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**Business Models for Sustainable Commercialisation of Digital Healthcare
(eHealth) Innovations for an Increasingly Aging Population**

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Business Models for Sustainable Commercialisation of Digital Healthcare (eHealth) Innovations for an Increasingly Aging Population

(A New Business Model for eHealth)

Abstract

A rapidly aging population, combined with restrictions on public spending, is creating strong latent demands for eHealth. For many older people, institutionalised inpatient care is not only expensive, but also less attractive than their being cared for in their own homes. eHealth innovations offer promising new avenues that will allow health and social care systems to cope with these challenges and improve the quality of life for older people. However, the user uptake of eHealth is surprisingly low, and successful deployment is not guaranteed unless the interests of key stakeholders are better addressed. While many previous studies have addressed technological aspects of eHealth innovations, the business models underpinning these innovations are often overlooked. This study thus examines the key characteristics of eHealth market from the dual perspectives of business model and information systems success model to contribute to more sustainable and scalable market development of eHealth innovations. A multiple-case study design based on 20 UK and 13 international cases in combination with expert workshops was used to formulate the main barriers and challenges for the commercialisation of eHealth innovations in UK and propose frameworks for more sustainable eHealth innovations. The implications for both management practice and policy are also discussed.

Keywords: EHealth, business model, telecare delivery, telehealth, telemedicine.

1 Introduction

The global population is rapidly aging. Currently, more than 566 million people are over 65 worldwide, with estimates of nearly 1.5 billion being that age by 2050 (Kline & Bowdish, 2016).

Although the steady and ongoing increase in life expectancy is a significant human achievement, it also poses significant challenges for future generations in terms of paying for increased health and care services (Oderanti & Li, 2016). Using the UK as an example, it has been estimated that the number of people in the UK will have increased by 5.9 million in 2033–34 compared to the listed population in 2018–19. People age 65 and over will have increased three times faster than people below that age and result in 4.4 million older people (that is, 65 years and above) compared to 1.5 million more people who are under-65 (Ham et al., 2015). The implication is that a greater demand and pressure will be placed on the health and social care sectors, as even more of the UK population will be living with chronic diseases and many with multiple conditions (Oderanti & Li, 2016). There are currently insufficient capacity and resources to maintain even the current level of service provision, let alone improving or expanding them. The radical changes to the UK National Health Service (NHS) in England outlined in that Government White Paper has further exacerbated the problem (Ham et al., 2015). The heavy burden placed on individual informal caregivers is also growing very rapidly. All these issues are taking place against the background of a growing demand for improving the mental and emotional well-being of older people and further enabling their independent healthy living in communities.

Rapid development of eHealth innovations offers significant opportunities for addressing the challenges in an ageing society by reforming the existing provisions and facilitating new market developments (Flick et al., 2020). Examples are abundant, and they include telehealth, telecare, and telemedicine technologies and services that are being developed to support older people remaining independent for longer and ‘age in place’. These eHealth innovations are expected to create and facilitate new avenues for cost effective and safe methods of care and enabling elderly people to live independently in their own homes and helping governments to cope with the challenges of an increasing ageing population.

However, despite the high demand from this ageing and increasingly unwell population, eHealth innovations have not been adopted on a large scale in most countries (Oderanti & Li, 2018). In particular, the uptake and use of these eHealth innovations is complex and often underutilised, and the role that informal caregivers have in using and implementing eHealth for their spouses or older members of their family is often not acknowledged (Oderanti & Li, 2016, Ehrenhard et al., 2014). One of the key barriers to any increased uptake and integration of eHealth innovations in the UK context is the uncertainty related to the sustainability of the business models (May et al., 2011). The creation of sustainable business models has been recommended as one of the most significant factors for improving health information technology and its implementation, including support of telemedicine functionality for home care (Abraham, Nishihara & Akiyama, 2011). Despite a few notable exceptions (Chen, Wen, & Yang, 2014; Pruthi et al. 2014; Tuan, Thanh, & Le Tuan, 2019) the empirical evidence on successful and sustainable eHealth business models remains low, in particular for assisted living technologies (Oderanti & Li, 2016).

Thus, the current research aims to examine and better understand the general dynamics of the eHealth markets and explore possible new routes for companies to market their eHealth innovations in ways that are sustainable and bring positive net benefits to both the users and the producers of these eHealth innovations. To accomplish these goals, we gathered comprehensive evidence from the eHealth sector, including case studies of relevant organisations and information from facilitated workshops. Our evidence places a particular focus on the UK's healthcare market (i.e., 20 of the case studies, users groups, and facilitated workshops) due to that government's vision of becoming a global leaders in this area of healthcare (Department of Health & Social Care, 2018). These data and other items of research evidence are complemented by insights from international cases (i.e., 13 of the gathered case studies) to explore both the similarities and the differences between the UK firms and other international business models and identify the key success factors in international cases that can be applied effectively to the UK context.

More specifically, this paper seeks to achieve the following objectives:

1. Describe the UK eHealth business models;
2. Investigate the barriers and challenges faced by the UK companies to commercialize their own eHealth innovations;
3. Develop eHealth business model frameworks for sustainable eHealth innovations; and
4. Provide relevant recommendations for healthcare practice in the UK and similar healthcare markets

Our data analysis was informed by the perspectives used for business models and information systems success models. We considered these two perspectives appropriate, because the former could be used to explain how companies develop and profit from technological innovations (Amit & Zott, 2012; Li, 2020), and because the latter could be useful in precisely and reliably understanding the key factors for success in using new information technologies (DeLone & McLean, 1992; DeLone & McLean, 2003).

This study makes two important contributions to the literature and the debate on eHealth products and innovations. First, it developed an eHealth business model that is informed by Information Systems Success Theory, which indicates that eHealth business models need to deliver value propositions that will satisfy or exceed users' needs via appropriate channels and ensure acceptability of the end products or services that become the input for the user uptake phase. By integrating these two perspectives, this paper offers a deeper understanding of the requirements for successful business model development in the context of the eHealth market. Secondly, this paper is based on extensive gathered evidence and analysis and provides important insights about the UK eHealth market, including its current status, the barriers and challenges, and business models, as complemented by the lessons learned from a review of the international market. Key recommendations for actual practice are also offered.

This study also develops significant new insights for business models in terms of facilitating

scalable and sustainable development of a vibrant new market for eHealth products and services, increase its capacity, and generate more new related resources. This study adopted an integrated, multi-perspective approach so as to contribute to these significant societal challenges in an ageing society by focusing on the key elements. It also developed new insights on reforming existing health and social care provisions, by co-constructing innovative, scalable, and workable solutions with multiple stakeholders so as to improve efficiency and effectiveness and also reduce costs.

This study significantly improves our understanding of user needs, informs and promotes user-centred design as well as the development of new eHealth technologies and personalised services. These changes/advances will contribute to improving the uptake and use of eHealth innovations and ultimately contribute to improving the autonomy and well-being of older people everywhere. Further still, this study contributes to the understanding of the current and future markets for eHealth technologies and services and how public funding structures and processes can improve that uptake and its use. It helps us better understand the contrast between rapid technological development, its uptake and use, the users and their contexts, and the barriers to adoption of eHealth at different levels and how to address them successfully.

The rest of this paper is structured as follows. Section 2 introduces the perspectives of the business model and the information systems success model. Section 3 explains the research design, Section 4 and Section 5 present the main findings, discuss the key contributions, and highlight the offered recommendations for both practitioners and policymakers. Finally, Section 6 concludes this paper with final thoughts and discussion.

2 The Theoretical Framework

This section introduces the theoretical perspectives of the business model and information systems success model that was used to explore how companies are able to commercialize their

eHealth innovations.

2.1. The Business Model

Despite the increasing attention given by both research and practice to business models in recent years, the literature has not yet reached a consensus on the precise definition of a business model. According to Li (2020, p. 2), earlier studies had defined it as “*a statement, a description, a representation, an architecture, a conceptual tool or model, a structural template, a method, a framework, a pattern and a set*”. However, more recent conceptualisations (Amit & Zott, 2012; Zott & Amit, 2010) defined a business model as “*a system of interdependent activities that transcends the focal firm and spans its boundaries*” (2010, p.1) aimed at satisfying the needs of a perceived market, along with the parties (the company, its customers, partners or vendors) that conduct these activities and the ways in which they conduct them. This activity-centred definition was adopted for the current study because of its suitability for explaining digital innovation in a business- to- consumer (B2C) context. More specifically, in a digital context, value creation can be frequently realised through a business model innovation that is performed via changes in the planned activities, the links between them, or who actively performs them in the business model activity system (Amit & Zott, 2012).

The literature suggests many frameworks to use when describing business models (Baden-Fuller & Mangematin, 2013; Hedman & Kalling, 2003; Johnson et al., 2008). Very often, these frameworks involve a component-based perspective or a description of company activities in an aggregated form wherein the number of components can vary significantly across different frameworks (Wirtz et al., 2016). The data collected for the current study were structured using the *business model canvas* (Osterwalder & Pigneur, 2010) due to its comprehensive nature and its widespread popularity, particularly among entrepreneurs and business executives. The *canvas* is a template used for describing a company’s business model. It is composed of nine building blocks, a value proposition, customer segments, customer relationships, channels, key partners, key activities, key resources, revenue streams, and a cost structure.

