010; Oderanti & Li, 2016). Many evaluations focus mainly on cost, but neglect other non-cost related outcomes. It is also important that more economic and business focused analyses are carried out in the UK because extrapolation of findings from American or Western European evaluations to the UK health care system may be inadvisable, given the differences (Boonstra, Broekhuis, van Offenbeek, & Wortmann, 2011) in how the health and social care systems are structured, funded and managed (Davies & Newman, 2011).

According to Celler et al (2007), with the management of chronic disease and its exacerbation now representing between 75-80% of healthcare budgets and the recognition that often quite small numbers of individuals are making disproportionate claims on these budgets through frequent hospitalisation and attendance at A&E departments, alternative models of social and healthcare delivery are being explored internationally (Celler, Lovell, Basilakis, & Ieee, 2007). Also Lin et al (2010) asserted that new technology alone does not guarantee the survival and the sustainability of a new service, just as simply “brilliant ideas” do not form an innovation because the true test of an innovation lies in whether it could provide new value for users and the general public such that it can be tested in the market to demonstrate that it is possible to sustain and can provide a new value proposition to its end users in (Lin et al., 2010).

Therefore, through case studies of relevant organisations, users’ focus group and facilitated workshops, this paper investigates current trends in eHealth innovations and their acceptance among the older population in the UK. The study identifies the factors that are responsible for these barriers. Various challenges that are facing their commercialisation

among older citizens are analysed and the study develops strategies for sustainable business models that could facilitate successful deployment of eHealth innovations into the mainstream health and social care sectors in the UK and other economies.

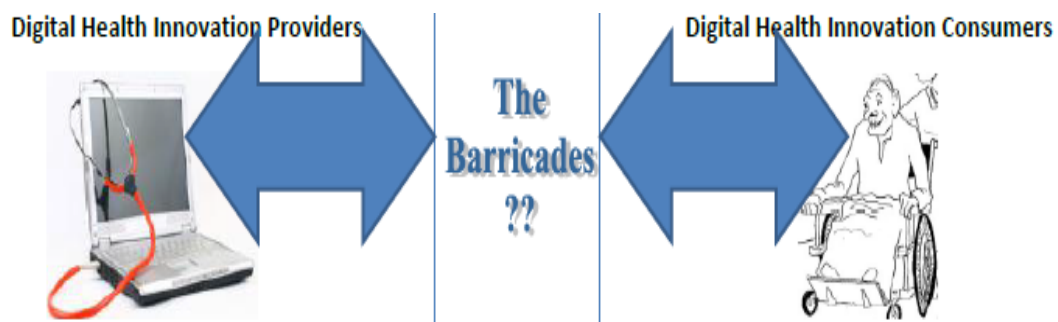


Figure 1: Illustration showing the barriers (diffusion chasm) between eHealth innovation entrepreneurs and potential consumers. *Sustainable business models* are expected to be the bridges necessary for eliminating the barriers to innovation commercialisation in this market.

1.1 Challenges of the NHS Business Model on Market Development of EHealth

The UK National Health Service (NHS) provides universal access to comprehensive healthcare, funded by taxation, free at the point of use and it came into existence on the 5th July 1948 (Bloor, 1998). As a result of the free healthcare being enjoyed by the elderly people, it is becoming increasingly difficult for the much more capitalist and small eHealth businesses to thrive in the UK market. This study's preliminary investigation, through focus groups, shows that most elderly people do not see reasons they should spend their own resources on eHealth equipment when they could easily go to the NHS as many times as they want and obtain equivalent services free of charge. More so, there is availability of unlimited free bus travelling for most elderly people across the country. Therefore, this paper investigates the factors (despite the NHS free healthcare alternatives) that could motivate elderly people to invest in eHealth technological innovations for their own wellbeing in order to be able to remain independent in their own homes for as long as possible.

2 *Research Questions and Objectives*

2.1 **Research Questions**

Research questions for this study are as follows:

- What are the main market segments of eHealth innovations in the UK and current commercialisation attempts?
- Are the current business models of eHealth firms in the UK sustainable?
- What are the main barriers to sustainable commercialisation of eHealth innovations in the UK market and what are the entrepreneurial strategies to overcome these barriers to ensure sustainable commercialisation of eHealth innovations in the UK and other similar economies?

2.2 **Research Objectives**

The main objectives of this study are:

- To understand the general dynamics of currently existing commercialisation attempts as well as business models of eHealth innovations in the UK
- To understand why multiple attempts to take these innovations into the mainstream markets have failed. Also from elderly users' perspective through focus group, various barriers of eHealth uptakes were investigated.
- To investigate entrepreneurial strategies that could attract elderly people into the private (profit-oriented) eHealth market despite the NHS business model and to develop workable strategies for sustainable business models for eHealth market.

Through various empirical approaches, this study investigates whether there are any sustainable eHealth BMs already in existence in UK that could be recommended for entrepreneurs in the market. It attempts to understand, identify and describe the factors that are inhibiting wide scale commercial deployment of these innovations into the health and social care sectors. The study then develops workable entrepreneurial strategies for sustainable business models for eHealth innovations which could help to reduce the pressure

on already stretched state funded health and social care services in the UK and other economies. These strategies are expected to help in attracting elderly people into the private eHealth market despite the NHS practices and policies.

The case studies were used to investigate whether business models that are sustainable are already in existence in the UK eHealth market. The workshops and other data collection methods employed in this study were used to investigate and suggest possible solutions to the identified problems and barriers to sustainable commercialisation of eHealth innovations.

3 *Theoretical Framework*

A useful perspective to frame the issues at stake is that of the “Diffusion of Innovation”(DOI) theory proposed by Rogers (1995) . DOI has been chosen as the framework for the research because according to Ruof et al (2002, p.2), ‘*most available theoretical frameworks for the dissemination and implementation of medical guidelines heavily rely on Roger’s ‘Diffusion of Innovations Theory’’*. This notion has equally been supported by several medical and related innovation adoption scholars (Knoester et al., 2004; Robinson, 2009; Sheridan, Atun, & Gurol-Urganci, 2007).

As we are in the new digital economy and everything that can be digitized are being digitized. Ubiquitous computing and pervasive connectivity at affordable prices allow new ways of doing business. However, best technologies, products or services are not sufficient for market success of any ICT innovations (Huang, 2013). New entrepreneurial strategies and new business models need to be available for successful and sustainable commercialisation of new technological innovations. From the theory of *Diffusion of Innovation’s* perspective, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system (Huang, Yu, & Lai, 2015; Parthasarathy & Forlani, 2010; Thurber & Fahey, 2009). Therefore, if successful business models can be deployed for the eHealth market, such models would help to strategize to cross the diffusion

chasm, reach different user segments and generate sustainable revenue for the eHealth provider. The theory could be used to explain the current trends of user uptake of eHealth products and services and how the level of adoption could be further enhanced to ensure market sustainability as further elaborated in Section 6 of this paper.

What is a Business Model?

A business model (BM) emphasizes a system-level, holistic approach to explaining how firms “do business” and it seeks to explain how value is created but not just how it is captured (Zott, Amit, & Massa, 2011). It described the effort asked of entrepreneurs to model their projects so as to make them more easily comprehensible by potential stakeholders (Glasby, Le Grand, & Duffy, 2009). The economic value of a technology remains latent until it is commercialized in some way via a business model (Aage & Belussi, 2008; Aksoy-Yurdagul, 2015; Ceci & Prencipe, 2008). It defines how a business works and the logic that creates its value. It is the representations of a class of organisations in the way they operate and ideal types that organisations should aspire to become (Angeli & Grimaldi, 2010). Incoming firms need to design their initial business models while established companies may need to redesign their existing business models to withstand threats to their continued ability to create values. While the ultimate goal from an extreme shareholder perspective could be said to increase the stock price by creating profit, business models sometimes address broader criteria such as *sustainable development*, which implies that focus is shifted from mere profit orientation towards sustainable enterprises and an economic reality that connects industry, society, and the environment (Bukh & Nielsen, 2010). The building blocks of business models are: (i) Value proposition (ii) Product innovation (iii) Infrastructure management (iv) Customer relations management (v) Financial viability and sustainability (vi) Stakeholder credibility (vii) Revenue Streams (Lin et al., 2010; Osterwalder & Pigneur, 2009). Therefore, effectiveness or sustainability of an organisation’s business model would depend on how an

organisation addresses each of these interacting factors and constructs (Lin et al., 2010; Osterwalder & Pigneur, 2009).

Since most eHealth firms in UK are small and medium-sized enterprises (SMEs) and the ultimate goal of a capitalist entrepreneur is to make profit (Knudsen & Swedberg, 2009), for the purpose of this research, a BM is considered sustainable when it is able to generate sufficient income to self-sustain the business after five years of operation. That is, when income exceeds expenditure (i.e corporate profitability).

A **value proposition** is a pledge of quality of eHealth value which is expected to be delivered by the service provider or supplier and an anticipating with confidence from the elderly users of value that will be experienced (Anderson, Narus, & Van Rossum, 2006).

Product (or service) innovation can also be summarily defined as the development of new products (or services) or, changes in design of established products, or use of new materials or components in the manufacture of established products and it could mean the same as \new or altered products (Crossan & Apaydin, 2010).

