Assessing the impact of smart home and ambient assisted living technology on the dementia care value network and business model

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Abstract

Critical to improving the commercial viability of technological health innovations is understanding the key changes it will pose on the existing business model elements. In this paper, changes to the elements of the business model of Geriant, a dementia care provider, are studied in the context of the emerging smart home and ambient assisted living technology. Additionally, a value network analysis revealed potential changes to the key partners that are identified by the emergence of the new role of digital health product provider and the transformation of the role of the patient with dementia and its informal caregiver. The integration of SHAAL technology in dementia poses organisational challenges including acquiring the right technology-based knowledge and capabilities, new business development, and strategic partnerships with existing digital product providers to develop SHAAL-enabled solutions for dementia care.

Keywords
Business model, e-health, SHAAL, AAL, value network, healthcare innovation, dementia care, independent living, aging-in-place

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1.1 Introduction

The ageing of populations in industrialized countries has been driving healthcare expenditure up to a point where the financial sustainability of Western healthcare systems is questionable. [1, 2, 3, 4, 5] Prevalent in this ageing population are cognitive impairments ranging from age-specific memory loss to clinically diagnosed dementia. 28% have mild cognitive changes such as memory loss and 11% currently is living with Alzheimer's disease or other forms of dementia. [6]

Smart Home and Ambient Assisted Living (SHAAL) technologies are being developed and can support the patient with dementia and its caregivers in different ways. SHAAL encompasses different types of sensors and devices for safety monitoring or to collect and analyse data and provide the patient and its healthcare provider with information on the environment and the patient itself. This information can reduce both the physical and mental burden on caregivers and the need for premature nursing home placement, and therefore improve the quality of service and health outcomes for the patient. [47]

Existing healthcare providers have been found unable to integrate new technologies into their business models [7] and commercially successful deployments of business models innovated with new technologies is low. According to Berg (1999), 75% of telemedicine innovations failed to be successful when deployed by existing healthcare providers. [8] Broens et al. (2007) explain that failure to understand the implications for the structure of the individual organisation and collaborations with external organisations, the value network, can explain the inability of existing healthcare providers to integrate new technologies into their business models. [9]

This paper aims to increase the commercial viability of business model innovations with SHAAL technology in dementia care by studying the impact of SHAAL on dementia care business model and identify new roles, activities, and relationships and the changes to existing ones in the current value network. In conclusion, a new value network configuration is proposed that integrates the changed and new elements required for deploying a SHAAL service by a dementia care provider.

1.2 Research Goal and Question

The central question in this paper revolves around understanding the impact of SHAAL technology on two elements, the value network and the business model of dementia care. The business model explains the key components that make up the organisation that are required to create, capture, and deliver value. While the value network explains how a network of organisations can create, capture, and deliver value together.

The research question combines both elements: "what is the impact of smart home and ambient assisted living technology on the value network and business model of dementia care?"

In order to explain technology in relation to the business model and value network we need to understand both concepts and explain them in the context of dementia care. Following the explanation of the concepts in the theoretical section, the underlying questions will be answered and are formulated as follows: "what is the business model of dementia care?" and "what is the value network of dementia care?" Based on our developed understanding of the value network and business model of dementia care we can identify the differences between the current state of the business model and the value network of dementia care and the future state in which SHAAL technology is integrated.

1.3 Academic relevance

Taking a business model perspective in healthcare in combination with a value network analysis is often forgotten in business model innovation with technology. [10] The bias in healthcare towards technology-driven innovation structurally fails to take all stakeholders of healthcare into account. [52] By taking a business approach to healthcare all stakeholders will be included in the innovation process, potentially increasing the commercial viability of business models in SHAAL-dementia care. This approach can be used for future research for the assessment of technological innovations in business models in healthcare.

1.4 Paper structure

In the next section we will conduct a literature study to establish the theoretical framework that includes the concepts for answering the research questions including the concepts of: smart home and ambient assisted living, business model, business model innovation, and the value network. The methodology section will explain the design of the research, data collection methods, the case study in this paper, and lastly the techniques and tools used to analyse the collected data of which the results will be reported on in section 4.