2.1.1 Business Models in eHealth Research

An increasing number of studies have shed light on the definitions of various business models and their components/themes and perspectives for innovations in the different sectors (Massa et al., 2016; Wirtz et al., 2016). In the healthcare sector, the lack of innovative business models has been noted as one of the main factors behind the current problems of both accessibility and affordability (Hwang & Christensen, 2008).

The link between innovative business models and technologies, especially those resulting from the Internet-based innovations since the mid-1990s, has been recognised by many scholars (Amit & Zott, 2012; Lehoux et al., 2014, Massa et al., 2016;). That link is particularly true in the healthcare sector, where business model innovation has been closely related to healthcare digitisation (van Velthoven, Cordon, & Challagalla, 2019), and in particular, the adoption and use of various eHealth technologies and services, such as point- of- care- testing (POCT) (Verhees, van Kuijk, & Simonse, 2018), wearable health monitors, Internet of things (IoT) (Tuan, Thanh, & Le Tuan, 2019), online medical consultations (OMC) (Visser et al., 2010; Jiang et al., 2021), and teletreatment/telemedicine (Kijl et al 2010; Pruthi et al., 2013; Shah et al., 2013).

Since the healthcare sector is highly institutional (Reibling et al., 2019), more empirical research is required to explore the full value of different business models in different settings (Lehoux, 2014). Some of the empirical studies on the use of business models in eHealth have started to emerge starting in 2010, including the studies done by Visser et al. (2010) and Kijl et al. (2010) which documented the most effective business model approaches for deploying eHealth services in The Netherlands, Belgium, Sweden and Germany. These studies were followed by research that described successful eHealth business models in the USA (Pruthi et al., 2013; Shah et al., 2013), Taiwan (Chen, Wen, & Yang, 2014), Vietnam (Tuan, Thanh, & Le Tuan, 2019) and China (Jiang et al., 2021). The context of these studies varies from those on general healthcare

(Verhees, Van Kuijk, & Simonse, 2018; Tuan, Thanh, & Le Tuan, 2019), to the specialist care (Kijl et al 2010; Pruthi et al., 2013; Jiang et al., 2021); the latter includes daily care of patients with chronic diseases (Visser et al., 2010) and care of elderly population (Shah et al., 2013; Chen, Wen, Y Yang, 2014).

The findings from these studies enhance our understanding of the ongoing relationships between different components in successful eHealth business models from the perspectives of either the service providers (Kijl et al 2010; Tuan, Thanh, Y Le Tuan, 2019; Jiang et al., 2021), the customers (Chen, Wen, & Yang, 2014), or the users (Shah et al. 2013). A pilot study by Pruthi et al. (2013) demonstrated the point that eHealth services need to assess the financial impact together with patient satisfaction in order to provide the most sustainable value generation. With the exception of their (2013) study, which was done in a context of cancer-prevention telemedicine in rural Alaska, the links between the business model and successful deployment of eHealth products and services from the perspective of both their users and their providers, remains unexplored. It was that particular issue that motivated this current research.

2.2 DeLone & McLean's (D&M) Information Systems Success Model

A useful perspective that underpins this research is that of DeLone & McLean (D&M) Information Systems (IS) Success Model theory (DeLone & McLean, 1992, DeLone & McLean, 2003). The D&M Information Systems (IS) Success model was introduced in 1992 to identify the most important categories (or dimensions) of information systems success based on the IS body of knowledge at that time. The model has attracted significant interest from the research community as a first holistic model of IS success, that incorporated the temporal as well as the causal relationships between the six dimensions of IS success, namely, system quality, information quality, (system) use, user satisfaction, and individual and organisational impact. The latter two dimensions refer to the impact on managerial decisions and organisational performance. Ten years later, based on the feedback from the IS research community, DeLone and McLean (2003) refined the model (i) to include some of the missing constructs (i.e. service

quality), which is particularly important for Internet-based businesses, (ii) further clarify the interpretation of the existing constructs (i.e. ‘use’ vs. ‘intention to use’), (iii) extend the target of the ‘impact’ constructs from individuals and organisations to any context in which an IS may operate, and (iv) expand the meaning of ‘impact’ to ‘net benefit’ by recognising the need to balance negative as well as positive consequences of IS use.

Since then, this updated version of the model has been used in the contexts of e-commerce (DeLone & McLean, 2004), e-learning (Wang, Wang, & Shee, 2007), e-government (Teo, Srivastava, & Jiang, 2008.) and other types of IS that have expanded from a purely organisational context to B2C and wider eco-systems, such as markets, economies, and society as a whole. Their theory (2003) states that the system, information, and service quality are all pre-requisites for the system’s use and user satisfaction with the system, which then influences each user as well as the net benefits obtained from the system.

The uptake of the D&M theory for eHealth research has been slower compared to that for e-commerce, and first publications only started to appear in mid-2010s covering digitalisation of electronic health records (Bossen, Jensen, & Udsen, 2013; Nguyen, Bellucci, and Nguyen, 2014). Since then the model has been applied to other eHealth system technologies, including the most recent ones, i.e., the Internet of Things (Martínez-Caro et al., 2018) and Artificial Intelligence (Magrabi et al., 2019). It should be noted as well that the (generic) interpretation of the D&M model’s categories within the eHealth research domain is not significantly different than that used for e-commerce research (see

Table 1).

Table 1. Interpretation of Information Systems (IS) success dimensions in the eHealth domain (adapted from DeLone and McLean, 2004).

IS success dimensions	eHealth systems interpretation
System quality	The desired characteristics of an eHealth system, including accessibility, availability, performance (e.g., response time), reliability, security, and ease of use.
Information quality	Content aspects of an eHealth system: accuracy, completeness, consistency, confidentiality, privacy, personalisation, relevance, reproducibility, sensitivity, and ease of understanding.
Service quality	The overall support delivered by the eHealth (system) service provider i.e., ‘help-desk’ support and support based on long-term feedback from users.
Usage	Actual use of the eHealth system measured by number of visits to a website (or clicks to an app), number of transactions, time spent online (within the actual eHealth application).
User satisfaction	User perceptions about eHealth system outputs and its overall user experience from the information retrieval to the service provision.
Net benefits	Positive and negative impacts (including risk), of the eHealth system to various stakeholders including users (i.e. patient outcomes), providers, healthcare organisations, markets, economies, and the society.

The interpretation of the D&M model’s categories within the eHealth research in reference to that used in e-commerce research.

The focus of this research is on the net benefits of the eHealth system for its users (consumers) and the system providers (producers). From the perspective of DeLone and McLean’s theory, if a successful business model (i.e., that model will create high quality products and services) can be deployed for the eHealth market, such a model would help encourage user uptake and create sufficient user satisfaction to facilitate positive net benefits for both eHealth producers and

consumers, which will in turn enable greater sustainability of the system. Our research further extends DeLone and McLean's model by integrating it with a business model for the successful deployment of eHealth products and services from its producers to end users in the Business-to-Consumer (B2C) relationship.

3 Research Design and Data Collection

3.1 Research Design

This research is primarily inductive, and as such, the research team conducted a set of case studies and facilitated workshops (Walsh et al., 2012) in two phases, in order to understand and explore the eHealth sector closely. The research design was based on multiple cases and multiple investigators in order to enable the use of replication logic and minimise potential bias (Yin, 2014). Replication logic in multiple-case study design is similar to the use of multiple experiments in science. Each new case is selected to either corroborate the existing findings or contrast them using other data (Yin, 2014). In this study, replication logic was used for the selection of UK cases (to predict similar results) and also international cases (to find contrasting cases) in order to understand the current state of the UK eHealth market and articulate international best practices in the sustainable eHealth market development as well.

The first phase involved desk research, while the second and third phases included interviews and observations of the UK and international case firms, respectively. The interviews with managers of the case firms, and observations of events and meetings within these case firms were conducted in order to better understand the eHealth market, the eHealth firms, and how these firms attempt to profit in their market. During the second and third phases, we conducted four carefully planned and facilitated workshops for 35 to 40 participants. During the workshops, we presented our early findings from the desk research, the interviews, and the observations to the invited eHealth stakeholders (i.e., from both the public and private sectors) for comments and a critique. The purpose of these workshops was to scrutinise, refine, and

validate the findings from the case studies on the barriers and challenges of eHealth commercialization in the UK as well as discuss potential solutions based on the best practices that were found in the international cases.

The case studies, the people interviewed, and the events observed were purposively sampled by the research team with advice from the industry partners in order to represent the range of eHealth services and practitioners currently in the market. Below we offer some details on the case studies and the workshops that we facilitated.