Infrastructure management in digital businesses could be defined as the coordination of the components of essential business operations which include equipment, processes, data, policies, human resources, and external contacts for the overall efficient and effective delivery of the IT business to the customer. The performance of the infrastructure directly impacts the performance of the employees and, ultimately, the way the customers perceive a company (Menard, Murthy, & Wolfe, 2006).

Customer relationship management (CRM) is a customer-focused business strategy that dynamically integrates sales, marketing and customer care service in order to create and add value for the company and its customers. It is a set of business processes and overall policies designed to capture, retain and provide service to customers (Chalmeta, 2006). CRM has developed as an approach based on maintaining positive relationships with customers, increasing customer loyalty, and expanding customer lifetime value while understanding the

needs of customers and offering value-added services are recognized as factors that determine the success or failure of companies (King & Burgess, 2008).

Financial viability and sustainability has become an important ingredient in contemporary public policy and considerable ambiguity surrounds the precise meaning of sustainability in concrete policy contexts, such as financial sustainability in an organisation (Dollery & Grant, 2011). A sustainable organization is one whose characteristics and actions are designed to lead to a desirable future state for all *stakeholders* and intangible indicators that gauge sustainability also can be indicators of efficacy - that is, of how well a company is run - and companies that actively manage and respond to a wide range of such indicators are better able to create *value for all stakeholders* over the long term (Funk, 2003). The challenge today is to develop sustainable businesses that are compatible with the current economic reality and innovative business models and products must therefore work financially, or it won't matter how good they are ecologically or socially (Senge, Carstedt, & Porter, 2001).

Revenue Streams: In an information economy, innovative revenue generating models are as critical for the sustenance of a firm as is bringing cutting edge technology to the market (Jonnalagedda, 2011). The revenue stream identifies how the organisations will earn revenue, and the logistics stream involves detailing how supply chain issues will affect the organisations involved (Hayes & Finnegan, 2005). An understanding of various revenue stream options available is critical as firms faced with resource constraints consider whether and how to leverage options created by technology (Gallaughar, Auger, & BarNir, 2001).

4 *Methodology*

This study adopts a two stage research design (Walsh, Wilson, Baines, & Martin, 2012) and the stages include exploratory investigation followed by facilitated workshops. The justifications for combining these approaches are: to be able to gather comprehensive items of

evidence and to obtain the complete picture of eHealth challenges in both the health and social care sectors.

The exploratory phase involves collection of data by a combination of desk research, case study interviews, observation of events and meetings. In the second phase, four carefully planned and facilitated workshops were conducted during which materials from the exploratory phase were presented to eHealth service providers from both private and public sectors for comment and critique. The industry partners helped to facilitate access to events and interviewees and they also offered feedback on research findings.

This study combined focus groups (n = 35), semi-structured interviews (n = 20) and four facilitated workshops with workshop attendance varying between n= 50 and n = 60 on the four different occasions. The study population was divided into two groups: 'older people' for the focus group data collection and the eHealth entrepreneurs for the semi-structured interviews. Focus group participants who were identified as 'older people' included 19 males and 16 females, their ages ranged from 55 to 90. Out of these respondents, 29 lived in the community while six lived in a care facility. The workshops' participants were from both older people, eHealth entrepreneur's populations as well as other eHealth practitioners across the country.

For the focus group, participants were recruited from age-related non-profit organizations based in North East of England. Information about potential focus group participants was obtained from their databases and details of the study were sent to them. Interested individuals were asked to complete and return a consent form. The focus groups took place in various accessible rooms at a University and offices of the organizations that recruited for the research project. Interviews and focus groups were all audio-recorded and transcribed verbatim, typically lasting between 50minutes and 90minutes. Interview and focus group transcripts were analyzed thematically and coded at sentence to paragraph level (Pritchard & Brittain, 2015).

For the case studies, the population of the study comprised of the entire eHealth companies from all the administrative regions in the UK and from each region, eHealth companies were randomly selected. Events to observe and people to interview were purposely sampled by the research team with advice from the industry partners in order to represent the range of e-Health services and practitioners in the market.

The research team used the four facilitated workshops to introduce the preliminary findings from the exploratory research to the professionals and representatives of organisations with a stake in the market of e-Health in the UK. Each workshop was designed for different set of stakeholders in eHealth market and practitioners. The workshops offered opportunities for participants to explore, experience, and respond to the barriers and challenges that are hindering eHealth commercialisation and to suggest possible solutions. The workshop facilitators offered creative discussions about current situations and future possibilities in e-Health by inviting participants to draw upon their own experiences and share their responses to the materials from the exploratory research.

The case studies aspect used transcription of semi-structured interviews with key informants who are major experts in e-Health market in the UK. The research design was based on multiple cases and multiple investigators, thereby allowing for replication logic (Amit & Zott, 2001). Twenty case studies of companies were conducted (represented by their senior management teams (directors)) that are operating in e-Health market in the UK. The case studies cover both established businesses and new start-ups and they were conducted with key decision makers to identify the main barriers and facilitators for sustainable development of eHealth technologies and services in the Country. These companies perform different functions in the market and these key informants that were qualitatively interviewed offered strategic views of problems and difficulties that are being faced in various commercialisation attempts of e-Health innovations in the UK.

There were 50 open-ended leading questions which revolve around the constructs of business models as described in Section 3 and designed to capture the research aims stated above (Section 2). The 50 questions enumerated in the questionnaire were open-ended, which was consistent with the study's primary objective of developing a conceptual framework that was informed by empirical evidence (Amit & Zott, 2001).

The process of analysis extends the business model methodology used in (Lin et al., 2010) as depicted in Figure 2 below. Each participant in the case study was asked the same 50 questions to ensure consistency in the data gathered and in the elicitation process. The findings from the business models of these companies were summarised and their sustainability trends were presented from their financial data. Based on suggested solutions from all these approaches, the study develops an integrated strategic framework towards sustainable business models for eHealth innovations.

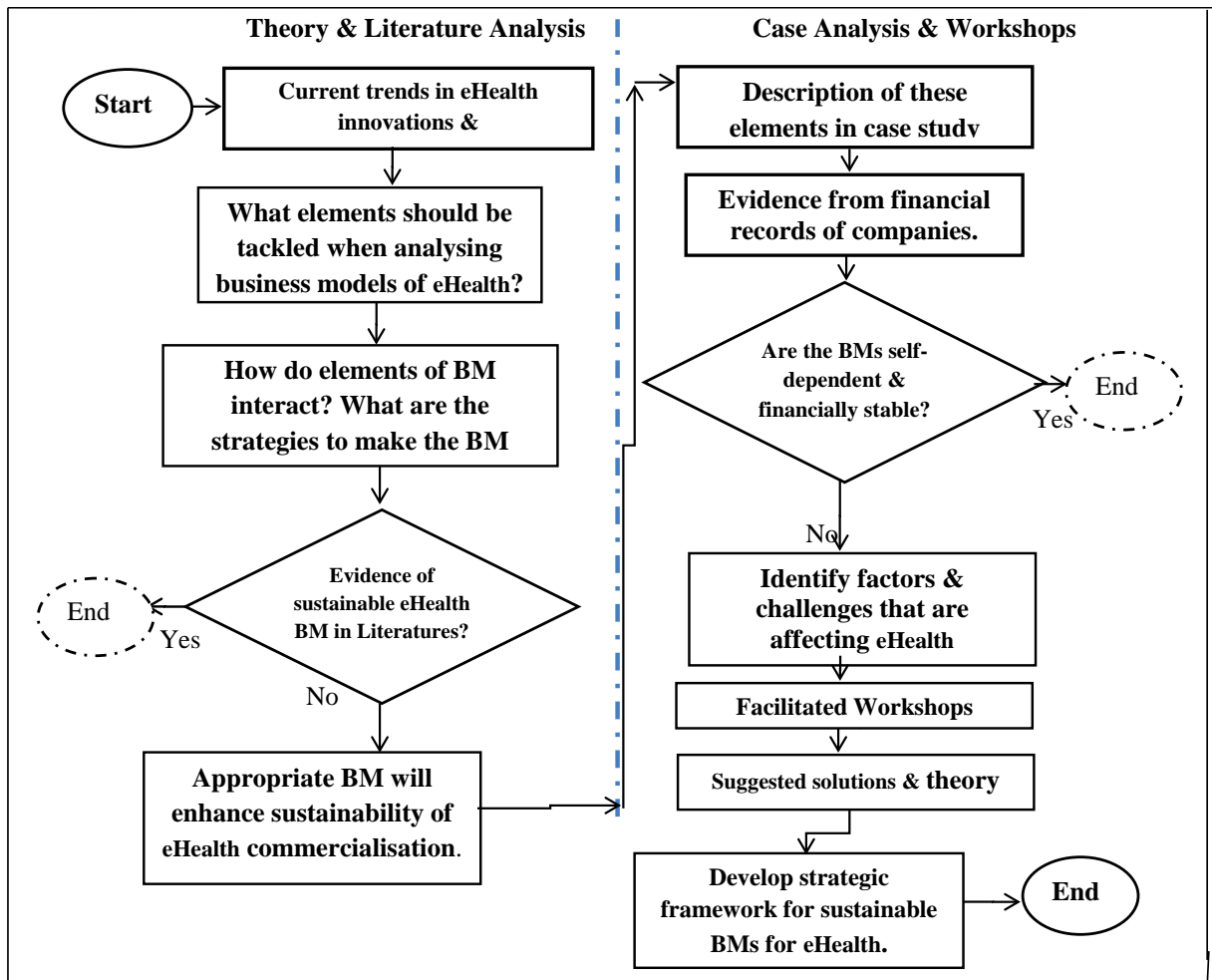


Figure 2: Method of research analysis: an extension of the methodology used in (Lin et al., 2010).