2. Theoretical Framework

Answering the research question revolves around the concepts of SHAAL, the business model, business model innovation, and the value network. This section provides clarification on the concepts through a literature study.

2.1 SHAAL technology

Smart Home and Ambient Assisted Living is a recent trend in health information technology that is being developed with the aim to empower human beings with ambient intelligence. Ambient intelligence is the awareness in a digital environment that is sensitive, adaptive and responsive to changes in

the patient's environment or the patient itself and is characterized by communication that is unobtrusive, anticipatory and pervasive. [11] Robotics, Smart Homes, and Mobile and Wearable Sensors are SHAAL technologies that each address the various issues related to dementia and the daily life of independent living elderly.

A smart home is a home that is augmented by an internet-of-things (IOT) network of interconnected sensors and actuators that can provide rich contextual information by combining different types of sensor data, as depicted by figure 0. [12] Various sensors that are widely used in smart homes include smart tiles, pressure, RFID, ultrasonic, infrared, camera, microphone, and magnetic switches. A central system controls the sensor network and combines the output with which the cognitive and physical health of the patient can be assessed as well as providing more comfort and automation for the patient. [13]

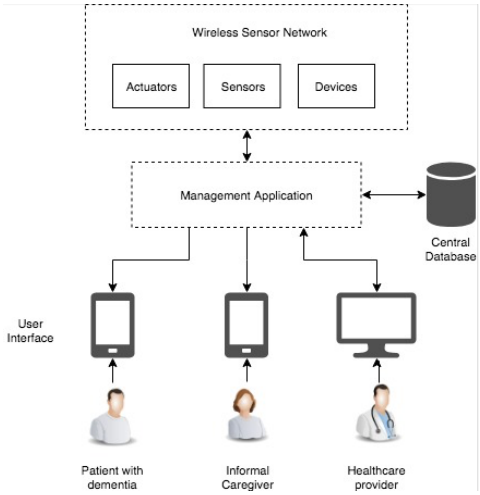


Fig 0. Smart home with SHAAL technology

Next to sensors that are fitted in the home, other sensors are fitted to the patient. Most smart phones already include many sensors such as GPS, accelerometer, gyroscope, proximity sensor that can be used for monitoring activity and mobility. These technologies offer low-cost, low-power solutions for wireless transmission of information to the healthcare provider. [38] More recent discoveries in epidermal and micro-electro-mechanical (MEMS) technology provide a new array of sensors use e.g. infrared sensing; optical sensing; and oscillometric and can provide more detailed information on the patient's health situation. Blood glucose, blood pressure, and cardiac activity are examples of measurements that can be performed with the new sensors. Another advancement in on-body sensors is e-textile, textile that integrates sensors seamlessly in the garment's fiber and provides a non-invasive method of monitoring and measuring conditions.

Elderly patients' physical abilities decline over time and can provide barriers to performing daily activities in independent living. Assistive robotics can help overcome these limitations. Assistive robotics are categorized into robotics assisting in daily activities (ADL), robots assisting with the usage of instruments in daily activities (IADL), and robots assisting with enhanced activities of daily living (EADL). ADL tasks include activities for self-maintenance such as eating and taking care of hygiene. Robots can help pick-up dropped objects from the floor [14], detect, grasp and exchange household items with humans [15], or lift and transfer elderly from and to their bed. [16] IADL include tasks that require instruments for the execution of ADL e.g. telephone calls and the preparation of food. IADL assistive robots can help with housekeeping [17], preparing meals, laundry, shopping and using the telephone. [18] EADL appertains to the participation in social activities, where robots can help with hobbies, social communication and new learning. [19] and can be further categorized into service and companion robots. [19] Companion robots provide emotional support, while service robots provide functional support, but both will play an active role in the daily life of the patient.