Table 2: Design of the Research

<p>Phase 1: Desk Research.</p> <p>Data was collected using desk research.</p> <ul style="list-style-type: none"> • Desk research was used to identify current trends in digital technologies and how these technologies are used in the delivery of eHealth. • Existing literature was reviewed for eHealth and its various commercialisation attempts. • Investigated factors and reasons (drawn from the literature) for why this market has proven to be difficult to develop. • At the end of Phase 1, the findings from this phase were presented for stakeholder comments and critiques. 		
Empirical Research	Case Studies (33)	Facilitated Workshops (4)
<p>Phase 2:</p> <p>20 UK case studies (n=20).</p>	<ul style="list-style-type: none"> • Data were collected from interviews, and observations. • 20 case studies came from companies (represented by their senior management teams (directors)) that are operating in e-Health market in the UK. They represented the full range of e-Health experienced practitioners in the health and social care sectors. • The key informants were interviewed. One to three top managers (based on their availabilities) from each organisation were interviewed. • There were 25 open-ended leading questions that revolved around the components of the business models as described (Osterwalder & Pigneur, 2010) and designed to capture the research aim and its objectives. • After each interview, the data from the case firms were further verified/extracted from relevant market databases, such as MarketLine Advantage. 	<p>Findings from Phase 2 were presented for stakeholder comments and critiques during the workshops.</p>

<p>Phase 3:</p> <p>13 International case studies (n=13).</p>	<ul style="list-style-type: none"> • Data were collected from the desk research, interviews, and observations. • 13 case studies were gathered with an extensive geographical coverage, including 4 cases from the United States, 2 from The Netherlands, 2 from Sweden, 2 from Spain, 1 from Germany, 1 from Denmark, and 1 from Nepal. • The key informants were interviewed. One to three top managers (based on their availabilities) from each organisation were interviewed. • The case studies were used to investigate the formation, strategies, and business models of the selected firms. • In addition, published reports on telehealth/telecare using empirical data from different countries were analysed. • Using both the local and international cases, lessons were drawn by comparing the differences and similarities between these international firms and the domestic UK firms that were also studied. • After each interview, additional data from the case firms were further verified and extracted from relevant market databases, such as MarketLine Advantage. 	<p>Findings from phase 3 were presented for stakeholders' comments and critiques during the workshop.</p>
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This table explains the research design step by step. During the four facilitated interleaved workshops, findings from the case studies were presented to all the stakeholders (including experts/practitioners/academics) in the healthcare industry for both peer and quality reviews. In the final phase, the overall findings were presented at the final workshop.

3.2 Case Studies on Different eHealth Companies

In total, we conducted two sets of case studies that is, 20 UK based eHealth companies and 13 international case studies. The case study companies perform different functions in the eHealth market. The key informants that were interviewed offered strategic views of the problems and difficulties that are being faced in various commercialisation attempts for eHealth innovations in the UK. The same procedure was replicated for the international eHealth case study companies. After we interviewed participants from the case study firms, we further verified and extracted relevant financial data from related databases, such as MarketLine Advantage and companycheck.co.uk. There were 25 open-ended leading questions that revolved around the components of the business models as described in Osterwalder and Pigneur (2010) and designed to capture the research goal and its objectives. This was consistent with our primary objective, which was to developing a conceptual framework that is well informed by empirical evidence (Amit UZott, 2001).

The thematic analysis process extended the business model methodology used in Oderanti and Li (2018). Each participant in the case study was asked the same 25 questions to ensure consistency in the data being gathered and the elicitation process, although further open-ended questions were asked at the end of each interview to encourage the informants to add any important points not already covered. We summarised the findings from the business models of

these companies and presented the sustainability trends from their financial data. Based on the suggested solutions from these approaches and drawing on the analogy of business sustainability from the literature, we developed strategic framework for more sustainable business models for the UK eHealth market. The models could also be applied in countries with similar healthcare sectors to the UK.

3.2.1 The UK Case Studies

We conducted a comprehensive case study of 20 UK-based companies involved in the development, commercialisation, and delivery of eHealth-related products and services.

Although we do discuss our empirical findings and analysis that emerged from the case studies, for ethical and confidentiality reasons, we are not able to reveal the identity of the firms nor their financial details and commercialisation strategies. These firms are operating within a similar and unique industry in which their value propositions are defined in terms of improving the health and social care of vulnerable and elderly people through employing technological innovations. However, they also provide a wide range of different products and services in the fields of tele-health and tele-care. Some of the firms were chiefly founded to develop and commercialise eHealth products, while others have focused on other markets, such as housing control systems (e.g., smoke alarm, temperature control systems) where eHealth is just an extension to their prior activities but not priority business models.

Further, some of the companies are focusing more on data driven technological platforms by developing remote systems for the management of patients with Long Term Conditions (LTC), such as motor actuators for opening and closing doors/windows, speech input devices, and gesture and movement detectors. Some others are involved mainly in the production of advanced tools that enable elderly people to find specific matches for needed equipment and products. The financials (i.e. the potential revenue streams) of almost all of the companies heavily rely on State funding where the relevant authorities, such as local government authorities or NHS, are those who pay for the services monthly, based on the number of users.

3.2.2 *International Case Studies*

We conducted 13 case studies that had extensive geographical coverage. They included 4 cases from the United States, 2 from The Netherlands, 2 from Sweden, 2 from Spain, 1 from Germany, 1 from Denmark and 1 from Nepal. In conducting these case studies, we focused on the formation, strategies, and business models of the selected firms. In addition, we conducted interviews with experts, practitioners, and academics in the healthcare industry in international markets and analysed published reports on telehealth and telecare based on empirical data gathered from different countries. These details let us understand the notion of eHealth in other countries and explore their strategies and business models for the commercialisation of such products and services, as well as the socio-technical aspects of these initiatives. We were also able to draw new lessons by comparing the differences and similarities between these international firms and the domestic UK firms that we also studied. This process was undertaken to either reinforce the findings from the UK cases or to contrast the UK findings with those from the international firms that have found ways for successful commercialization of eHealth innovations. The best practices from international firms were then used to guide the development of a framework for more successful and sustainable eHealth innovation (see Figure 4).

3.3 *Facilitated Workshops*

Four facilitated workshops were conducted in conjunction with the case studies to present the preliminary findings from the exploratory research to representatives of case firms and other stakeholders from the UK's eHealth sector. We designed each workshop for a different set of stakeholders in the eHealth market and their practitioners. The workshop facilitators offered creative discussions about their current situations and future possibilities in eHealth by inviting the participants to draw on their own experiences and share their responses to the materials gathered during the exploratory research. As a result, the participants were able to explore, experience, and respond to the barriers and challenges that are currently hindering eHealth commercialisation and thereby suggest possible solutions.

4 Research Results

This section starts with an overview of the results gathered from the desk research (Section 4.1) and is followed with a presentation of empirical findings from UK case organisations and the best practices gathered from the international cases in Sections 4.2 and 4.3, respectively.

4.1. The eHealth Market (Desk Research)

Over the past few decades, the interest in eHealth innovations has constantly grown, not only in terms of research, but also in its applications because of advances in fields like ICT. Many previous authors have investigated the use of advanced telecommunications and information technologies (Gagnon et al., 2012; Peek et al., 2014). However, according to Farzad Mostashari, the U.S. Government's coordinator for health information technology, the problem with ICT-enabled health technologies is not the technology—it is related to the business case because the business case often has not been strong enough to support viable adoption (Regalado, 2011). Evidence from the literature has shown that only a small proportion of the evaluations of eHealth interventions have addressed the question of business outcomes, and that the quality of those evaluations needs to be improved. Another issue to note is that many economic analyses evaluate only cost and do not examine any non-cost related outcomes (Davies & Newman, 2011). Even though, the potential for eHealth has been extensively discussed and there are many instances of evidence that eHealth may make better use of professionals' time, many hospitals and doctors simply do not see many positive business reasons to share information with competitors or even to avoid repeating tests. Further still, Steven Waldren, Director of the AAFP's Centre for Health IT remarked that healthcare professionals want these kinds of technologies and love them, but the problem has been that no one is willing to invest to build the network or pay for the transactions (Regalado, 2011).

Traditionally, technological systems have often been developed almost entirely from the commercial perspective, and therefore, they are often detached from a deep enough understanding or even an accurate consideration of the environment or users of that technology (Kushniruk & Nøhr, 2016). Concerns over high rates of abandonment of eHealth devices have also led to attempts to match individuals more closely to these devices, as they are being developed (Greenhalgh et al., 2017).

Integrating technologies into everyday life is a complex process and often involves hidden problems for users, especially when modifying the design and way in which the technologies are used. There are a range of important human, social and organisational factors that can either promote or inhibit the successful adoption or use of technologies in people's lives (Mosconi et al., 2019). Understanding and highlighting these factors is vital for proceeding with the design processes for eHealth, and can open up new avenues for sustainable market development. This process calls for the development of sustainable and scalable new business models to align the social objectives of caring for the elderly with robust enough business principles to ensure that both these products and their services are affordable and usable.

The sustainability of health and social care systems has been a matter of continuing concern as a result of the growth in the aging population and indeed, eHealth technologies have been proven to work and now considered to be a viable option for future healthcare delivery, thereby allowing healthcare and social care organisations to provide better care in a more economical and comprehensive manner (Zanaboni & Wootton, 2012).

4.1.1 Definition and Classification of the eHealth Market

A survey of previous studies (Oderanti and Li, 2016) revealed that digital technologies in support of home and health care (i.e., eHealth) go by a number of labels (e.g., assistive technology, assistive living, assisted living, and adaptive technology), which can be

classified under different health market segments including telehealth, telecare, and telemedicine. As a generalised term, eHealth products refer to devices and services that utilize computer-based systems to support delivery of care to the home and let users prolong independent living at home (Roth & Eckert, 2011; Catharina, 2011; Turner, 2010; Valkila & Saari, 2011). In the United States, such products commonly are referred to as “*products, devices or equipment, whether acquired commercially, modified or customized, that are used to maintain, increase or improve the functional capabilities of individuals with disabilities*”, according to the definition proposed in the United States Assistive Technology Act 1998 (Warnes & Hawley, 2011, p.1). While these definitions cover the *telecare* and *telehealth* segments, they seem not to include *telemedicine*, which is defined as the application of ICT-based systems to facilitate the exchange of information between healthcare professionals, such as diagnosis or referral. It also tends to focus on specific applications like teledermatology or teleradiology (Rogers et al., 2011). In the current study, we considered eHealth innovations as including all three market segments of telecare, telehealth, and telemedicine, and explain these three segments as follows.