5 Results

5.1 Segments of EHealth Markets

Generally, four main segments of eHealth market were identified in the literature and these include: (1) telecare; (2) telehealth; (3) telemedicine; and (4) digital participation services.

Analysis of previous studies shows that the first three terms have been poorly defined, misrepresented and confusingly used in different papers with authors misinterpreting one term for another. Some claim to have addressed telecare while they actually worked on telehealth (Lin et al., 2010; Mair, Hiscock, & Beaton, 2008; May et al., 2011; A. Rogers, Kirk, Gately, May, & Finch, 2011) and many others claimed to have researched in telemedicine which in

actual facts, their research were attempting to address telehealth but not telemedicine (Ekelanda, Bowesb, & Flottorp, 2010; Olumide Sunday, 2004; Zanaboni & Wootton, 2012).

This lack of consensus raises questions on the quality of research outcomes of these previous studies which include the data they collected and analysed, and also in terms of data evaluation approaches. This is because their underlying methodologies may not be capable of addressing the research questions to which different stakeholders seek answers. These reasons might not be unconnected with the present lack of sustainable business models because the business models of telehealth and telecare, which require installation at patients' homes, are expected to be entirely different from that of telemedicine that are installed between healthcare professionals. This study relies on the classification from the UK Department of Health (DPH) and a brief summary and definitions of these segments according to the DPH are as follows:

a) Telehealth

Telehealth are technologies and services which enable the monitoring of people's health in their own homes and telehealth monitoring is the remote exchange of physiological data between a patient at home and medical staff at a hospital to assist in diagnosis and monitoring (Lewin et al., 2010; Turner, 2010; Warnes & Hawley, 2011). It is the remote monitoring of a patient's medical condition (Davies & Newman, 2011; Lewin et al., 2010; Turner, 2010). The UK Department of Health defined telehealth as a service that uses equipment to monitor people's health in their own home by monitoring vital signs such as blood pressure, blood oxygen levels or weight (Davies & Newman, 2011).

b) Telecare

Telecare is concerned with keeping people safe and independent in their own homes using remotely accessed technologies such as telephone, mobile or wireless connections (Davies & Newman, 2011; Lewin et al., 2010; May et al., 2011; Turner, 2010). The UK Department of

Health defined telecare as a service that uses a combination of alarms, sensors and other equipment to help people live independently and this is done by monitoring activity changes over time and will raise a call for help in emergency situations, such as a fall, fire or a flood (Davies & Newman, 2011). Traditionally, telecare product offerings were dominated by alarm based devices such as pendants and call alarm buttons.

c) Telemedicine

Telemedicine are ICT enabled services that aid remote consultations between primary and secondary health care service providers and are attributed to services such as teleradiology, telepsychiatry, transmission of echocardiographic images (Ekelanda et al., 2010; Weinstein et al., 2009). These terminals and inter-connecting networks allow doctors to discuss, in real time, the patient's case based on transmitted images and to adopt jointly, the best treatment strategy, and whether the patient should be transferred to the specialist unit or treated locally.

d) Digital participation services

Digital participation services include services that are delivered to entertain, educate and stimulate social interaction so as to enrich the lives of older and disabled people who live at home (Lewin et al., 2010). They are digital inclusion measures to encourage older and disabled people to go online.

The case studies and other analyses sections in this paper cover telehealth and telecare businesses while other segments of eHealth have been covered in another paper of this research project.

5.1.1 Summary of Challenges of EHealth BM from Literature and Desk Research

In summary, through literature and desk research, it was observed that while there are advancing eHealth technologies, there has been a lack of sustainable method of

commercializing innovations within this market. The direct payment initiative (Glasby et al., 2009) was plagued by low user uptake and private markets for eHealth innovations in UK are hindered by small market size.

Generally, detailed analysis of previous studies shows that failure of successful deployment and commercialization of eHealth innovations are primarily connected with the lack of sustainable business models and authors have premised the reasons behind these failures under different headings which could be summarily classified into five primary reasons; (i) Poor coordination; (ii) Lack of user centred design; (iii) Security and privacy concern; (iv) Poor integration of policy and practice; and (v) Small market size and cost effectiveness. These reasons are as summarised for each eHealth market segment in Table 4.

Table 1: Reasons for failure of eHealth business models.

eHealth Segments	Reasons for failure of eHealth BM	References
Telecare	<u>Lack of user centered design</u> : New systems are rarely negotiated with service users and there is a general lack of focus on the end users of telecare (May et al., 2011). The business model will probably only be successful when the majority of the user feel that the device is easy to use and has a high acceptance rate (Lin et al., 2010). Technology should support the needs of the user, not drive them (Navein, Arose, & Pietermich, 1999)	(Boonstra et al., 2011; May et al., 2011).
	<u>Poor integration of policy and practice</u> : These include uncertainty about ownership, responsibilities and direction of business (Boonstra et al., 2011; May et al., 2011).	
Telehealth	<u>Coordination</u> : Commercialisation of telehealth failed because inventors do not carry along the business expert in order to cross the diffusion chasm from invention to market penetration (Cho, Mathiassen, & Gallivan, 2009).	(Cho et al., 2009; Visser, Bloo, Grobde, & Vollenbroek-Hutten, 2010)
	<u>Small Market size</u> : Implementation of the video teleconsult service requires multidisciplinary cooperation and integration, however one of the main challenges is the small market size (Visser et al., 2010).	
Telemedicine	<u>Inadequate planning, integration or coordination</u> : Telemedicine projects were driven by enthusiastic individual but failed because of inadequate planning and coordination (Navein et al., 1999; H. S. Pak, 2005; Hon S. Pak et al., 2008; Weaver & Spence, 2000).	(Cavallerano & Aiello, 2005; Gamble, Savage, & Icenogle, 2004; Hughes, Marshall, Murphy, & Mun, 2011; Lin et al., 2010; Navein et al., 1999; Olumide Sunday, 2004; H. S. Pak, 2005; Hon S. Pak et al., 2008; Shea, 2006; Weaver & Spence, 2000; Yun & Park, 2007).
	<u>Cost effectiveness</u> : While telemedicine's clinical effectiveness and educational benefits are accepted, its cost-effectiveness is controversial (Cavallerano & Aiello, 2005; Gamble et al., 2004; Hughes et al., 2011; Shea, 2006).	
	<u>Organisation and cultural inertial</u> : This is identified as one of the main problems of implementing telemedicine in developing nations (Olumide Sunday, 2004; Yun & Park, 2007).	
	<u>Security and privacy concern</u> : Electronic exchange of data among physicians and hospitals makes privacy and security part of the concerns of telemedicine users (Cavallerano & Aiello, 2005; Olumide Sunday, 2004; Hon S. Pak et al., 2008).	

Table showing the reasons eHealth market has proven difficult to develop and references of literature that mentioned them.

5.2 Challenges of EHealth Business Models: Evidence from Case Studies

The case study questions were designed to capture the research aims (stated in Section 2) and the study followed the methodology illustrated in Section 4 and Figure 2 of this paper.

During the interviews of the case study companies, the managers of the 20 case study companies gave different reasons for the perceived challenges or barriers to successful commercialization of eHealth innovations. Thematic analysis of the responses captured the following reasons (1) Technophobes (2) Elderly with disabilities (3) Security issues (4) Small market size (5) Inadequate planning, integration or coordination (6) Technological problems and interoperability (7) Poor user centered design, and (9) Cost effectiveness. As shown in Table 5, the numbers in the second column indicate the number (frequency) of companies (out of 20 in total) that mentioned the reasons with example of the comments and suggested solutions (column 3) while column 4 shows how the reasons, comments and solutions relate to characteristics stated in Roger’s diffusion of innovation theory (DOI) that is further explained in Section 6.

5.2.1 Description of Business Models of Sampled Case Study Companies

Generally, analysis from the case studies and the facilitated workshops shows that market development of eHealth is suffering from lack of sustainable business models. Evidence from the field studies shows that while effective eHealth innovations certainly exist, they are generally run by local champions and are mostly state funded. Presently, almost no eHealth applications (innovations) have been successful in reaching enterprise-wide and large scale adoption. Evidence from their revenue streams (as measures of their financial sustainability), shown in **Figure 3** depicts the trends in financial net worth of the six of these case study companies. The figure shows the financial net worth of only six companies (among the 20) that already have up to three years financial records while others have less than three years market operation.