Applications of SHAAL

SHAAL can be applied in different facets of elderly care such as prevention, curing, and improving health conditions and wellness of elderly patients, but the majority of SHAAL tools monitor a subset of daily life activities. Monitoring can help to identify changes in the health and cognitive status of the patient. Through continuous assessment the status of dementia in the patient can be estimated and acted upon. Monitoring of sleep rhythm with smart matresses [20], walking speed and movement patterns can signal the onset of dementia. [21, 22, 23] A large collection of wearable sensors can provide real-time information of the concentration levels of different vital elements in the blood, and non-invasive e.g. the BIOTEXT project [24]. Another important application of SHAAL in the context of independent living elderly is in fall detection. Various systems based on camera, wearables, or ambience intelligence have been developed. Falling is an important cause to morbidity and mortality of elderly and constitutes a risk that can be mitigated with SHAAL.

Preventing dementia patients from wandering is something SHAAL can prove very useful. Different researches such GPSShoes [25] and EmFinder [26] employ GPS-technology to track movements of patients or alert caretakers in case of a deviation from the predefined routes like KopAL [27] and OutCare [28]. Combined with machine learning algorithms SHAAL can also be used to identify the standard patterns of behaviour and anomalous wandering behaviour of the dementia patient. [29, 30,31].

As cognitive functionality declines, cognitive orthotics tools can be used for rehabilitation or to provide support. Simple reminder systems such as NeuroPager [32] and MemoJog [33] provide reminders for activity or medication. Cognitive orthotics can also help the patient rehabilitate by training the brain. Microsoft's SenseCam shows the wearer a series of photos taken through the day and helps the wearer recollect its memories. Low medication compliance is a risk factor that can benefit from SHAAL e.g. Jakkula and Cook [34] propose

advanced algorithms to detect anomalies in the patient's medicine compliance.

2.2 Business Model

The term business model is often used to describe the key components that make up a business. McGrath & MacMillan describe the business model as the way an organisation organises its inputs, converts these into valuable outputs, and gets customers to pay for them' in the business model concept. [35] Eisenhardt & Sull suggest that the business model is found in the position a company takes on the product market, in its resource base or in the key processes – all of which could be referred to as components of a business model. [36] McGrath & MacMillan take a systems view on the business where the business converts inputs with processes into outputs, but they also consider marketing aspects. Eisenhardt & Sull also consider marketing as a component, next to resources and key processes required to transform resources into outputs.

According to Chesbrough & Rosenbloom, [37] business models explain the way companies create value. Osterwalder and Pigneur, [38] and Teece [39] define the business model as a model that is about value creation, delivery and capture as well as a source of competitive advantage that is non-imitable. Zott et al. describe the business model concept as the rationale of how an organisation creates, delivers and captures value in relationship with a network of exchange partners. [40] Zott et al. describe that value is created together with partnerships with organisations in the network. They find that it is not only important how the organisation creates value from its resources, but also this value depends on collaboration with network partners.

The application of the business model concept is particularly popular within research on and among e-businesses. [41] Timmers defines an e-business model as: 'An architecture for the products, service and information flows, including a description of the various business activities and their roles'. [42] Weill & Vitale propose a likewise definition, but also consider like Zott et al. the importance of network partners: 'A description of the roles and relations among a firm's consumers, customers, allies, and suppliers that identifies the major flows of product, information, and money, and the major benefits to participants.' [43]

To analyse e-health business models we require more explicit conceptualization of the different business model components. Amit & Zott (2001) presented three components of e-business models, including content (exchanged goods and information), structure (the links between transaction stakeholders), and governance of transactions (the control of the flows of goods, information and resources). [44] Afuah & Tucci provide a list of components including customer value (distinctive offering or low cost), scope (customers and products/ services), price, revenue sources, connected activities, implementation (required resources), capabilities (required skills), and sustainability. [41]

Taking a business model perspective encourages systematic and holistic thinking. [40] A business model framework offers a structured way for granular analysis of business model components. The popular business model canvas (BMC) framework based on the works of Osterwalder and Pigneur includes: 1) the value proposition; 2) customer segment; 3) customer relationships; 4) channels; 5) cost structure; 6) revenue streams; 7) key partners; 8) key resources, and 9) key activities of the business. [38]

In our study we will use the business model as defined by Zott et al., because it is the more appropriate definition for dementia care, because Zott et al. describe that value is created with network partners. We described how dementia care providers see the collaboration with network partners as the solution to better health outcomes and lower health costs.