Telehealth refers to products and services that can monitor people's health in their own homes, through the combination use of sensors, hubs, and remote servers to provide better and more cost-efficient management of chronic conditions, such as diabetes, chronic obstructive pulmonary disease (COPD), heart failure, and asthma (Lewin et al., 2010). Because of modern technology, patients can be monitored in their own homes for blood pressure, blood oxygen levels, cardiac arrhythmia, and medication reminders.

Telecare concerns those products and services that can monitor people's activity changes over time and call for help in emergency situations where there are movement/non-movement sensors, falling sensors, and fire/smoke alarms. They usually employ a combination of alarms, sensors, and other equipment to help older or disabled people live

independently.

Although telehealth within the UK is comparably less widespread than telecare, both services are greatly beneficial for those with long-term health conditions. Traditionally, telecare offerings have mainly been alarm-based devices, such as pendants and call alarm buttons, but today's smartphones allow companies to create relevant functions aimed at the mass market. Similarly, many telehealth devices require the user to actively interact with a device to transmit data; still, the technology still exists to have wireless mobile monitors that can be worn by a user and allow seamless transmission of vital signs (Goodwin & Clark, 2010, Oderanti & Li, 2018). Therefore, a key issue for the current context of telecare and telehealth is to develop software and devices that are interoperable, because the developers are now coming from a range of technological backgrounds, including mobile ICT, thereby making this industry even more complex and dispersed.

Telemedicine focuses on ICT-based applications to help facilitate the exchange of information between healthcare professionals, such as the digital diagnosis of X-rays by an off-site radiologist (Oderanti and Li, 2016). Other examples include applications that allow hospitals to transfer medical data (e.g., diagnostic and therapeutic advice) necessary for emergency assistance, and the mobile telemedicine system (MTS) that transmits the different parameters between moving ambulances and physicians during a cardiac emergency (Oderanti & Li, 2018).

4.1.2 Ongoing Barriers in the UK eHealth Market

Despite significant long-term market potential, many eHealth providers have yet to achieve sustainability and scalability in the conventional business sense. Below we highlight the key barriers that keep firms from developing and marketing eHealth innovations sustainably.

4.1.2.1 Inconsistent Understanding of the Phenomenon

Although the literature contains a large number of publications on eHealth, most appear in the form of reports and white papers on practice and policy, preliminary findings from research and pilot projects, and opinion pieces published in trade journals and newspapers. In contrast, the number of academic publications, particularly those in high impact, peer-reviewed journals have been very limited, especially in the business and management field. Many publications have lacked robust theoretical consistency and enough methodological rigour. The many overlapping terminologies and narratives for eHealth (i.e., see Section 4.1) also have lacked consistency when making/arguing business cases for policy and practice, often mixing reality with rhetoric, necessity with desirability, future aspiration with everyday practice.

4.1.2.2 An Immature Self Purchase Market

Despite numerous policy initiatives and pilot projects that have been funded by central and local governments, the current market for eHealth technologies and services remains small and highly fragmented. Actual market growth has also been significantly slower than previously projected. It is dominated by a large number of small to medium sized technology and service providers, many new start-ups with immature products and business models. According to Barlow et al. (2012) the potential market in the UK is roughly 1.4 million people and likely to grow to 3.2 million by 2050. The actual number of users of telehealth and telecare, however, is estimated to be fewer than 350,000. This statistic raises fundamental issues of market sustainability and whether today's specialist market for the elderly is sufficiently large enough to sustain this eHealth technologies and services industry.

4.1.2.3 Limited Market Routes for eHealth Innovations in the UK

Based on these analyses of previous research that specifically focused on telecare and telehealth, we summarised the current available routes to use to obtain eHealth technologies and services in the UK as shown in Figure1. Around 75% of social care is provided by friends and family (informal caregivers), while the remainder is provided by a wide range of formal care providers

funded largely by local authority social services departments. The literature has consistently raised concern about the declining levels of informal care noting a number of reasons, including a higher proportion of older people in the population, reduced size of families, a higher number of women in employment, and ongoing changes in the care preferences of older people.

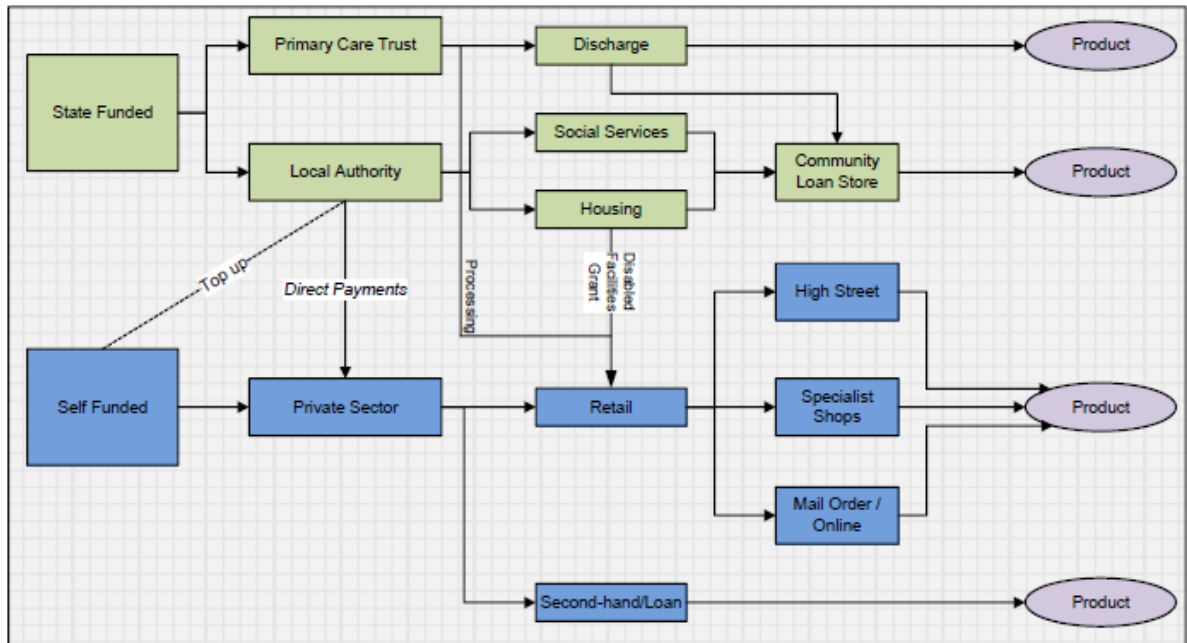


Figure 1: Main Routes for the eHealth Market in the UK (Adapted from Oderanti & Li, 2016).

4.2 Empirical Evidence from UK Case Studies and Facilitated Workshops

4.2.1 Current eHealth Firms in the UK Market

Our case study investigation shows that there are at least three groups of business players in the eHealth market: (a) the traditional eHealth technology and service providers who are often highly profitable with their non-digital products and services, but adopting a wait and see attitude toward digitally enabled (i.e., eHealth) new products and services; (b) large multinationals from other sectors (e.g., IT or consumer electronics) who show strategic interests in eHealth, but their revenues from these technologies and services are often not reported separately; (c) and the largest group, the specialist SMEs – many of these new business start-ups – that provide new eHealth services. We found that effective innovations do exist, but most

providers are still small in scale, often run by local champions and funded or partially funded by the State.

Throughout our case study investigation, we were unable to identify eHealth businesses that have achieved financial sustainability on a large scale in the UK in the conventional business sense. Most businesses we studied are generating sufficient income, but often not from their mainstream business, eHealth products, and services. Many rely on side activities, such as research and development (R&D) income from different funding bodies, government grants, cash injections from owners or investors, or income from traditional products and services. In other words, they are sustainable in a sense, but not on any large, commercially viable scales.

4.2.2 Challenges for eHealth Firms

Our empirical evidence shows that there are many new technologies and applications, but most have only reached a small number of end users or consumers often paid for or heavily subsidised by the state. Further still, there are often intricate mismatches between the supply and demand. For example, local authorities are often interested in cheap technologies and services to replace traditional care services to reduce costs, while many technology and service providers are marketing sophisticated technologies and services that are often too expensive for local authorities and not contributing enough to efficiency and cost reduction. .

Although many eHealth technologies and services are designed to enable elderly people to live independently in their own homes for longer periods and reduce the number of hospital visits, hospitals earn their revenue from people who are admitted, so it is not in the interest of hospitals to support the other services under the current tariff system. The result is that everyone talks about their preventative agenda and building up long- term benefits, but these plans often fail to translate into real activities in pilot projects or large-scale initiatives. When new eHealth technologies and services are introduced, they are often run as additional services alongside already existing provisions, and the extra costs are not supported by the current National

Health Service (NHS) tariff system, which is based on the average cost of a group of procedures. These short-term costs often limit the scaling up of pilot projects even when they are deemed to be able to improve the effectiveness and quality of care over time.