Table 2: Challenges of eHealth Commercialisation from Case Studies and Facilitated Workshops

Reasons	Frequency	Comments and Suggested Solutions	DOI Xteristics
Technophobes	18	-Easy to use product. -Keep it simple; incorporate game computers. -Products must not be those that would stigmatise users.	Complexity, compatibility and relative advantage
Elderly with disabilities	13	-Large buttons and easy to read. -Devices that are as simple as possible	Complexity and compatibility

Security issues	18	Locked down system, with access to specified individuals.	Compatibility
Small Market size	20	Use of existing technologies, with amendments for specific users. Products that are extendable to the general markets.	Compatibility and relative advantage
Inadequate planning, integration or coordination	16	- Consistent policy in government to avoid politics and policy somersaults - 'Holistic' approach to system design.	Compatibility and complexity
Poor user centered design.	19	-Designing user friendly interfaces. -Patient involvement during development.	Complexity and observability
Technological problems and interoperability	15	Increase in availability of broadband and its bandwidths.	Complexity
Cost effectiveness	19	-Products that are extendable to the general markets. -Increase in market size will reduce cost. -High quality and high standard products	Relative advantage and trialability
Policy and regulations	20	-Reduction in the cost of maintaining regulations and standards -Reduction in the number of accreditation standards and agencies. -Reduction in time or duration of securing accreditation.	Compatibility
Market Competitions	17	-Competitive bids -Products and services that have better features than those of others	Relative advantage
Control and Interference	20	-User be given more flexibility on how to use their personal budget (Glasby et al., 2009)and reduction in interference from local councils	Compatibility

Different reasons that were given by managers of case study companies for the perceived challenges or barriers to successful commercialization of eHealth. The numbers in second column indicate the number of companies (out of 20 in total) that mentioned the reasons with examples of the comments and suggested solutions (column 3). Column 4 shows how the reasons, comments and solutions relate to characteristics stated in Roger's innovation diffusion theory explained in Section 6.

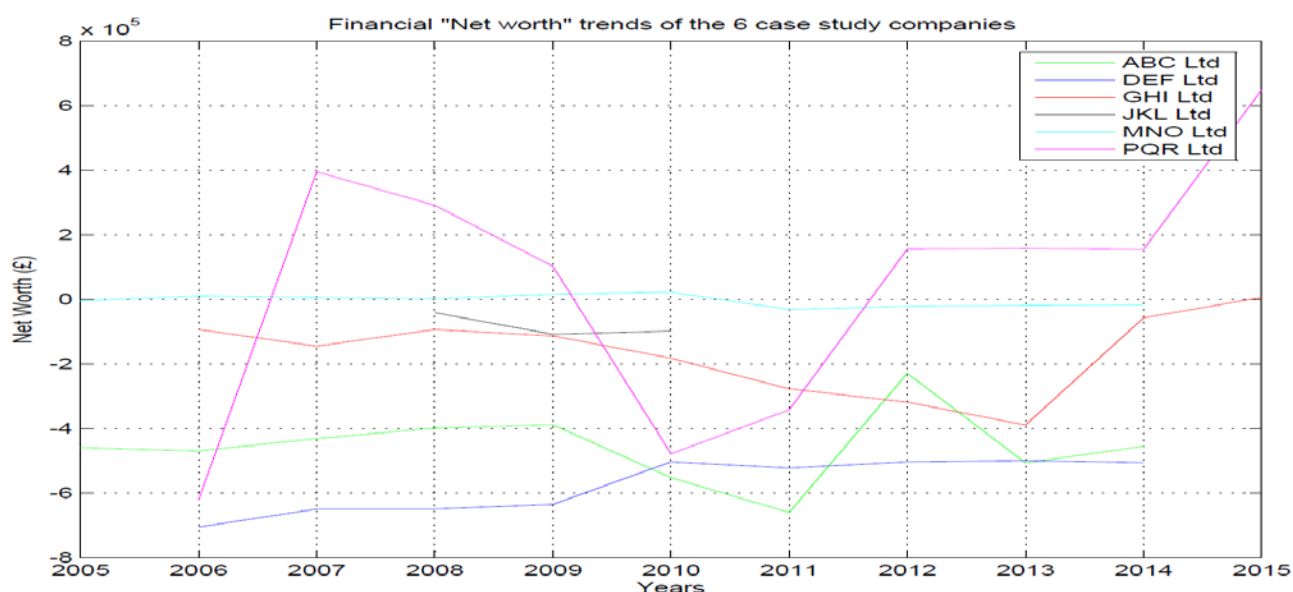


Figure 3: Financial 'Net worth' trends (negative figures) of 6 case study companies. The figure shows that all the eHealth companies have negative trends in their financial net worth which further reveals the unsustainability nature of their business models.

To illustrate further, following the methodology used in (Lin et al., 2010), the study summarised the findings from the business models of three of these companies who are the major players in the UK's eHealth market and we presented their sustainability trends. In order to keep the names of these three companies with their products and services anonymous, the study adopted the following pseudonyms for them: (1) ABC Telehealth Limited (2) DEF

EHealth Limited, and (3) GHI EHealth Limited. Their products are named after these pseudonyms. For example, ABC1, ABC2 are two of the products of ABC Telehealth Limited. The study illustrates with these three companies as representatives of other companies (in this group of 20) that have similar products and services and those whose responses to interview questions and financial viability follow the same trends and also, in order to optimize the number of pages used in this paper for presenting data from these case study companies.

5.2.2 Case Study Questions and Responses

The interview questions for the managers who represented these companies focused on the elements of the business model identified in (Osterwalder & Pigneur, 2009) and as illustrated and used in (Lin et al., 2010). That is, the managers were asked on how their companies address each of the following business model components: (i) Value proposition (ii) Product innovation (iii) Infrastructure management (iv) Customer relations management (v) Financial viability and sustainability (vi) Stakeholder credibility, and (vii) Revenue Streams. The responses to the questions are as tabulated in Table 6 while graphs in **Figure 3** reveal their sustainability trends from their financial data.

Table 3 : Business models of three eHealth companies in UK

BM components	ABC Telehealth Ltd	DEF eHealth Limited	GHI eHealth Limited.
Value proposition	Real time data transfer and receipt of messages permit effective and efficient management of patients in their own homes.	By matching people with the most appropriate equipment, they help users to reduce risks that could be associated with the use of inappropriate equipment.	Improve social inclusion through community website
		It greatly reduces the cost. The cost of doing the assessment by the local council staff members was £200.00 whereas; the cost of doing same assessment by the <i>DEF</i> is just £20.	Provides IT platform for telehealth and eHealth.
		Their assessments achieve twenty times what the Local Council official would achieve within the same time frame and is twenty times more efficient than the way they were previously done before the <i>DEF</i> innovation.	Encouraging lifelong learning / home-school links, better ICT skills
	Efficient interaction between clinicians and patients at home.		Economic regeneration through improved ICT skills/broadband
	Helps patients develop self-care skills to empower them to be more involved in their own health.	It reduces the consumer's waiting time. The waiting time by the consumer when the assessments were carried out by the council official was on average of 12 months while the waiting time for <i>DEF</i> assessment is a maximum of one month.	Encourages take up of e-government services
Product innovation &	ABC1 service for the management of chronic disease.	DEF1 system uses proven state-of-the-art matching algorithms and is a comprehensive and proven algorithm in their field.	Provides broadband to rural households and organise community broadband workshop at rural areas.

commercialisation	ABC2 for collecting physiological, quality of life and life style data; data transfer and receipt of messages permit effective and efficient management of patients in their own homes.	DEF2 gives users the ability to perform unique supported self-assessments for aids to daily living e.g. raised toilet seats, bath boards, tap turners, etc. Products can be ordered privately through mail order, local dealers or from the local Social Services.	Involved in developing community owned, social enterprise wireless and next generation access networks.
	Other products include: third party equipment such as blood pressure monitors, Oximeters etc.		Expertise in supporting databases, managing IT suppliers, common faults, and equipment loan agreements.
Infrastructure Management	ABC Ltd infrastructures include computer systems, broadband and communication equipment, servers, software for ABC1, multi-user ABC2 software, blood pressure monitors and other similar telehealth equipment. These are managed by ABC Ltd's technical staff and the technical staff of third party organisations.	DEF infrastructures include hardware and software with which they analyse data. Licensed database which cost about £13,000 per month and Cisco firewalls which cost around £400 per month. Backup battery and backup power generating sets to ensure business continuity.	Infrastructures include broadband equipment, computer hardware and software. These are managed by the company's technical staff and external organisation.
Customer relations management (CRM) (& No of Users)	They have dedicated customer service line for their equipment. The customer service provides answer to the technical problems and problems related to the health issues are promptly responded to by the trained clinicians. They presently have about 3,000 users in UK.	After recommendation of the most appropriate eHealth equipment to users, users are free to buy the products from any accredited retailers. Customer relationship management will be done by the product manufacturers or retailers or as agreed during the purchase between the customers and the retailers based on their SLAs. They have about 40,000 with whom they have done full assessments and about 100,000 users whom they have offered certain levels of advice.	*Pro-actively contacting all their users *Identify anyone who has 'fallen through the crack' *Helping users with confidence and skills on one-to-one home visits *Small scale training and coaching programmes to improve ICT skills *Dedicated support officer *All technical support and hardware repairs directed to third party organisation. *Volunteers in the community. *They presently have a total of 40 PCT users in the region they operate.
Financial viability and sustainability	Sustainability trend of the company is shown in Figure 3. From the figure and also from this project's perspective, business is unsustainable because it relies on state funds.	Sustainability trend of the company is shown in Figure 3. From this project's perspective, business is unsustainable because it relies on state (local councils) funds.	Business entirely relies on funding from the state and therefore, unsustainable. The trend is shown in Figure 3.
Stakeholder credibility	Stakeholders include elderly people, DPH, NHS and other related organisations.	Stakeholders include: •The users (elderly people) •The council •The eHealth manufacturers and retailers •NHS:- These include both primary care and secondary care. •Social and Care/Services •Individuals and families •Private Health Care	Stakeholders include elderly people, local councils, DPH, NHS and other related organisations.
Revenue Streams	Presently, NHS and local authorities pay for their services.	Revenues come directly from the local councils who are directly responsible for the assessments of the health needs of their citizens.	Funding of their projects is mainly from the DPH.
	Funding from R&D agencies such as TSB.	Funding from R&D agencies such as TSB.	Funding from R&D agencies such as TSB.
	Tender for supplying of telehealth systems.	DEF Ltd also provides advisory services to manufacturers on product designs that best suit customer needs or on necessary adjustments that manufacturers need to make to their existing products. Manufacturers do offer certain remuneration for the DEF Ltd advisory services	Other sources of revenue streams include: grant support, sale of knowledge and know-how, revenue from sale of services, developing new applications or content to increase revenue from users
	Costs are based on the number of users.		
Future Plan	To move telehealth from State funded to private	They are constantly striving to develop and introduce new tools to support their customers.	Moving their business into a model where users (but not DPH etc.) pay for their products and services.

