Roadmap for Collaborative eHealth Service Architectures for Homecare

General eBusiness Requirements

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Abstract— **In many industrialized countries, such as the Scandinavian, one of the main goals for eHealth innovation is to use information and communication technologies to avoid the approaching inflection point in healthcare: it is estimated that by 2025 the demand of care could not be sufficiently attended based on today's healthcare delivery. eHealth services and business models for enabling older people in need of care and patients with chronic conditions may increase efficiency of healthcare and improve Quality of Life for residents. However, eHealth business models are known by their fast speed of change, what results in the need of a methodology to rapidly adapt technical requirements to these typical inter-agency changes. This work presents a research roadmap for collaborative eHealth Service Architectures for homecare. The research focused on the business requirements in service architectures (eBusiness, Enterprise systems), whose findings can inform eHealth research in general, health professionals and vendors.**

Keywords-eHealth; Service architecture; Business models; Enterprise systems; technology innovation; technology adoption.

I. INTRODUCTION

In many industrialized countries, such as Norway, one of the main goals for eHealth innovation is the use of information and communication technologies (ICT) and information systems (IS) to avoid the inflection point in healthcare: it is estimated that by the year 2025, the demand of care could not be sufficiently covered based on today's healthcare delivery [1]. Change and innovation are needed for treatments maintaining the quality of care within assigned budgets, where the resources needed transcend those of one singular organization. Technology that helps people with care needs to stay safely, longer at home and out of institutions and hospitals may be a strategy to reduce the total healthcare costs of society [2].

The authors present a roadmap for service design and architecture development in collaboration across organizations in healthcare. The research focuses in the home care, leaving clinical care outside the scope of this study. A challenge associated to the home care is that it presents a broad spectrum of user requirements within the same information technology (IT) infrastructure. Research in eBusiness models may inform future strategies and

research in eHealth service design, especially in homecare, see Fig. 1. In this first paper, the authors reviewed the literature related to (e-)business models and eHealth to then offer propositions on service design.
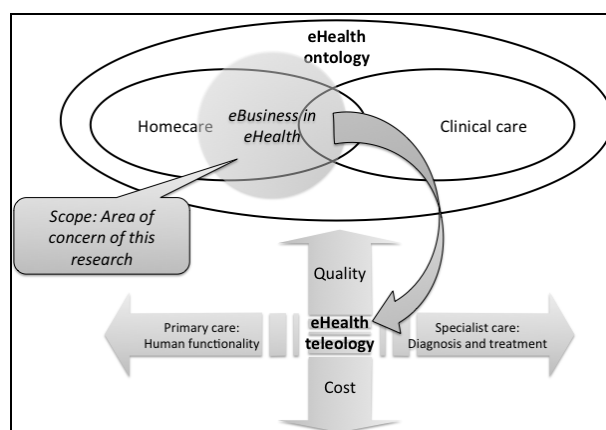

Figure 1. eHealth ontology, teleology and scope of the research

Studies of stakeholder requirements in eHealth innovation and pre-procurement [3] underline the need for increasing stakeholder involvement. Furthermore, design principles for business models that can facilitate such involvement are here elicited. The need in homecare is to develop an adaptive framework that allows front-line personnel (e.g., nurse, general practitioner) and other end-users to dynamically manage and (re-) configure business processes, patient services and health treatment clinical pathways, with the purpose creating service-oriented solutions whose core elements are patient autonomy and interactivity.

The authors have designed a three-step research roadmap with a peer-reviewed research article associated to each step (see Fig. 2). This article represents the first step, where we present the literature review on (e-) business models in the domain described followed by general business propositions. In the second step, a case study on the process of eHealth innovations will serve as a test of the elicited general (e-) business propositions and requirements of a design-process through action research in projects in a

Living Lab research methodology. In the third step, we seek to generalize the findings from the second step into a unified architecture or design model: an innovation and pre-procurement roadmap towards a technical architecture for a dynamic service management infrastructure that meets these requirements, enabling co-creation of eHealth services with end-users. Our level of analysis in the organization varies with each step. In the first one, we take a holistic view of the business model. In the second one, we focus on transitions in end-users' life, downstream activities and their consequences for collaboration with eHealth technology-vendors. In the third one, we apply findings from the two previous steps to induce a general design model for the architecture of ICT applications and infrastructure integrations, see Fig. 3 at the end of this article.