Based on our empirical investigation and thematic analysis, the challenges and barriers of eHealth innovations commercialization are summarised in Table 3. The statements in the table were those extracted from the respondents of case companies and the facilitated workshops. The table illustrates how these challenges and barriers cut across different stakeholders in the sector. It confirms the conceptual framework in Figure 4, namely, that commercialisation of eHealth is hindered by various external (micro and macro environments) as well as the internal factors of these firms. It shows that majority of the issues are firm and sector or Government related. The sector or government related issues are mostly inseparable because the sector is being regulated by Government and the NHS (which is also wholly financed by the Government).

Table 3: eHealth commercialisation problems discovered via empirical investigations as related to and cutting across different stakeholders in the eHealth market

<u>The Government or Health Sector</u>	<u>eHealth Firms</u>	<u>Elderly Users</u>
<p align="center">Small Scale Enterprises and Infrastructure Availability:</p> <p><i>Most provider lacked the resources and large scale infrastructure required to provide higher value, longer term, contract-based, supported services, which limited their business model options to providing stand-alone, single, or limited function equipment that can be difficult to install, maintain and use</i></p>		<p>Technophobes: <i>Most elderly people are digital aliens and generally slow to change and adapt. They are the late adopters and laggards of the Web2.0 technologies.</i></p>
<p align="center">Poor Integration of Policy, Practice and regulations:</p> <p><i>High cost of maintaining regulations and standards and numerous accreditation standards and agencies requirements, which delay the time or duration of securing accreditation and time to take innovation to market.</i></p>	<p>Cost effectiveness: <i>While eHealth's clinical effectiveness and educational benefits are generally accepted, the cost-effectiveness remains controversial.</i></p>	
<p align="center">Market Control and Interference:</p> <p><i>For example, users are not given enough flexibility on how to use their personal budget. From the users' perspective, a personal budget is not really personal because the Local Councils (LC) determine, regulate, and control what that budget can be used for.</i></p>	<p>Security Issues: <i>Electronic exchange of data between physicians, hospitals, and patients makes privacy and security two concerns of eHealth users.</i></p>	
<p align="center">Multiple Stakeholders and Complex Relationships:</p> <p><i>There is a diverse range of stakeholders and a complex relationship between them. In the UK, the assisted living technologies and services market (eHealth) are currently dominated by the State for health and social care; further, the insurance-funded market and the self-purchase market are fragmented and small.</i></p>		<p align="center">Elderly With Disabilities</p> <p><i>Some elderly people have key disability issues (e.g. stroke, dementia, etc.) which limit their choice of technologies.</i></p>
<p align="center">Fragmentation of the Health and Social Care Sectors:</p> <p><i>There is e fragmentation between Health and Social Care sectors due to different pulses and budgets. Also, there is silo-based behaviour in terms of procurement and management, in particular lack of integration and joint-up thinking across both health care and delivery of social care.</i></p>		
<p align="center">Business Model of the UK National Health Services (NHS):</p> <p><i>As a result of the free healthcare currently enjoyed by the elderly, it is becoming increasingly difficult for more capitalist eHealth businesses to thrive in the UK market. Our investigation, using focus groups, shows that most elderly people do not see any reasons for spending their pensions on eHealth equipment when they can easily go to the NHS as many times as they want and obtain the equivalent services free of charge.</i></p>		
<p align="center">Constant Reorganisation Within the NHS and Lower Staff Morale:</p> <p><i>In a climate where reorganisations regularly are taking place in the NHS, it can be difficult for staff to feel in control and understand the impact of ongoing changes on them personally. With so much effort placed on the re-organisation of the NHS in recent years, the appetite to adopt new technology and change the way they work has diminished considerably.</i></p>		
<p align="center">Risk Ownership</p> <p><i>These risks include uncertainty about ownership, responsibilities and direction of a business. With this data also being accessible to clinicians via telemonitoring, there is a fear that failing to notice trends or events or seeing them quickly enough can make the clinician liable should the patient's condition deteriorate.</i></p>		

Inadequate Planning, Integration or Lack of Coordination:

Most eHealth projects were driven by enthusiastic individual, but failed because of inadequate planning and coordination. Commercialisation of eHealth also failed because inventors did not carry along the business expert to cross the diffusion chasm from invention to market penetration.

Poor user- centered

design: *New systems are rarely negotiated with service users, and there is a general lack of focus on end user usability*

Small Market Size and Small Scalability:

Implementation of a video teleconsult service requires multidisciplinary cooperation and integration One of the main challenges is small market size. The size of the self-purchase market for eHealth – those markets privately arranged and paid for by individuals or their relatives – is small. Few eHealth providers have managed to come up with products or services that successfully reach a significant number of such consumers through self-purchase.

Technological Problems and Interoperability Issues:

The lack of product maturity and a common standard and the low levels of interoperability between the different technologies and services have discouraged investment and prevented people with the resources to purchase products and services for themselves or their older relatives.

Market Competitions:

Stiffer competition immensely affects the sustainability of eHealth businesses and to overcome these issues, companies are forced to provide competitive bids and invest in products that have better features than those of others and at a greatly cheaper price. Most of these competitors are Local Councils, who offer these eHealth products free of charge or at very cheap prices.

Specific challenges and barriers that are affecting the commercialisation of eHealth innovations in the UK healthcare sector. This table illustrates how these challenges or barriers cut across different stakeholders in that sector. It confirms the conceptual framework noted in Figure 4 and that the commercialisation of eHealth is hindered by various external (micro and macro environments) as well as the internal factors of these firms. It shows that the majority of the issues are firm and sector/Government related. The sector or government- related issues are mostly inseparable because of the fact that sector is regulated by Government and the NHS (which is also wholly financed by the Government).

4.2.3 *Market Development of eHealth Innovations*

The analysis of the case studies reveals that the market development of eHealth is suffering from a lack of effective commercialisation strategies. It can thus be argued that while within this industry technological innovations certainly exist; they are generally run by local champions and are mostly State funded. Currently, almost no eHealth-related applications have been successful in achieving enterprise-wide and large-scale adoption. To justify this process further, findings from the Whole System Demonstrator (WSD) stated that there are at least 3 million people with Long Term Conditions and/or social care needs that would benefit from telehealth and telecare (DPH 2011). Using this figure as the potential target for the companies we studied and the empirical data gathered from the case studies, we can determine the current segments of the population that each of the companies has already covered to show the level of adoption of eHealth-related products and services.

All of the case studies indicated a low adoption level for their eHealth innovations. Based on three samples of case data, *Case Study 1* had 3,000 users (out of the at least, three million people suggested in the WSD programme) with an adoption level at 0.1%; *Case Study 2* with 140,000 (out of 3 million stated in WSD) with an adoption level of 4.67%; and *Case Study 3* with 40 (out of 1,128 population in their local region) and an adoption level of 3.55%. The results and trends from these cases follow the bell curve of individual innovativeness (technology adoption life cycle) seen in a population as demonstrated in Rogers' (1962) diffusion of innovation (DOI). The percentages of adopters (and potential adopters) confirmed each of the segments in the bell curve in accordance with Rogers' (1962) diffusion of innovation (DOI) theory (Oderanti & Li, 2018; Janssen & Moors, 2013). It was discovered that most of the companies we studied are still operating within the first two segments of the population (that is, innovators and early adopter segments of Rogers' (1962) DOI). Based on the expert review undertaken during the facilitated workshops phase of this study, findings from these sampled case study companies were discovered to represent the general nature of the eHealth market in the UK.

It was also discovered that there remains a major chasm before the companies can reach the mainstream market. Since innovators and early adopters represent a very small percentage of the population (Hall, 2005), business sustainability and operational scalability cannot be achieved by simply selling to them alone. Therefore, for these eHealth businesses to be sustainable, they need to move across the eHealth Chasm in order to move into the mainstream markets. For the eHealth case study businesses to cross that chasm, they first need to get to it by covering the early adopter segment because early adopters are the pillars that are needed to cross that chasm (Moore, 1991). Previous research (Oderanti & Li, 2018, Oderanti & Li, 2016) have confirmed that the success of a business in each segment heavily depends on a good understanding of the characteristics and needs of different user segments of the DOI's technology adoption life cycle.

Evidence from the revenue streams for the case study companies (as key measures of their financial sustainability) also showed the downward trends/slopes of their incomes as shown in **Figure 2**. This visual shows the financial net worth of only six companies (of the 20) that already have available up to three-year financial records. The others have less than three years of market operation.