Business models (Osterwalder & Pigneur, 2009) of three out of the 20 eHealth companies interviewed in UK as described by their managers. We keep the names of these companies with their products and services anonymous and used pseudonyms to represent them. For example, ABC1, ABC2 are two of the products of ABC Telehealth Limited.

5.3 Challenges of EHealth BMs: Evidence from Facilitated Workshops

At the facilitated workshops, the participants who are mainly, user representatives, owners of established businesses as well as new start-ups gave different reasons for the perceived challenges or barriers to eHealth businesses. The workshop participants screened, verified and agreed to the evidence from the desk research and the case studies.

During the focus group interviews, most elderly people clearly indicated that it is very unlikely for them to spend huge amount of money on private eHealth innovations if they could easily get equivalent services free of charge from the NHS unless such eHealth innovations have huge and compelling “*relative advantages*” as well as other attractive features when compared with the NHS free alternatives.

The elderly users also explained that they are unable to use most of those eHealth products that were given to them freely by their Local Councils because they are mostly difficult to use (that is: *complexity and user-centred design*). Others complained mostly about “*compatibility*” of the products. For instance, an elderly person brought out an “*epileptic alarm*” which he supposed to be hanging on his neck like a chain pendant. The device was almost as big as a 33cl can of *Coca-Cola*. He said:

“...I just dumped it in my garage because I was wondering how they expect me to hang such a huge device on my neck and go about in public without being stigmatised...”

Another user commented:

“...the business model really needs to show how it would reduce these challenges of eHealth innovations and NHS such as the much criticized waiting time of the NHS...”

When a Chief Executive Officer (CEO) of one of the branches of the Age UK was asked on how the challenges pose by the NHS business model to eHealth could be overcome by eHealth entrepreneurs, she replied:

“...the challenges could be overcome if the quality of the products or services offered is raised higher than what are offered by the traditional health and social care systems. For

example, orthopaedic patients may prefer to pay for artificial limbs that are more comfortable, stylish, user friendly and that satisfy their needs more than the free unfashionable alternatives offered by the NHS... ”.

She said further "*...this also happens in the optical glasses market. While the NHS provides free glasses, most people still prefer to buy from private market because they are more fashionable and stylish than what the NHS offers*".

Evidently, most of the issues raised by the focus group relate to the innovation adoption and diffusion characteristics (that is, *relative advantage, compatibility, complexity*, and others) of DOI theory (Rogers, 1995).

Further reasons identified (from the workshops) by eHealth entrepreneurs as main barriers to sustainable development of eHealth technologies and services in the UK include: (1) Policy and regulations, (2) Control and Interference and (3) Market competition and small market size.

5.3.1 Policy and Regulations

Participants mentioned that there are lots of regulations that have been hindering commercialisation of eHealth innovations. They identified some of the regulations to include:

1. Medical Device Regulations

This regulates the standards of all medical equipment and services that are sold to users such as telehealth equipment. They said that it costs very much to maintain these standards and abide by the regulations which in turn increase the cost of the products and thereby hindering the market development for eHealth. For instance, telecare products also need to abide by regulations such as communication protocols. They lamented that it could take up to 3 years to get a product approved by the regulatory bodies. Apart from cost, this also increases the duration (or time) at which new products could be rolled out into the market.

For example, the representatives of ABC Telehealth Limited (described in Section 5.2.1) stated that even though their business started in 2001, it could not roll out products until 2005 because it takes very long time to get approval from the policy and regulating agencies.

A notable eHealth industrialist reported:

“...Because of the nature of the sector and regulations, most companies attempt to avoid the “medical device” label as otherwise they must pass the regulatory approvals. The current regulations are incredibly expensive and very time-consuming to pass through. For an industry like game or software industry, if the developers want to go through those regulations, by the time when their software is out, most of the game controllers are outdated...”

Another eHealth company’s chief executive officer (CEO) commented:

“... The last labour government set up a committee to investigate what made a successful SME in Medical Devices Industry, and the very sad conclusion was that you are only successful if you first launched in America, since their regulations are pro-commercialisation of medical devices not against ...”

2. Clinical Governance and Ethical Guidelines:

They said that this requires limited access to patient records and are limited to only a few nominated staff of each organisation. For example, only 3 of ABC Telehealth’s staff (Table 3) are given this privilege.

Other policies and regulations that pose important challenges to the market development include: (a) Clinical governance (b) Information governance and (c) Telecare Services Association (TSA). Participants lamented that these constitute huge overhead cost into eHealth production.

5.3.2 Control and Interference

According to participants, from users' perspective, personal budget (Glasby et al., 2009) was not really "*personal*" because the Local Councils (LCs) determine, regulate and control what it could be used for. They said that in some LCs, user could use it mainly to employ carers but could not be used to purchase eHealth products while in some other LCs, the reverse is the case. Therefore at the end, the money for the personal budget is eventually returned to the LCs almost unused at the end of the period which reduces users' interests in taking the initiative.

5.3.3 Market Competitions and Small Market size

Apart from policy and regulations, workshop participants mentioned that stiffer competitions and small market size also immensely affect sustainability of eHealth businesses and in order to overcome these, companies are forced to provide competitive bids and invest on products that have better features than those of others (*that is: relative advantages*) and at extremely cheap price. Most of these competitors are Local Councils and the NHS who offer these eHealth products free of charge or at very cheap prices.

According to a Business Development Manager of a Telehealth firm:

"...Our company as well as our Telehealth and Community Solutions products also offer a comprehensive Risk Stratification Tool and you will find that the number of really poorly co-morbid patients in say a CCG of 250000 in England that will require the full range of comprehensive services is about 250 people (1 per 1000) so despite what Frost and Sullivan say about the market the reality is with the figures suggesting 15million elderly people this only means a market of about 15000 for comprehensive Telehealth..."

Also, according to another CEO of an eHealth firm:

*"..To realise the savings that can emerge from telehealth, **scale is important**. Working across a number of commissioners with a novel idea is challenging – but when an Acute Hospital needs to be engaged with telehealth, for example, for the treatment of COPD, they need it to be available across their area. Providing a service for patients in just one area means that clinical pathways cannot be redesigned for all patients. This leaves hard pressed clinicians with a good excuse not to engage with telehealth..."*

6 Discussion

6.1 Sustainable BMs for EHealth Innovations in the Digital Economy

There is the apparent need to develop a strategic framework necessary for sustainable business models for eHealth innovations that are workable for UK health and social care systems and possibly extendable to other economies with similar systems. This is necessary as a result of the research gaps highlighted in previous sections. The proposed conceptual framework for eHealth business models is shown in Figure 5 and it consists of two main parts:

1. Business model framework as defined in (Lin et al., 2010; Osterwalder & Pigneur, 2009).
2. Diffusion of Innovation theory (Rogers, 1995).

The term “*business model*” is more widely used nowadays than almost any other concept in strategy and one of its roles is to provide a set of generic level descriptors of how a firm organises itself to create and distribute value in a profitable manner. The business model frameworks (explained in Section 5) as developed in (Osterwalder & Pigneur, 2009) has been successfully applied by various researchers (Lin et al., 2010; Zott et al., 2011) for analysing commercialisation of products and service and it has proven to be a reliable model which could be adopted in many situations. However, while the frameworks could be said to successfully capture factors that entrepreneurs would consider within their organisations when introducing products and services into the market, it seems not to have taken the characteristics of the markets and attitudes of various user groups toward innovation adoption into consideration (Kulins, Leonardy, & Weber, 2016). The framework does not specifically relate innovation qualities to the characteristics of the various user segments in the market. These factors are necessary in order to take (and diffuse) the eHealth innovations into the

mainstream market, lead to sufficient adoption, generate sufficient revenue streams and in ensuring sustainability of the business model.