2.3 Business Model Innovation

Business model innovation is key to the performance of firms (Chesbrough, 2007). Business model innovation (BMI) refers to the design of novel BMs for newly formed organisations, or the reconfiguration of existing BMs. Zott and Amit [40] view business models as a system of boundary spanning interdependent activities. They explain business model innovation as the adding of new business activities, linking activities in novel ways that create more or new value, or changing which network partners perform an activity.

Technological development can facilitate new business models that increate the novel technological features in the business logic (Baden-Fuller & Haefliger, 2013). Technological development is seen as one of the external antecedent that can lead to business model innovation (Foss & Saebi, 2016). Advances in information and communication technologies open up new opportunities to organise new business activities and business models. [41, 42, 44]

Business model innovation process

Salehar (2017) recognized business modelling as a potential tool to help healthcare to determine technology implementation strategy by involving all important stakeholders in a value-driven dialogue about the way in which the technology should be utilized. [45]

Next to business modelling, business model patterns can be used as a tool for business model innovation. Ansoff (2015) defines these patterns as: proven business model elements, which reveal valuable insights about pursued business logics. (Amshoff et al., 2015) According to Gassmann a business model pattern is "a specific configuration of the business model dimensions that has proven to be successful" (Gassmann et al., 2015). Due to the emergent stage of infor-

mation technology in dementia care, and in the healthcare industry overall, the existence of literature on business model patterns is very limited and business model patterns is therefore not considered in this study.

In this study, we will look at how a technological innovation can facilitate business model innovation and how this innovation can create more value to customers.

2.4 Value Network

To understand how health care organisations create goods and services that deliver quality patient care it is necessary to know where value is created (Saliola and Zanfei, 2009).
Normann et. al explain that value creation as depicted by business models typically occurs in a value network (Normann and Ramirez, 1993; Parolini, 1999), which can include suppliers, partners, distribution channels, and coalitions that extend the company's resources, and that its therefore necessary to include the value network as a unit of analysis.

Underlying the value creation by a network is value creation on firm level, in firm-specific value chains. According to Porter (1985), value chains analyse value creation at firm level by identifying activities of the firm and the logic of linking those activities. Value chains present critical relationships which facilitate the flow of products and services from manufacturers, to distributors, to providers to consumers, to intermediaries who ultimately define how the products and services are paid for (Austin and Seitanidi, 2012). Healthcare value chains are resource intensive (Pedroso and Malik, 2012).

From a consumer-centric perspective, healthcare value chains must have the capacity and capabilities to deliver value before and after the consumer has utilized products and services (Al-Abri, and Al-Balushi, 2014). Furthermore, as care delivery improves, synergies are expected within intra and inter-organisational clusters (Eisingerich, Falck, Heblich, and Kretschmer, 2012). Intra-organisational clusters are vertically and horizontally aligned sets of employees that interact and work on shared goals within the healthcare organisation.

As most organisations do not possess all the required capabilities to provide end-to-end services on its own, organisations build transactional relationships with external firms, resulting in value networks (Möller, Rajala, & Svahn, 2005; Kothandaraman & Wilson, 2001). This is especially true for traditional care, where the independent care provider only possesses domain-specific knowledge and therefore only provides health care focussed on domain-specific health conditions.

According to transaction cost theory, firms need to decide whether they acquire the necessary capabilities for in-house production of production or services, or to purchasing the products from external parties. When the costs of acquiring new capabilities exceeds the transaction costs of doing business with the external environment, firms choose to enter in partnerships. During this process, several activities need to be combined by multiple actors and together form end-products that create value (Anderson & Narus, 1999; Peppard & Rylander, 2006; Cravens, Piercy & Shipp, 1996). For independent health care providers, the costs of acquiring new healthcare knowledge and capabilities outside of their domain are most of the time high due to the specialised nature of healthcare. Through the formation of a value network by integrating different roles with strategic partnerships, the collaboration between different network partners becomes closer, implying more efficient coordination and exchange of information as result of the reduced complexity and thus reducing the amount of resources used.