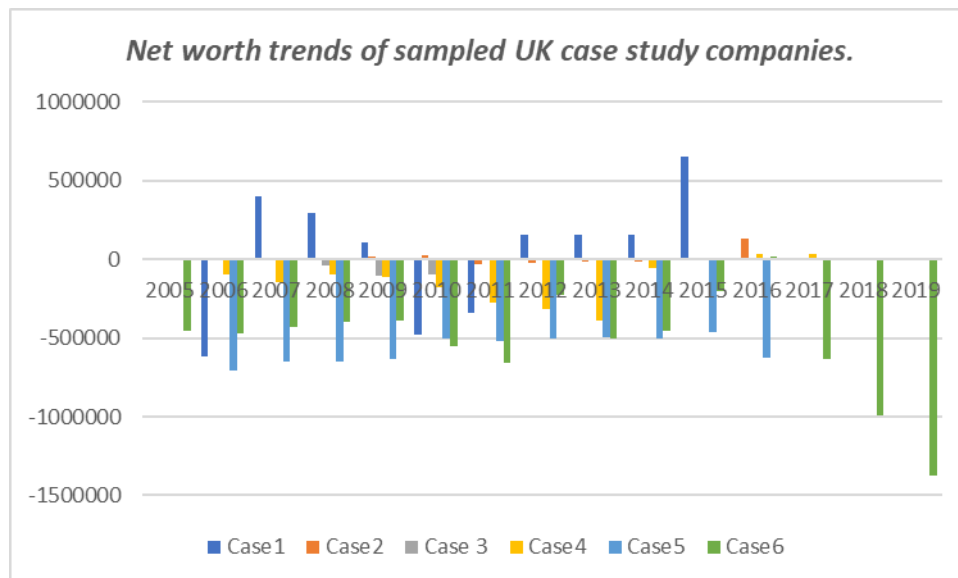


Figure 2: Net worth trends of sampled UK case study companies. The figure shows that all companies have negative financial net worth trends which illustrate the unprofitability and unsustainability trends of their firms' business models. Further analysis of the companies' annual accounts showed that none of the companies recorded any profits since they were founded, and many have closed down after only a few years of operation (e.g., Case 3 in this visual).

4.3 Complementary Evidence from the International Best Practices of eHealth Case Studies

This section presents the key lessons learned from the international case studies on eHealth companies. In particular, we highlight the key findings that either contradict or complement the results from our UK case studies and workshops (i.e., See Section 4.2).

4.3.1 The International eHealth Market

Our assessments concluded that the current market for eHealth products and services in some foreign countries is less fragmented than in the UK market. Of these international firms, there appeared to be less confusion about the understanding of the eHealth - related product domains, i.e. tele-health, tele-medicine, tele-care, etc. From the business model perspective, two key success factors were widely acknowledged, namely, effective collaboration (including acquisition) and product diversification. The firms (including multinationals) have recognized many innovative products or services are developed within small firms, but these firms often do not have the infrastructure to deliver these products and services on a large scale; hence, collaboration becomes an indispensable element for growth and sustainability. The eHealth ecosystem has indeed been carefully defined (especially in Scandinavian countries), wherein key

stakeholders, including providers, voluntary organisers, insurers, social enterprises, financiers, customers and users and their requirements have been identified. The companies also have recognised that the different niches of the eHealth market are often not sufficiently large enough to achieve sustainability via a single product; therefore, many have invested heavily in diversifying their product lines. We summarise our analysis in four categories, namely, those linked to the regulatory and policy environment, the business models, technology, and actual user adoption and cultural issues as discussed below.

4.3.2 The Regulatory and Policy Environment

In contrast with the UK market where the eHealth market is dominated by the State and supplemented by third sector organisations and a large number of small businesses and new start-ups, some international markets are often dominated by medium- to- large-size companies who specialise in eHealth, including a few multinational corporations with annual sales of over a billion dollars (US\$). The revenue streams of these selected cases illustrate that most are financially sustainable and have either initiated or planned to scale up their operations through penetrating other markets with the objective of setting up a worldwide distribution network.

Similar to the UK cases, several of our other international case studies are spinouts from academic institutes (i.e. university spinouts), and their formation and initial growth was based on public research funds. However, some have been more successful in sustaining their operations beyond their initial funding period. In some cases, not only has their return on investments (ROIs) been met within a specific timeframe, but also those companies have successfully attracted new investors beyond the public- funding period. For instance, the founders of a Danish firm specialised in monitoring the rehabilitation of patients discharged from hospitals, started their career with one of the leading universities in Denmark where they secured major public grants to conduct research in tele-monitoring rehabilitation. The successful outcomes of their initial experiment projects resulted in several rounds of private investments, which made the company one of the largest telecare/telehealth firms in the country. Those

cases are more international-oriented (especially those companies based in the US) than the UK eHealth firms. Their success and growth in international markets is largely based on the acquisition of small specialised firms to obtain new technology, and distribution opportunities via local partners and access their domestic channels in foreign markets.

4.3.3 *Business Models Structure*

In the UK and also internationally, there are fundamental concerns regarding market sustainability and whether the specialist market for the elderly is sufficiently large to sustain the eHealth technologies and services industry. Although every country follows a different model in its delivery of eHealth services, we identified three major categories of business models for the delivery of telehealth services across the world. These include a state reimbursement & purchasing system, insurance-fund reimbursement, and a self-purchased market. The first business model involves incorporation into the traditional healthcare system structure where the State-owned health authorities use the existing structures to reimburse the health providers. This model is dominated by the UK government in which the Health Trusts pay the providers for the products and services rendered to the patients in their homes. Some Scandinavian countries like Sweden employ this model to deliver their eHealth-related products. There are two major payment methods for providing remote patient monitoring services as suppliers in this business model- one time-investment by the provider or a license fee per patient. The second type of business model is insurance fund reimbursement where the users pay for the products/services through the insurance companies.

4.3.4 *User Adoption / Cultural Issues*

Sensitivity to family values and cultural differences strongly influences the adoption of eHealth innovations and/or assistive living technologies and services (ALTS). The ways in which immediate families pay attention to and care for their elderly parents and grandparents are significantly different in different parts of the world. For instance, families from Western European countries (such as those from Italy and The Netherlands) do not have any cultural barriers against sending their elderly parents to care homes, while families from the Middle

East (like those from Iran or UAE) tend to look after the older members of their immediate families at home instead of considering the care home option. In Far Eastern countries like China and South Korea, unless the families can afford the cost of luxurious, high-quality care homes, they will look after their older parents and relatives at home themselves. These are significant cultural differences that also influence the adoption of telehealth/telecare products and services. Therefore, we should not expect that successful adoption of eHealth in one country will have similar results in other countries.

4.3.5 Summary of the Findings from the International eHealth Market.

To summarise, as was expected, there are significant differences between the eHealth markets in the UK and internationally. Based on 13 international case studies and interviews with experts from health and social caregivers, we identified these differences and categorised our findings/analyses into four major categories. First, we explored and presented the similarities and differences for the UK and international markets in terms of their regulatory and policy environments. We found that the notion of eHealth in international markets is less fragmented; and many international firms, compared to the one in the UK, are financially more sustainable. This can be attributed to the fact that the international firms we studied have not relied as heavily on the state-funded market. Moreover, many are also positively embracing industrial partnerships, as they have learned that they should be part of the entire eHealth eco-system in order to be successful.

We have presented three categories of business models for the delivery of telehealth and telecare services across the world, namely, the State reimbursement/purchasing model, insurance-fund reimbursement, and the self-purchased market. While we argue that the self-purchased market is relatively small in the international markets, several European governments have encouraged insurance companies to subsidise parts of the expenses for tele-health services.

Size has forced international companies to diversify their products and services to cover

more potential customers and ongoing consumers. However, this focus has led to a complex maintenance of the heterogeneous platforms. Subsequently, it was discussed that due to family values and cultural differences, we should not expect that successful adoption of eHealth in one country would have similar results in other countries.

Figure 3 illustrates the sampled financial trends of these three, as representatives of the successful international eHealth companies that we investigated. These include Philips Healthcare, Siemens Healthcare and GE Healthcare. The sustainability of these companies is in sharp contrast to those of the UK companies as shown in **Figure 2** above.

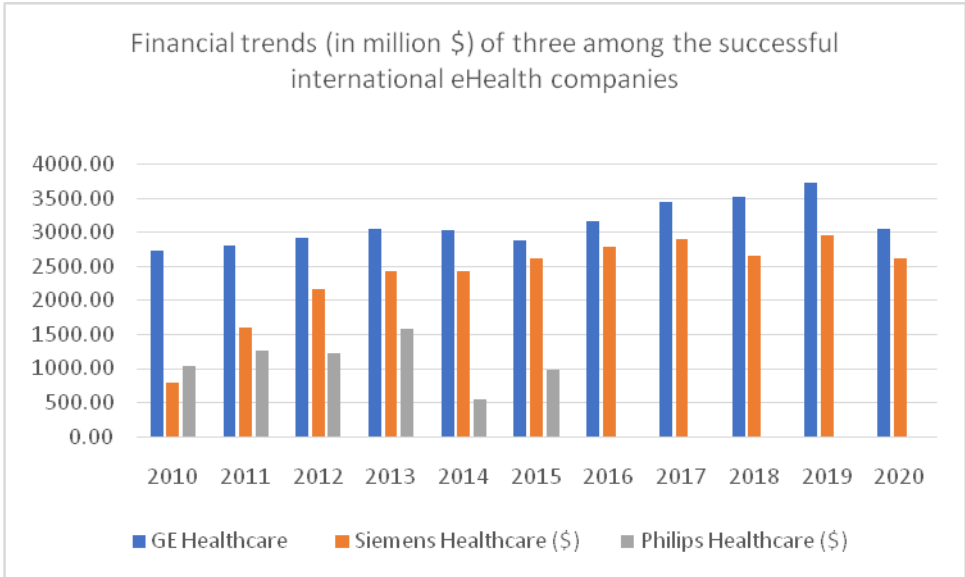


Figure 3: Finance sustainability trends of some international companies (in million \$). Philips Healthcare data stopped at 2015 because its Healthcare segment was subsequently broken into several sub-segments businesses that include Personal Health businesses, Diagnosis & Treatment, Connected Care & Health Informatics, HealthTech Other, Lighting, and Legacy Items. Therefore, it was impossible to reconcile the separate data reporting with previous years. Currency conversions of Philips and Siemens data were calculated at \$1.2 to €1.