On the other hand, diffusion of innovation theory as developed by Everett Rogers in (Rogers, 1995) highlights different strategies necessary for taking innovations into the market, for capturing different user segments and it effectively relates innovation qualities to the characteristics of various population segments of the market. It explored innovation characteristics and qualities that aid adoption (Ganglmair-Wooliscroft & Wooliscroft, 2016). It has been successfully applied in investigating how innovations spread across populations and how entrepreneurs could strategize to reach each market segment. However, this theory does not consider the wider organisational structures and decisions variables that are necessary in determining whether an entrepreneur would produce or invest in an innovation or not. These variables include value proposition, organisation's infrastructure management strategies, stakeholders' credibility and most especially, the financial viability of the business as well as other related variables.

Therefore, these two models appear to complement each other and this study has used an integration of the concepts/constructs presented by them to review the business model frameworks proposed in (Osterwalder & Pigneur, 2009) to develop the strategic and integrated entrepreneurial frameworks for sustainable eHealth business models as shown in Table 4, Figure 4 and Figure 5. The proposed model incorporates factors identified from this study's empirical studies (as well as from literature) as influencing commercialisation of eHealth innovations (Table 4). The conventional business model frameworks in (Osterwalder & Pigneur, 2009) were refined by integrating it with factors discussed in previous studies (as affecting eHealth commercialization) as well as concepts from diffusion of innovation theory, thus resulting in the development of an integrated model for eHealth business sustainability.

6.2 Sustainable EHealth BMs, Case Studies and Diffusion of Innovation

The academic literature arguing that there is an urgent requirement for businesses to become more sustainable with durable profits is rapidly expanding and there is also a demonstrated need for managers to develop a better understanding of sustainability and the appropriate strategies required to improve business sustainability (Fisher & Bonn, 2011). Most available theoretical frameworks for the dissemination and implementation of medical innovations heavily rely on Roger's 'Diffusion of Innovations Theory' (DOI) (Ruof, Mittendorf, Pirk, & Schulenburg, 2002; Urueña et al., 2016). 'Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system...it is a kind of social change' (Rogers, 1995; Thurber & Fahey, 2009). From the definition, the theory identifies four main elements in the diffusion of new ideas as (1) the innovation (2) communication channels (3) Time, and (4) the social system (context). According to the theory, new ideas are adopted very slowly during the early stages of the diffusion process and if the innovation is perceived as advantageous by its early adopters, however, the rate of adoption steadily increases, resulting in an S-shaped rate of adoption of the innovation over time (Ruof et al., 2002). Diffusion of Innovations attempts to explain how innovations are taken up in a population and diffusion scholars recognise five qualities that determine the success of an innovation (Parthasarathy & Forlani, 2010; Rogers, 1995; Thurber & Fahey, 2009) which include: (a) relative advantage (b) compatibility (c) trialability (d) observability, and (e) complexity. The first four factors are positively correlated with rate of adoption while the last factor, complexity, is generally negatively correlated (Rogers, 1995). **Relative advantage** is the extent to which an innovation is perceived as being better or more useful than the idea it supersedes (value proposition) while **Compatibility** is a measure of how well an innovation is consistent with existing social and cultural practices, if it is likeable, and if it meets the needs of potential adopters (Thurber & Fahey, 2009). **Observability** is used to

describe how well the results of the innovation can be seen and communicated to others, ***Trialability*** refers to the ability of an innovation to be experimented with, while ***Complexity*** is the level to which the innovation is perceived to be difficult to understand or use (Rogers, 1995; Ruof et al., 2002).

From the case of the 20 eHealth companies, systematic barriers that are slowing down the market penetration of eHealth innovations were identified. Column 4 of Table 5 shows how the responses from the case studies relate to the five qualities that determine the market success of an innovation in accordance with the diffusion of innovation theory.

Furthermore, diffusion researchers believe that a population can be broken down into five different segments and percentages, based on their propensity to adopt a specific innovation and these are (i) innovators: 2.5% (ii) early adopters: 13.5% (iii) early majorities: 34% (iv) late majorities: 34%, and (v) laggards: 16% (Ganglmair-Wooliscroft & Wooliscroft, 2016; Robinson, 2009). According to Rogers in (Rogers, 1995), the following are the characteristics of each population segment: ***innovators*** are venturesome, educated with multiple information sources; ***early adopters*** are social leaders, popular, educated; ***early majority*** are deliberate, with many informal social contacts; ***late majority*** are sceptical, traditional, with lower socio-economic status; ***laggards*** heavily rely on neighbours and friends as main information sources and are constantly in fear of debt.

6.3 Case Study Companies and Diffusion of Innovation Curve

Findings from the Whole System Demonstrator stated that there are at least three million people with Long Term Conditions and/or social care needs that could benefit from using telehealth and telecare (DPH, 2011). Using this number as the potential population target for ***ABC Telehealth Ltd*** and ***DEF EHealth Ltd*** and the population of the local region where ***GHI EHealth Ltd*** operates (1,128) as its own target (because the company is a regional or local type), The current segments of the population where each of the three companies has already

covered can be determined to show the current level of adoption of these eHealth companies' innovations with respect to the diffusion of innovation theory's perspectives. From case studies data in Table 6, *ABC Telehealth Ltd* currently has 3,000 users, *DEF EHealth Limited* has 140,000 (out of 3 million stated in Whole System Demonstrator (DPH, 2011)) while *GHI EHealth Ltd* has 40 (out of 1,128 population in their local region). Therefore, the current level of adoption of *ABC Telehealth Limited's* innovations is: $(3,000 \times 100)/3,000,000 = 0.1\%$, level of adoption of *DEF EHealth Limited's* innovations is: 4.67% and that of *GHI EHealth* is: 3.55%.

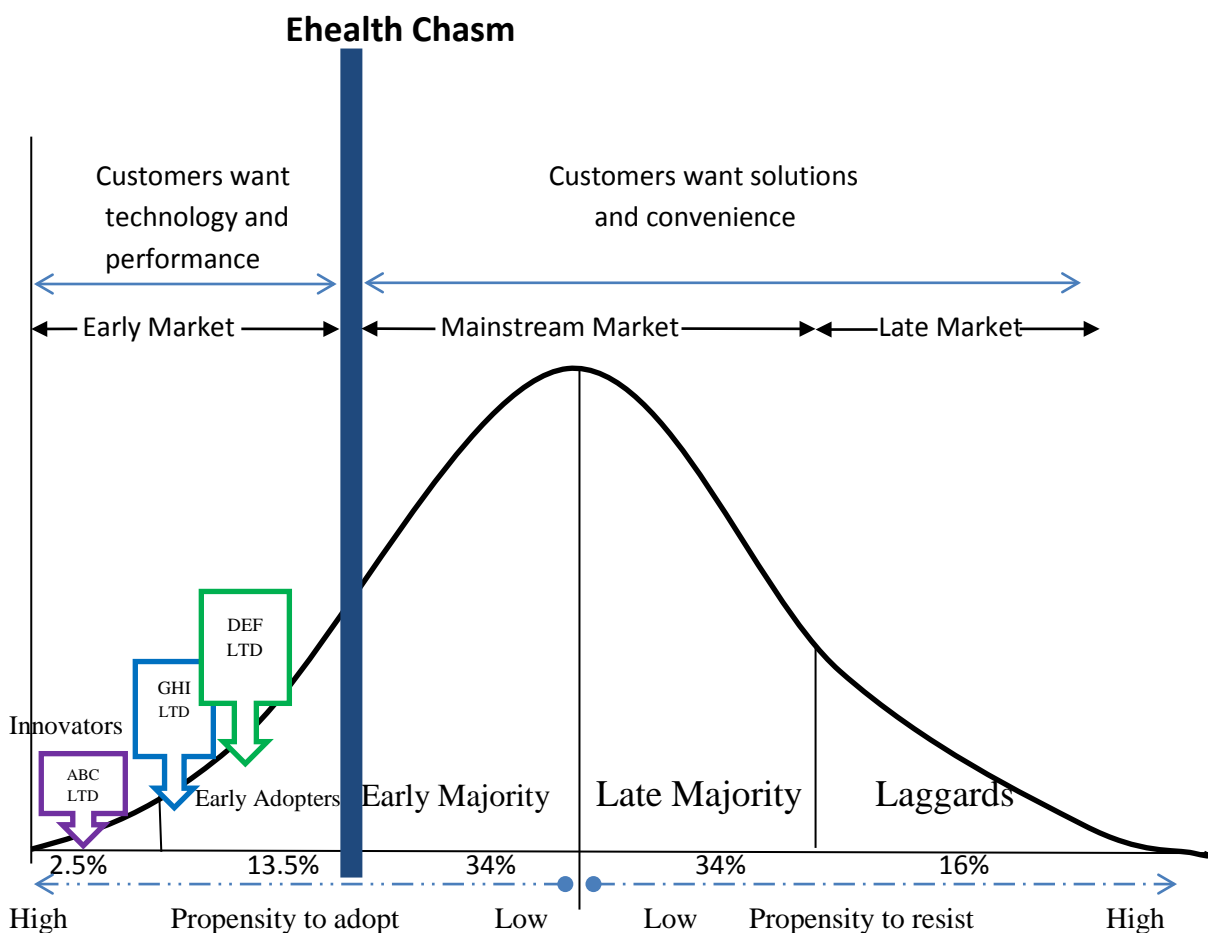


Figure 4: Showing the bell curve for the distribution of individual innovativeness (innovation adoption life cycle) in a population from DOI perspective and the segments where the three case study companies interviewed in Section 5.2.1 are presently operating. The graph shows that *ABC Telehealth Ltd* (represented with purple sticker) is still operating at the innovators' segment with its 0.1% adoption rate while both *GHI Ehealth Ltd* (blue sticker) with (3.55%) and *DEF Ehealth Ltd* with (4.67%) are at the early adopters' segment. Innovations will spread (and business becomes sustainable) when they evolve to meet the needs of successive segments. The colours are chosen arbitrarily for visual purpose.