The main research question in this article is to find in the research literature general business requirements that influence eHealth services in home care. This lead to the
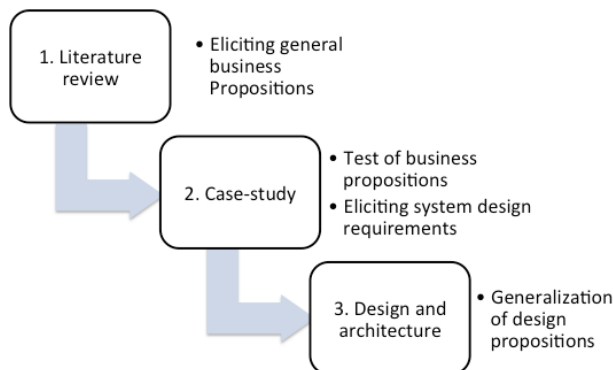

Figure 2. Research design, steps and expected research outcomes

two research questions addressed in this paper:

RQ 1. What are the business requirements for Enterprise Systems that create value for users in the context of eHealth?

RQ 2. What are user preconditions to gain benefits from new Enterprise Systems and increase efficiency and quality in eHealth adoption?

The paper is structured in different sections. A theoretical framework is presented in Section 2. The method employed is described in Section 3. Section 4 presents the results, with the answers to the research questions. The paper ends with the conclusion and future work in Section 5.

II. THEORETICAL FRAMEWORK

There is a variety of business models, but Hwang proposes three main types or business model templates that explain the business processes of modern enterprises better than the traditional Value Chain model of the firm [4] does alone [5]:

1. Solution shop. A place where customers describe their problem and it is fixed. For example, general practitioners and hospitals curing patients.

2. Value-adding process (comparable to the Value Chain) typical of manufacturing enterprises; comparable to Porters' [4] model of the firm. For example, pharmaceutical producers.

3. Facilitated user networks (Value Networks) to connect users and services. For example, different web communities (most communication- and internet-based businesses fall under this category).

With regard to these models, Hwang [5], building on works by Stabell and Fjeldstad [6], states that the facilitated user network is under-represented in the health sector—and, thus, represents growth potential: as more businesses move online, facilitated user networks represent a business model template of increasing significance, including eHealth. Thus the authors will explore these concepts further in relation to eHealth service architecture. Frameworks for analyzing value creation in e-Business (e.g., Amit and Zott, [7]) are relevant for understanding the eHealth landscape because many eHealth systems contain elements of e-Business models which belong to the category of Value Networks.

Amit and Zott's [7] e-business value creation model categorizes the sources of value creation into four main groups: *efficiency*, *novelty*, *lock-in* and *complementarity*. These groups are relevant to e-business models that often implement instances of the facilitated user network archetype of business models, and inter-organizational process collaborations. According to Amit and Zott, *efficiency* has been one of the primary driving forces for the transition to a more digital economy in all phases of the transaction. Complementarities that arrive from the bundle of goods provide more value to the users than the sum of values provided by each good alone. *Complementarity* and novelty imply collaboration and innovation—both themes of significance in healthcare. *Novelty* means that there is a "first" here, either in the service itself or in the way that it is conceived or delivered. Combining or connecting two or more previously unconnected parties, domains or methods often achieves this. A *lock-in* value is created through users' reuse of one-time transactions costs (e.g., for registration and service customization).

Seddon et al [8] proposed a model that explains how organizations, such as municipalities, can overcome organizational inertia and successfully adopt new enterprise systems and obtain benefits, e.g., quality and efficiency.

Enterprise systems support processes, information flows, reporting and business analytics within and between organizations and individuals. Specifically, these processes support organizations' business models. Business models are models of how enterprises create value for themselves and other, while also capturing value. An organization can have more than one business model, and business models can include more than one organization.

Since RQ 2 aims to explore the affordance of ES in realizing emergent business models in eHealth, the authors have chosen to use Seddon et al.'s model of key factors affecting Organizational Benefits from ES (OBES) [8]:

1. Short term/On-going business improvement projects:
   a. Functional fit (FF)
   b. Overcoming organizational inertia (OOI)
2. With the addition of long-term organizational benefit factors:
   a. Integration
   b. Process optimization
   c. Improved access to information

Functional fit of software means that the processes supported by the ES are efficient and effective for the organization and that they help people to finish their tasks. Overcoming organizational inertia is the extent to which organizations' members are motivated to learn, use and accept new systems. Integration refers to the unification of systems and/or data from resources within and outside an organization. Tailoring the information systems to an organization's goals help to achieve process optimization. This often necessitates improved access to information.

III. METHOD

The authors searched through scientific literature about business models in eHealth using Amit and Zott's framework [7] for value creation in eBusiness to answer RQ 1., and conceptualize the requirements. Then, we analyze concepts found in the review with the model proposed by Seddon et al [8] to answer RQ 2., and produce general propositions for information system design with special regards to primary care and homecare.