5 Discussion and Recommendations

Our findings show that despite its huge potential, the eHealth market is surprisingly small and still highly fragmented, and actual market growth has been significantly slower than previously projected. Large scale deployment of this market remains rare either in the UK or internationally. Furthermore, the lack of conceptual clarity and consistency in eHealth nomenclature, although largely unproblematic in everyday conversations, continues to cause

significant problems whenever setting boundaries, measuring sizes and impact, and developing and implementing clear business strategies and policies. It leads to inconsistent measures of user uptake, market potentials. Furthermore, it is very difficult for businesses to describe their coherent value propositions, customers, and market segments, as well as their pricing and revenue strategies.

Looking after the older population adequately is a highly desirable social and political objective, and indeed, a basic condition and duty of a civilised society, but financial sustainability and affordability of any interventions still cannot be overlooked. In other words, the objectives are social and positive, but the means to achieve them are economical. This need calls for the development of not only new business models, but also new types of organisations that can adequately address the challenges.

Different from many other related services, the quality of health and social care often depends not only on professionalism, but also on genuine compassion and care on a personal level. You can buy love and care, but it would cost one a lot of money. Thus, other incentives and rewards are often required. Paying caregivers low wages while expecting genuine compassion and consistent high-quality services is a tall order. For these older people themselves and their relatives, the focus on cost and profit could make customers highly sensitive to price. Thus, there is a call for the development of not only new business models, but also new forms of organisations (such as social businesses) where success is measured not only in financial terms, but also in terms of the contributions being made to human dignity and to civilization overall.

5.1 A Proposed Framework for eHealth Business Models

Financial sustainability is very crucial to any business and most importantly to small and medium-sized enterprises (SMEs) because the level profitability impacts whether a company can attract investors to fund its operations and grow its business and is an important deciding factor on whether a firm will be able to secure financing from a bank (Anane et al., 2013). SMEs

cannot remain in business for a long time without turning a profit. Furthermore, many previous studies have argued about the need for managers to develop a better understanding of sustainability and the appropriate strategies needed to improve business sustainability (Fisher & Bonn, 2011).

Based on the findings derived from our empirical data, the model in Figure 4 shows the pictorial relationship between the building blocks (discussed in Section 2) of a sustainable business model for eHealth market. This model revolves around the work of the D&M IS Success theory (DeLone & McLean, 1992; DeLone & McLean, 2003) by looking at the success of the IS systems and innovations from the perspectives of both the end users and the producers. Our research examines the successful deployment of these IS products and services from producers to end users and the net benefits accrued to both parties in terms of the sustainability of the business as a successful entity. As shown in the figure here, the output of eHealth products and services from the “*business model component phase*” which serves as input to the user “*uptake phase*” is expected to satisfy the required qualities (system, information and service) for a D&M IS Success model (Dabbous & Tarhini, 2019). Enhancements of these qualities as they relate to eHealth businesses are further elaborated in Table 1. These qualities jointly affect “use” and “user satisfaction” of the eHealth products and services. Additionally, the level of “user satisfaction” determines whether or not the net benefits of the IS system will be positive or negative (DeLone & McLean, 1992) and thereby determine the sustainability of the business.

Both “use” and “user satisfaction” are closely interrelated and positive experience with “use” will lead to greater “user satisfaction” in a *causal* sense. Moreover, increased “user satisfaction” will lead to increased “*user uptake*” which is a principal requirement for market success for eHealth, its products and its sustainability.

As a result of increased “*user uptake*”, certain “net benefits” will eventually occur. If the IS or

service is to continue, it is assumed that the “net benefits” from the perspective of the end user are positive, thereby influencing and reinforcing subsequent “use” and “user satisfaction” and revenue streams to the eHealth producers. However, if the “net benefits” are negative, then this outcome is likely to lead to decreased use and even possible discontinuance of the system and thus, an unsuccessful and even unsustainable business.

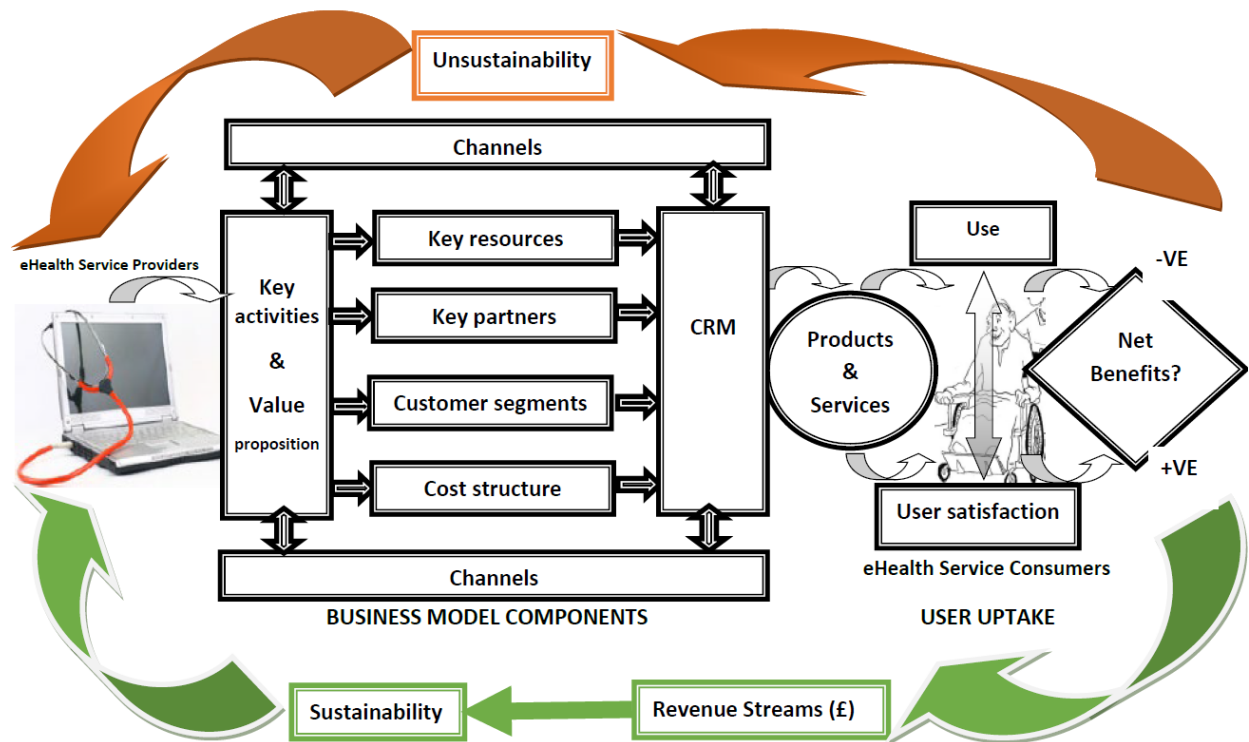


Figure 4: A canvas showing the building blocks of the proposed sustainable business model in eHealth market from the perspective of DeLone & McLean Information Systems Success Model Theory. The figure shows that for an eHealth system to be sustainable, the business model of the organisation must be such to deliver value propositions that satisfy or exceed users’ need via appropriate channels to ensure acceptability of the end products or services which serves as input to the *user uptake phase*. This will help to ensure its usage (user uptake). When this yields sufficient satisfaction to the user, it leads to positive net benefits which in turn facilitate further usage of the eHealth products or services. When this forms a continuous loop (as shown on the lower part of the model) such that sufficient revenues streams are generated from continuous usage of the eHealth products or services, then the IS System could be said to be successful and thus, leads to sustainability of the systems.

5.2 Summary of Insights, Recommendations, and Implications for Practice

The overall summary of our key findings and discussion from various empirical approaches are highlighted below and offer useful insights with key implications for business practitioners and perhaps even policymakers in the healthcare sector:

5.2.1 The Barriers, Failure, and Challenges

Based on this study’s empirical findings, the following points summarize the identified barriers, failures, and ongoing challenges for the eHealth market:

- The self-purchase market is particularly underdeveloped. Few eHealth providers have managed to reach a significant number of consumers through self-purchase. The lack of product maturity and common standard and the low levels of interoperability discouraged investment and prevented people from purchasing these products and services.
- Despite strategic interest from some eHealth providers and large multinationals from other sectors, the eHealth market is primarily served by a large number of SMEs, many of them new start-ups with immature products and new business models. Many rely on side activities to sustain their activities, such as R&D income from different funding bodies, government grants and subsidies, cash injection from owners or investors, or income from traditional eHealth products and services.
- The size of the eHealth market is difficult to estimate, partially due to the high level of informal care that cannot be easily measured. The large number of research and pilot projects has so far failed to generate concrete, consistent evidence regarding the benefits from large scale deployment of eHealth; indeed, the fragmentation of health and social care and the limited development of the self-purchase market will continue to hamper the development of sustainable and scalable business models in this particular domain.
- Looking after the older/elderly population adequately is a highly desirable social - and policy - objective, and indeed, a basic condition of maintaining a civilised society, but financial sustainability and the affordability of any of these interventions cannot be overlooked. In other words, the objectives are social, but the means to achieve them are economic. There is a call for the development of not only new business models, but also new forms of organisations that can adequately address these dual challenges.
- The eHealth market is highly heterogeneous, which entails significant costs and risks when developing and supporting new products and services for different market niches. Most providers lacked the resources, capabilities and large-scale infrastructure required to provide higher value, longer term, contract-based, supported services. Those

circumstances limited their business model options to providing stand-alone, single, or limited function equipment that can be difficult to install, maintain, and use.