The bell curve in Figure 4 shows the distribution of individual innovativeness (innovation adoption life cycle) in a population, the percentage of potential adopters from DOI perspective and the segments where the three case study companies interviewed in Section 5.2.1 are presently operating. The innovations will spread (and business becomes sustainable) when they evolve to meet the needs of successive segments of the population according to the DOI theory. The graph provides insights for the companies on which segments to address next and how to design their projects, strategies as well as communication channels to reach target segments. Further readings on different strategic approaches to reach the population in each segment of the curve could be found in (Robinson, 2009; Rogers, 1995; Ruof et al., 2002; Thurber & Fahey, 2009) .

The framework in Figure 5 shows the pictorial relationship between the building blocks of a business model (discussed in Sections 5 and 5.2.2) that could be sustainable for eHealth innovations and Table 4 shows these building blocks as they relate to eHealth technologies and services. The components with green colour labels shows the five qualities that determine the success (adoption) of an innovation in accordance with the diffusion of innovation theory and how these qualities relate with the business model framework described in (Lin et al., 2010; Osterwalder & Pigneur, 2009).

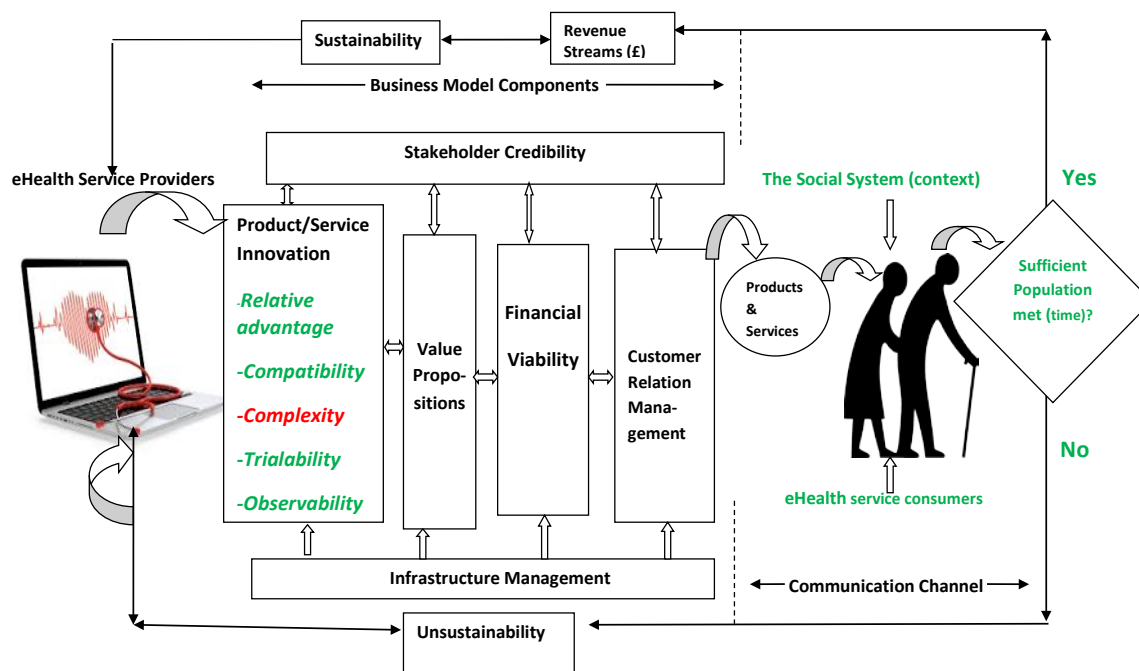


Figure 5: Following BM constructs discussed in Section 3, this figure shows an integrated framework showing the building blocks of a sustainable business model in eHealth market from the perspective of diffusion of innovation theory. The figure shows that for an eHealth system to be sustainable, credibility of the stakeholders is very important from the onset of the business model development in order to ensure acceptability of the end products or services. The components with coloured labels show the qualities that determine the success of an innovation in accordance with the diffusion of innovation theory and how these qualities relate with the business model framework described in (Lin et al., 2010; Osterwalder & Pigneur, 2009). The business becomes sustainable when the innovation reaches sufficient members of the population.

Table 4: Entrepreneurial framework for sustainable business models for eHealth innovations.

eHealth BM components	Entrepreneurial Strategies for eHealth Business Models Sustainability	References
Product innovation & commercialisation	According to Lin et al, the true test of an innovation lies in whether it could provide new value for users and the general public and this should apply to the eHealth innovation, such that it can be tested in the market to demonstrate that it is possible to sustain and can provide a new value proposition to its end users (Lin et al., 2010). In the development, marketing, adoption, and implementation of these tools and technologies, communication, training, cultural sensitivity, and end-user customization are critical pieces to the process (Ackerman, Filart, Burgess, Lee, & Poropatich, 2010).	(Lin et al., 2010; Visser et al., 2010).
Value proposition	Ehealth innovations have altered profoundly the manner in which primary care physicians can interact with hospitals and specialists and as dedicated medical ICT systems evolve, medical care will be delivered to patients in remote locations in a more efficient and cost-effective way (Madera & Castelli, 2004). <u>Acceptability:</u> The service will be accepted if it has added value for the quality of care (Visser et al., 2010). <u>User centred design:</u> Ensuring user centred rather than biomedical/service-centred models of care (May et al., 2011). A good eHealth business model should adopt a policy to use only elderly friendly devices as this is the only way to make new technology quickly and widely accepted by the users (Lin et al., 2010). Ehealth completes and consolidates the health and social care systems by allowing a continuum of care based on patient needs (Pare et al., 2010).	(Ackerman et al., 2010; Lin et al., 2010; Madera & Castelli, 2004; May et al., 2011; Pare, Moqadem, Pineau, & St-Hilaire, 2010; Visser et al., 2010).
Customer relations management	A good eHealth business model is expected to deliver 24/7/365 call service provided by experienced health and care personnel (Lin et al., 2010). With respect to the patients targeted by home telemonitoring programs (also known as telehealth), it needs to be determined whether home telemonitoring is suitable to everyone (Pare et al., 2010).	(Cavallerano & Aiello, 2005; Lin et al., 2010; Pare et al., 2010)

Infrastructure Management	<p>According to Visser et al in (Visser et al., 2010), the technology consists of a secured Internet Web-based application, standard personal computer, broadband Internet connection, and a digital camera. It must bring together the four domains that make up a business model, that is, service, technology, organization, and finance, and covers the integration of these domains.</p> <p>Next-generation tools and technologies are vehicles toward personalized medicine and these include cell phones and Internet-based telecommunications tools for remote and home health management with video assessment, remote bedside monitoring, and patient-specific care tools with event logs, patient electronic profile, and physician note-writing capability (Ackerman et al., 2010; Seror, 2002).</p> <p>In managing eHealth infrastructures, important steps include: (1) understanding how the organization delivers care; (2) analysing the alternatives, including cost-benefit analysis; (3) obtaining organizational support; (4) formulating an execution plan; (5) training staff and monitoring the process (H. S. Pak, 2005).</p>	(Ackerman et al., 2010; H. S. Pak, 2005; Pare & Trudel, 2007; Seror, 2002; Visser et al., 2010).
Stakeholder credibility	<p>The stakeholders of eHealth identified in (Ackerman et al., 2010) include patients, patient communities, research funders, researchers, healthcare services providers, professional societies, industry, healthcare management/economists, and healthcare policy makers. Also, legal and regulatory issues need to be adequate addressed (Weinstein et al., 2009).</p> <p>It is expected that various actors other than those involved in traditional care are involved in and need to cooperate, to deliver these services (Leff & Burton, 2001; Visser et al., 2010). This is because implementation of the video teleconsult service requires multidisciplinary cooperation and integration.</p> <p>Home telemonitoring application must be designed and implemented with the understanding that it is a complementary intervention and not a solution that replaces primary care (Pare et al., 2010). The American Telemedicine Association (ATA) in cooperation with the US National Institute of Standards and Technology, the guiding principle is that it would be inappropriate to use telemedicine to provide anything less than the accepted standard of clinical care (Cavallerano & Aiello, 2005).</p>	(Ackerman et al., 2010; Cavallerano & Aiello, 2005; Leff & Burton, 2001; Pare et al., 2010; Visser et al., 2010; Weinstein et al., 2009)
Financial viability and sustainability	<p>Financial reimbursement for the service delivery is expected to be most successful when set up through healthcare insurance companies (Visser et al., 2010). Medical technology companies developing eHealth products have to consider the market needs, the customer, the product development aspect, the business model, and the long process of market penetration, in order to choose the commercially correct idea and successfully bring it to the market (Zeevi, 2003). A self-sustaining business model balances the cost and value associated with each eHealth activity (Gamble et al., 2004).</p>	(Gamble et al., 2004; Visser et al., 2010; Zeevi, 2003)
Revenue Streams	<p>Pricing needs to account for the fee of healthcare professionals as well as for technical aspects, education, and future innovation(Visser et al., 2010). The model may also charge users directly and not through the national health insurance system (Barker et al., 2005; Lin et al., 2010).</p>	(Barker et al., 2005; Lin et al., 2010; Visser et al., 2010).