The literature search was performed in spring 2014 using the search engines ProQuest and EBSCOhost. The search engines targeted science and social science disciplines. The authors used truncations *health* AND (*ecommerce* OR *reward*) AND "business models" in the search terms. The search included scholarly papers and trade journals, choosing to include the latter due to the "newness" of the area in explored. The authors found 286 papers that matched the search criteria. However, a screening showed that 246 of the found papers were not related with eHealth business models. These papers were excluded. The excluded papers were concerned with topics such as: clinical trials, environmental issues, other non-health-related issues and management issues at large.

The remaining 40 papers (34 found through ProQuest and 6 found through EBSCOhost) were rated as relevant to the research topic and, thus, analyzed. A table showing the results and list of the searched and reviewed articles is included in the appendix.

IV. RESULTS

A. Answer to RQ1

This section shows the findings from the systematic literature review (for details, see appendix), which were aggregated and conceptualized following the guidance of Webster and Watson [9], and then sorted according to Amit and Zott's model. The authors added the category "Other" to collect concepts that were not easily sorted under Amit and Zott's four main sources; these were predominantly societal and public policy factors. These other sources stemmed from the special public or semi-public financial context of eHealth in countries like the British and Scandinavian.

1) Efficiency concepts

Easier scaling and sharing: new eHealth concepts leverage the efficiency and cost-flexibility of cloud computing. Cloud computing facilitates the use of intelligent algorithms to detect heightened risks of worsening conditions and supports the triage classification of patients (triage is an assessment of urgency of treatment). Such capabilities can be shared and utilized by several organizations. Standardizations and reductions in the number of product lines greatly reduce overhead cost ratios. Companies must defend low costs against overly personalized service.

Transaction cost efficiency: through e-business' transaction efficiency, doctors can now charge costs associated to phone calls and online consultation. Cloud computing also creates the opportunity for self-service solutions. Online solutions also enable easier care and quality coordination.

Easier sourcing: cloud services provide easier possibilities for sourcing support functions (e.g., system running).

2) Novel concepts

Rapid customization and co-innovation: the cloud model allows for rapid prototyping and innovation in processes, products and services. Co-innovation and co-creation generate new organizational and shared values. Surplus innovation can be sold-off, generating rent (commercial profit). Moreover, the possibility of doctor "visits" via secure video-conferencing enthuses patients. Partnerships with educational providers provide focused and personalized professional training.

3) Lock-In concepts

Revenue and reward splits: cloud services can store user preferences, which can enable product and service customization. Offering consumers, a choice of market channels can be mutually beneficial for all channels, due to the aggregation of products and services. For instance, the Hello Health website [10] negotiates a revenue split of subscriptions with physicians. Sharing information across organizational borders creates better possibilities for personalized health coaching.

Fun and belonging: online solutions can leverage the network and "gamification" (i.e., comparing progress with peers) effects of social media. Algorithms for the content and sentiment analysis of entries in online communities can suggest alternatives or interest groups that might be beneficial to join. Corporations should link medical plans

for employees with corporate strategies, which could, for example, reward the use of fitness facilities and programs.

4) Complementarity concepts

Aggregating services: Internet offers possibilities for aggregating and sourcing services and finance. For instance, a combination of many travel-related and medical businesses and services can facilitate medical tourism).

Shared development risk: alliance management capabilities have positive effects on research and development capabilities. For example, in targeted medicine, there is a call for cross-business collaboration. Targeted medicine makes it possible to treat rare, previously untreatable conditions; however, the cost per patient is high, and some governments may refuse reimbursement. By reducing development time through improved collaborations between test laboratories and pharmaceutical companies, targeted medicine can be achieved at manageable costs. Pharmaceutical companies must learn how to fit into other companies' business models. All actors need to be satisfied, for example with "win-win" scenarios.

Management coordination: primary and secondary care must be better coordinated. Companies' external and internal resources must be aligned in order to facilitate the internalization of knowledge. Many user networks' business models are without profit or low profit; however, as a potential source of empowerment of patients, they represent ideal opportunities for business models for treating chronic diseases. These are costly treatments and are not well suited to the traditional business model of hospitals and physicians.

5) Other effects: Public and Societal concepts

New reimbursement schemes for better coordination: payment models in health should encourage coordination. Reimbursement models should encourage preventive measures, such as Healthy Outlook [11]. They should also reward the results of coherent treatment over "pay-per-consultation" systems. New reimbursement schemes may pose new challenges for financial reporting.

Knowledge management: knowledge benefits from exchange, rather than protection. The best "players" build "invisible" information infrastructures for developing, for example, cancer-focused IT system and evidence-based medicines.