- The heterogeneous nature of the eHealth market also means that individual market niches are small. Many eHealth providers have found that conventional retail or wholesale models are insufficient to generate the level of returns required to sustain and scale up their operations. New business model innovations are required (such as servitization) in order to achieve both sustainability and scalability.
- The UK has often been regarded as a world leader in eHealth innovations although concrete evidence to support such an assertion remains patchy and that lead is being eroded rapidly in recent years. Some innovative eHealth firms from other countries are actively exploring different routes to the UK market, and this competition is intensifying rapidly.
- The mixed economy in eHealth products and services remains problematic. A mixed economy relies on mixing actually being possible. The current point of mixing is very much at the individual level and that immediate network/career level.
- Commercial and retail organisations providing products and services into this fragmented marketplace have struggled to move away from providing closed platforms/integrated solutions to specific conditions and/or assistive living problems. This fragmentation stifles innovation, limits inter-operability, and fails to achieve the full potential benefits of network externalities. It also leads to limited joining up between the commercial and public sectors to personalise the client/patient/customer experience.
- Problems in the insurance market mean there are problems identifying exactly who should pay for social care. Failure in the insurance market requires government intervention. This intervention means that individuals do not insure (privately) to protect against old age and leads to individuals not engaging in the market.
- The presence of a very large health sector may crowd out possibilities in social care. The problem of crowding out is potentially the largest issue facing the eHealth market.

Whether because of the size of the health sector, the potential problems of supplier induced demand, or because of user expectations, it remains difficult for these eHealth markets to grow.

- Perspectives on eHealth depended in large part on factors external to the individual, for example, awareness, cost, method of provision (i.e. private or public) and also the type of assessment and consultation provided by ‘experts’. The concepts of ‘independence’ and ‘stigma’ were shown also to be important personal influences that affected how older people view eHealth innovations and other assistive technologies.
- Occasionally some eHealth-related products are not effective or efficient; they can shift extra work onto older people and their caregivers; they can work to dehumanize an older person by causing stigma and changing the care relationship. However, older people can subvert the intended function of these products and resist these dehumanization effects by using the devices selectively, or not at all.
- In the UK, the eHealth market is dominated by the State (health and social care). As a comparison, the insurance funded market and the self-purchase market remain very small.

5.2.2 Suggested Solutions to the Identified Barriers, Failure and Challenges

Based on the identified barriers, failures, and challenges noted above, the following are the summary of possible solutions determined based on our empirical findings:

- Due to the rapidly ageing population, the increasing demand for social and health care cannot be fully met by the State alone. The insurance- funded market and the self-purchase market will need to grow significantly and provide new opportunities for eHealth providers. However, there are significant cultural barriers still to overcome which may call for policy interventions and more public debate.
- The culture of universal free health care in the UK negatively influences sustainable eHealth market development when elderly people and/or their relatives may have to pay for the products and services. However, our empirical observations revealed

that these challenges can be overcome if new products and services can effectively address user needs and improve the quality of their lives.

- A sustainable business model can be achieved through servitization, a strategic reorientation that allows firms to broaden their position in the value chain by generating revenues from services as well as products. Our empirical analysis suggests that users often prefer to be charged for services rather than for the product or equipment itself. In telecare and telehealth initiatives, revenues can be generated from analysis of the data gathered from the use of the products (e.g. data gathered through tele-rehabilitation processes), or the license fees for the software they use, as well as directly from the selling of products and services.
- Personalisation of products and services, particularly through user-centred design, can increase user uptake and ensure business sustainability. For example, devices that are easy to use and that users are familiar with for any data analysis will make those products more user friendly. These devices may include general purpose devices, such as mobile phones and televisions. Any value propositions need to articulate clearly the values and benefits that their products have to offer.
- To be more sustainable, manufacturers of eHealth products may need to design products that are extendable to other user groups rather than only products that are exclusively designed for older people. This choice will help reduce the barrier posed by the small market size of eHealth products and increase user uptakes and thus also increase business sustainability.
- Recommendations by trusted professionals, such as Medical General Practitioners (GPs), can significantly increase user acceptability of eHealth products and services. For example, a physician may advise a user that rather than coming to the hospital once each week, the user's conditions can be remotely monitored and hospital visits can be reduced to just once a month.
- Different stakeholders need to work more effectively together to determine where cost

savings are realised and who should pay for what services. The focus should be on achieving savings at the whole system level, not simply reducing costs, for example, of social care at the expense of increased health care cost.

- eHealth requires close collaboration between different industries, ranging from health and social care, computing and telecommunications to manufacturing, home electronics, transportation, and even construction. What still needs to be developed is not only a common standard for interoperability, but also a cross-industry eco-system. This goal raises significant new challenges that go beyond current mainstream management practices.
- eHealth entrepreneurs should avoid designing technologies that add only simplistic reward systems for volunteering based on how much time is spent with people or the 'depth' of the activity and duties being performed. The primary value of voluntary care was seen to be in its personalised qualities, where caregivers respond to the fluctuating needs of the person they are visiting. Instead, they should look at forms of rewards that support the exchange of appreciation and 'gifts' between those who receive care and those that give it, rewarding those who are more responsive to the individuals they visit.
- The rising popularity and lower barriers to access to consumer mobile and wearable technologies offers new opportunities for eHealth companies to be able to create resources, tools, and applications for individuals to be able to track and monitor their own health.
- eHealth can play an important role in the management of long-term conditions (or chronic diseases) by delivering effective health and social care services that enable more independent living for older people. However, this goal can only be achieved by deploying sustainable and scalable business models and generating healthy financial returns for the providers. Even though the ultimate objectives are social, ethical, and political, the means to achieve them are indeed financial and economic.
- This research also identified significant cultural differences between different regions

and countries that will significantly affect eHealth uptake and use. What works in one country may not translate into success in another. Different business models may also be required when entering different international markets.

- The future of the eHealth market depends on providing tools and platforms for the public to be able to create their own knowledge resources that can then be shared with and by their peers. We thus highlighted a range of barriers to trusting online content surrounding eHealth use, many of which come down to issues that are related to the provenance of information and the need to get ‘hands on experience’ of aids and equipment.

6 Conclusions and Final Thoughts

The vision and indeed the goal of the UK government have been to liberate the NHS by putting power into the hands of patients and clinicians, thereby reducing the layers of management. One way this goal may be achieved is by general practice forming GP consortia. It is hoped that this shift in power will bring decision-making closer to the patients. More radical reform in current health and social service provision is urgently needed, by developing innovative solutions that are viable, scalable, and sustainable so as to improve both their efficiency and their effectiveness. The enormous complexity and the practical difficulties involved necessitates a co-construction approach and creating a context in which different stakeholders can explore, discuss, and make sense of the complex relationships and conflicting demands, and then negotiate and co-develop a consensus and plausible and workable solutions. This process/outcome will facilitate significant reforms within the current health and social care provision of services to improve efficiency and effectiveness and reduce costs. Such an approach can also be extended further to address sensitive issues of private-public mix wherein public services work with private businesses in health and social care services. In particular, it enables the effective exploration of community initiatives and ethical businesses that are indeed likely to play a key role in future health and social care.

The growing demand for health and social care due to a rapidly aging population also calls for new market development of eHealth products and services. Market development in eHealth has been both slow and fragmented. In fact, even many pilot projects that have been deemed successful often fail to scale up or become financially sustainable once the initial funding has run out. Important lessons can also be learned from other sectors that have successfully deployed new business models and promoted sustainable new market development. This study has identified new business models that support sustainable and scalable new market development in eHealth for greater independent healthy living by older people in communities and improve the well-being and welfare of older people, their relatives and their caregivers.

To develop scalable business solutions for successful personalised services, entrepreneurs need to understand the preferences and use of eHealth by both current and future users and also the contexts in which they are used and integrated into people's lives and everyday routines. This focus will ensure there are informed design processes for eHealth. In particular, questions need to be asked and answered concerning how 'need' is conceptualised in the successful provision of eHealth and how this provision impacts the acceptability, use, and user satisfaction of eHealth in the home context, as well as the role of 'choice' when developing economic and business solutions that connect with users and their perspectives to best satisfy their needs and provide net benefits to users as well as the eHealth providers in terms of sustainable revenue generation. Future research should employ economic modelling activities to estimate the costs of introducing eHealth innovations, as well as the financial and other benefits to the eHealth firms and the broader society and inform on the requirements for and the evaluation of eHealth for users, researchers, policy makers, service providers and industries. This area is still a rapidly evolving one with enormous uncertainties; therefore, a lot still remains to be done. Our ageing society poses a serious societal challenge, but it also opens up vast, lucrative, and helpful/beneficial business opportunities for better care. Our future research will aim at deepening our understanding of these new opportunities and investigate the new, different, and

possible solutions to all these identified challenges.

7 References

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