3. Methodology

3.1 Research Design

This research will be conducted based on qualitative methods including a case study conducted by Glimmerveen and Nies of a dementia care organisation of which the data will be collected through desk research. Their in-depth analysis of Geriant will be able to provide the majority of the necessary information in this research on the dementia care organisation. An interview with Henk Herman Nap of Vilans, an expert in healthcare technology to review and verify the results and assumptions. Vilans is a research centre with a primary focus on long-term health care and runs large scale and nationwide programs such as the National Dementia Program.

While the case study will serve as primary source of data that will be used to describe the dementia care business model, the expert interview will be used to understand the value network of dementia care, but can also provide additional information to describe the business model. The same expert will provide information that will be used to assess how the roles in the current value network will change due to technological innovation.

The first part of the research focusses on analysing the value network of dementia care. In this analysis the actors and their roles, activities and relationships will be described. The configuration of the dementia care value network that results from this analysis will form the basis for describing a potential evolution from the current state to the future situation of dementia care with SHAAL. To describe the evolution of dementia care's value network an assessment of the impact of SHAAL on the key roles in dementia care based on Petrovic's methodology (explained in 3.4) will describe whether elements are missing or if existing elements need to change to support the integration of SHAAL in dementia care.

In the second part the business model of dementia care will be analysed. Based on the business model canvas, various el-

ements that make up a dementia care organisation will be described. To understand the impact of SHAAL on the business model, Petrovic [25] indicates the necessity to identify the potential benefits of SHAAL for the actors in the users. We will consider the actors identified in the value network analysis as the users. The impact of SHAAL on actors and their roles, activities and relationships should indicate which elements of the business model and how they will be impacted. The results of the impact of SHAAL on the business model will be used to indicate opportunities and challenges to business model innovation with SHAAL.

Value network evolution

In this study, a potential future configuration of the value network is proposed by explaining how the current state of the value network can evolve into this new state. "Evolution" refers to gradual development of a technology, product, or value network from simple to more advanced state due to the use of innovative technological and business approaches. First, the current state needs to be studied and explained. In the first steps of the value network, the key value creating actors, and their interdependencies, in dementia care are explained. In the second stage, the impact of the technological innovation on the actors and their activities, but also the relationships is assessed. In this step, it will become clearer what is required to integrate SHAAL in dementia care, in terms of what new activities (future state) are required and what already exists. This analysis will reveal the gaps that need to filled either by existing roles or new ones. In the concluding step, the existing state of the value network and what changes have been identified as required to implement the technological innovation are assessed. It is in this step that potential changes (additional or transformed roles, activities and relationships) to the current value network can provide an insight to a potential new configuration of the value network.

3.2 Case Company

In this research Geriant, a Dutch dementia care provider serves as a case study for studying the healthcare business model and the value network of dementia care. Further research will be based on the results of the analysis of this case company. The results are verified through an expert interview as described in 3.1.

Before the impact of SHAAL on the dementia care organisation can be described, the value network, business model and other organisational and operational aspects of a dementia care need to be described. Geriant has been identified as the unit of analysis for the case study, because it has a proven business model (operational since 2000); and it is a valid example of a dementia care provider as it (1) revolves around one medical condition, dementia; (2) provides multi-disciplinary services; (3) provides patient education; (4) offers out- and inpatient treatment for dementia, and (5) integrates the patients' informal caregiver in the care process. Moreover, Geriant connects its patients with its value network, to be able to provide complementary services (e.g. nursing; home and social care). Compared to existing models that are organised by specialty and discrete services, Geriant is organised into a single unit that integrates different healthcare disciplines from primary care (e.g. physician; dietician; physiotherapist, and psychologist), that provides health care in the across the whole care process of a specific medical condition, namely dementia.

Geriant was established in 2000 in a collaboration of nursing homes and public mental health care organisation, because the services for people living at home suffering from dementia was of insufficient quality and fragmented.