The table shows entrepreneurial framework for sustainable BM for eHealth innovations in the UK Healthcare sector. The framework highlights the expected strategies for each of the BM components (identified in Section 3 and **Figure 5**) that could make the business successful and financially sustainable.

6.4 Management Strategies for Crossing the Diffusion Chasm (*eHealth Chasm*)

From the case study data and analysis shown in Figure 4, it can be observed that the sampled eHealth companies (same for all the 20 eHealth companies studied) are still operating in the first two segments of the population and the figure shows a big gap (the chasm) between the companies and the next segments (mainstream market). Since innovators and early adopters represent a very small percentage of the population, business sustainability cannot be achieved by just selling to them alone. Therefore, for the eHealth business to be sustainable, it needs to cross the *eHealth Chasm* depicted in the figure in order to move to the mainstream markets. For the eHealth case study businesses to cross, they first need to get to the chasm by covering the early adopter segment because early adopters are pillars that are needed to cross.

Geoffrey Moore in (Moore, 2002) analysed the fundamental differences between sales to each of these segments and he further divided the market into three main groups: (i) early market; which consist of the innovator and early adopter segments, (ii) mainstream market; which spans through the early and late majority segments and late market which consist of the laggards (Ruof et al., 2002). He suggested the success of a business in each segments heavily depends on good understanding of the characteristics and needs of different user segments (Robinson, 2009).

According to Moore, to get an early eHealth market started requires an entrepreneurial company with a breakthrough eHealth product that enables a new and compelling application. **Innovators** are venturesome, educated with multiple information sources and to catch them among these elderly people, one needs to track them down and invite the keen innovators to be partners in designing the eHealth projects. **Early adopters** are social leaders, popular, educated and to penetrate them (a) offer strong face-to-face support for a small number of them to trial the eHealth products (b) carefully analyse the trials to determine how and where to make the innovation more convenient, cheaper and marketable (c) delight these elderly people them by rewarding their egos such as with media coverage (d) promote them as fashion leaders (e) involve and train some as peer educators, and (f) maintain relationships and frequently request for feedback from them concerning the eHealth products. **Early majority** are deliberate elderly people, with many informal social contacts and to win them: (a) provide give-aways or competitions to stimulate buzz (b) mainstream advertising with media stories that feature endorsements from respected, credible, similar peers. According to an elderly user from this research's user groups:

“... in order to increase user uptakes, supplier or manufacturers of eHealth products (and services) should use better advertising techniques in order to attract older consumers. They should not use the stigmatising statements such as ‘you need to use these XYZ products because you are old or because of your age’. Otherwise, there may be denial of conditions by the older consumers...”

(c) Reduce the entry cost and guarantee performance of the eHealth products (d) simplified products with maximum ease of use because these elderly people may not be very comfortable with complex technologies unlike the younger generations. (e) cut the red tape by simplifying application forms and few instructions, and (f) efficient and effective customer service and support (Robinson, 2009). *Late majority* are conservative pragmatists, uncomfortable with new ideas, hate risk, always fear of not fitting in and will only follow tested and trusted standards and mainstream fashions, often influenced by the fears and views of laggards (Thurber and Fahey 2009). To win late majority for eHealth products: (a) instead of promoting product benefits, emphasis should be on promoting social norms: they are interested in hearing that plenty of other conservative peers like them talk favourable about the eHealth innovation (b) possible reduction in costs and redesigned product to increase convenience and ease of use (c) emphasis on the risks of being left behind, and (e) prompt response to laggards' criticisms. *Laggards* heavily rely on neighbours and friends as main information sources and are constantly in fear of debt and abhor risks. To penetrate laggards: (a) offer them high levels of personal control over how, when, where and what to do with the new eHealth idea (b) ensure total familiarity with the new eHealth products or services, and (c) show them evidence of other laggards, among their elderly peers, who have successfully adopted the new technology.

Finally, to cross the *EHealth Chasm* and enter the mainstream markets, it is essential for eHealth entrepreneurs to note the difference in personalities of each adopter group stated and to understand the percentage that has already taken up the innovation. These give insight into which segments to target next and to strategize to meet the challenges of those segments.

7 Conclusion

Through evidence from case studies of relevant companies, facilitated workshops, user groups and other empirical approaches, this study has identified current trends in digital economy as

they relate to eHealth market. Various segments of eHealth market were investigated and categorised. In general, this study shows that previous attempts to commercialise eHealth innovations were plagued with several problems as identified in this paper. Also, it shows that most of the existing business models for eHealth are state funded which have placed much pressure on government's health and social care budgets and therefore becoming unsustainable for governments due to budget cuts and the increasing number of older people.

Also, research evidence from this study shows that scholars do not agree on the terms and definitions of various technologies and services of eHealth (such as telehealth, telecare, and telemedicine) and their segments and thus on what their business models (BMs) ought to be. This lack of consensus raises doubts concerning the usefulness of their empirical research and on the quality of research outcomes of these previous studies which include the data they collected and analysed, and also in terms of data evaluation approaches. This research has explored this area with robust and holistic approach to eHealth innovations, with clear definitions, examples, practical illustrations of each segment and suggested solutions to identified problems or commercialisation barriers.

Generally, analysis from the case studies shows that eHealth technologies and services deployment appear to have suffered from lack of sustainable business models. The fact that most of the companies in eHealth market and the 20 companies investigated mostly rely on state funding reveals the unsustainability of their business models. Even with the funding from the state, the fact that their net worth (negative) and total current asset graphs are slopping downward (**Figure 3**) further reveals their unsustainable trends.

Analysis from the perspective of diffusion of innovation (DOI) theory showed that while there have been heavy investments in eHealth innovations, adoption process is still in its early stages (Figure 4). While effective eHealth innovations certainly exist, they are generally run by local champions and are mostly state funded. Presently, almost no eHealth applications (innovations) have been successful in reaching enterprise-wide and large scale

adoption. Various barriers to adoption of eHealth innovations were investigated in this paper and suggested solutions were prescribed. Examples of identified market barriers of eHealth innovations include: technophobic nature of most elderly users; elderly with disabilities; security issues; small market size; inadequate planning, integration or coordination among the providers and policy makers; technological and interoperability problems; poor user centered design, and cost effectiveness.

Through DOI theory, integrated strategic frameworks for sustainable business models that could make commercialisation of eHealth products and services more effective are then presented in an organised manner. The case studies and their analysis in this study give various insights into commercialisation of eHealth and strategies for driving these innovations through the '*Diffusion Chasm*' (Figure 4) into the mainstream markets by segmenting users into different populations based on individual innovativeness. The study provided various characteristics of individuals (elderly people) in each segment of potential eHealth users as well as suggested strategies to reach them. The study approach suggests that business model and diffusion of innovation theory are complements but not substitutes. That is, to achieve profitability, the product innovation aspects of the eHealth BMs need to satisfy all the innovation diffusion characteristics as highlighted in DOI.

Through the interviews of elderly people focus groups and facilitated workshops, the investigation discovered that compelling "*relative advantage*" is the most important factor of the DOI characteristics that could motivate the elderly people to pay for eHealth innovations despite the freely available NHS services. Other DOI characteristics mentioned are "*compatibility*" and "*complexity*" (Table 5). While relative advantage and compatibility are positively correlated to the diffusion of eHealth innovations, complexity is negatively correlated. This is because most elderly people did not grow up with advanced technologies and therefore tend to avoid complex eHealth technological innovations and gadgets.

In conclusion, eHealth innovations might have important roles as part of the strategies for the management of long term conditions (or chronic diseases) and delivery of effective health and social care services to enable independent living for older people. However, the services will only become meaningful to the producer and the general public when the business models are sustainable such that they will provide mutual benefits for the providers as well as the users. Ultimately, according to the findings from this research, the successful business model will depend on the capacity to provide very “*quality*” products and services to the customers at the least cost, high credibility to stakeholders and generate sustainable “*revenue*” streams to the service providers. The expected “*quality*” of these eHealth innovations will need to satisfy the innovation adoption characteristics as highlighted in the DOI theory (Section 6) and also tailored to the elderly peoples’ use. It is then that self-funded business models where users (or relations) pay for their services (despite the tax supported NHS services) could be realistic and this is most likely to be the most sustainable model.

Future research will be channelled towards economic modelling in order to obtain the costs of eHealth and care services and the proposed sustainable BM strategies. We will estimate the financial and other benefits of eHealth innovations and calculate the cost-effectiveness of the proposed strategies.

We will use further data analysis techniques such as fuzzy set Qualitative Comparative Analysis (FsQCA) to investigate which constructs (or combination of constructs i.e conditions) of the proposed business models framework/canvas as well as diffusion of innovation characteristics are necessary and/or sufficient to produce sustainable business model outcomes.

8 References

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