Ethical compliance: Ethical compliance management is of growing significance in a changing eHealth business environment. Better management can be achieved through collaboration and democratic governance.

B. Answer to RQ2

Based on the business concepts induced from literature and rendered in the previous section, the authors propose the following propositions as design principles for a Municipal eHealth architecture:

Proposition 1. Shared e-commerce solutions: E-commerce solutions shared among collaborating partners, such as Hello Health [10], enable easier scaling and sharing, greater transaction cost efficiency and easier sourcing of non-strategic support functions, such as system running (i.e., application-server management). Shared e-commerce solutions support short-term functional fit and long-term business benefits, providing integration, process optimization and improved access to information.

Proposition 2. Co-creation with partners and clients (and patients): by providing customers and partners alternatives for customizing their services and by encouraging and proactively collecting feedback on services, it is possible to distinguish patterns that provide an impetus for improving services and creating new ones. Co-creation may produce positive short-term effects and long-term effects.

Proposition 3. Aligning internal and external resources: to overcome organizational inertia, structural changes may become necessary. Internal organizational resources should be dedicated to match external resources (business partners) in order to extract and embed external knowledge within an organization. This process is linked to propositions 4, 5 and 7.

Proposition 4. Aligning price and reward (bonuses and revenue sharing): aligning rewards and bonus schemes through the delivery chain and throughout user levels encourages the achievement of goals for treatment and health policies.

Proposition 5. Iterations for the economic alignment of interests: throughout a delivery chain, there is information asymmetry with regard to knowledge of processes and costs. Over time, all actors in the chain experience a learning curve; thus, collaborative iterations are needed to optimize business processes and to maintain win-win situations throughout the delivery chain. The role of ES is to provide accurate, reliable and comparable data for collaborative decision-making, thereby stimulating and supporting organizational learning.

Proposition 6. Social media integration and capabilities: to ensure that users and patients choose digital solutions and achieve the efficiency benefits that such solutions provide, the digital solutions should ideally be socially oriented and easy and fun to use. Gamification allows users to compare their personal data in fitness or treatment programs—and, thus, encourages and motivates users/patients to adapt and use solutions. Gamification can be developed and stimulated through social networks. Actors in healthcare (e.g., hospitals, primary care) need to develop their social media strategies [12].

Proposition 7. Alignment of incentives: a strong reallocation of Intellectual Property Rights and revenue sources may be necessary to encourage more efficient research and development and to achieve joint goals for development, thereby lowering the costs of new treatments (e.g., targeted medicine). Increased use of public-private collaboration contracts around research and development might be potentially considered.

Proposition 8. Transparency (sharing information across different levels): often, the patient is not the one who pays the full price for a medical service. In many economies, the state or voluntary or compulsory insurance or company medical plans pay for such services. Demographic changes, combined with improving treatment options, have led to rising costs of healthcare. To counter this, reimbursement schemes increasingly seek possibilities to pay for results rather than consultations. For health providers, this calls for increased information sharing, and transparency of treatment results. This proposition is linked to proposition 9.

Proposition 9. Linking performance measurement and finance: the enterprise/planning systems of medical providers and vendors must increasingly be able to provide data for quality performance and financial performance to both the market and the government. Business intelligence and balanced scorecard systems are needed for quality and performance management, and they can be directly linked to reimbursement schemes in the future.

Proposition 10. Democratic governance: ethical compliance is gaining importance in many areas, and it has great significance in eHealth [13]. A proactive strategy for compliance management, involving consistent policies for handling legal, quality and treatment deviations or complaints, including privacy and security issues, may benefit an organization in the long term. This may help overcoming barriers to e-Health adoption [14]. Actively involving users and employees in this work through democratic governance can enable such a result [13].

V. CONCLUSION AND FUTURE WORK

This study has answered the two research questions (RQs) by eliciting business models and enterprise systems design principles that may inform future eHealth architectures and applications. Although these principles are not exhaustive, they illustrate the need for flexibility and capability of co-creation with users at all levels.

In the future, the authors will test the found propositions in a Living Lab test setting [15], with special regard to adaptability, flexibility and facility for user-co-creation in design of eHealth services. Based on the empirical findings from these case-studies, we will seek to generalize a pre-procurement design process-model; a roadmap, in step three, which allows for a co-creation process that combines the goals of all stakeholders; application-vendors, municipalities and their constituents and end-users (see Fig. 3). The connection between innovations in local media and applications and central information infrastructures

Figure 3. A general model of Municipal/Homecare eHealth Service Design: Level of analysis in each research step

(Software as a Service, cloud computing solutions) will also be explored.

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