The distinct care process offered by Geriant is described as follows: a patient with assumed dementia is referred to Geriant by the general practitioner for diagnosis. In case of dementia, the patient and its informal caregiver can be enrolled in the programme of Geriant and a case manager is assigned to the patient. Different services dependent on the stage of dementia are now provided to the patient. For patients in the early stage of dementia that can live independent, Geriant offers education (e.g. diet and physical and mental exercises) to the patient and education to the informal caregiver (e.g. dealing with the patient; crisis and incident management). In case the patient requests aid for daily activities, Geriant enables its partners both home and social organisations that can provide services like cleaning, dressing, cooking, but also for medicating the patient.

As the disease progresses, or if the patient is already in a state that to be unable to live at home independent, Geriant offers housing. Geriant has four sites where patients can stay and treatment is offered by multidisciplinary teams. Geriant also has network partners to which the patient can be referred to for short- and long term housing (e.g. nursing and care homes). For patients in incidents or crises, Geriant offers short-term in- and outpatient treatment offered by its multidisciplinary teams.

In the last stages of the disease, the patient will be unable to live independent and requires support in all activities. It is in this case that Geriant offers long-term housing through its care home partners. In conclusion, Geriant offers services to patients with dementia from the early to the last stages of the disease by integrating different disciplines and collaborating with value network partners.

Although the care services provided by Geriant are variable, the average cost is €8 per day per client (excluding social care and home care services provided by network partners). A comparison of the costs per patient of Geriant with the national average costs of mental healthcare services shows that the total expenditure in the last life phase was 47% lower for Geriant, saving on average around €48.000 per patient. The majority of the difference in costs can be explained by the reduced need of generalist services such as home care, but also a prolonged stay of patients at home. In addition to lower

costs, the average length of stay in a nursing home was around 9 months lower for Geriant' patient group. A study by the regional care purchasing office suggested that nationwide implementation of this model would save an annual 200 million euros on public long-term care. [47]

Traditional methods of care are fragmented and therefore provides lower health outcomes and resulted into premature admissions to nursing homes. [47] Fragmentation is described by focusing and acting on the parts without adequately appreciating their relation to the evolving whole. [39] In healthcare this translates to independent primary care providers that deliver care to the patient while focusing on the specific disease symptoms that fall within the scope of their profession. Traditional care lacks the coordination of the care provided by the independent care providers. It lacked a holistic approach in health care delivery which is regarded as the reason for high costs and low health outcomes. [47]

Dementia care process
Service delivery starts when the general practitioner refers a potential patient to Geriant. A social geriatrician in the multidisciplinary team diagnosis the patient. In case of dementia a care programme for this patient is started and funding is enabled through the insurance company. The patient case manager collaborates closely with the patient's informal caregiver and provides support and education. In case the patient requires assistance at home, Geriant will contact one of its home and social care organisation partners. In a situation where the patient requires the moving to a location for basic medical treatment, Geriant will provide housing either with one of its own four care sites or through its network partners (nursing and care homes). If the patient requires advanced medical care, the patient is referred to the local hospital partner. This hospital also trains Geriant's case manager to improve the quality of the service delivery.

3.3 Value Network Analysis

Value network analysis offers a way to model, evaluate, and improve the capability of a business to convert both tangible and intangible assets into other forms of negotiable value, and to realize greater value for itself. [48] With a value network analysis, we will identify the different actors in the network, linkages between actors, and the interactions performed by actors (individuals, teams, units or organisations) that add value to a relationship or activity (Allee, 2008).

In this paper, we will use the methodology proposed by Pepper and Rylander. [49] Pepper and Rylander's structural approach to value network analysis consists of five steps:

In the first step the objectives of the network are defined in order to create a description of where the value of the network gets created. It defines the network and creates boundaries for the analysis. The focal point of the network is the firm or business unit that relies on the network for their business model.

In step 2 the nodes in the network are defined from the focal standpoint.

In step 3 the requirements of each value network actor are described. The overall objective is to capture the value that is perceived by various participants who are part of the network. It also about finding out why certain members want to be part of the network. The perceived value is what directs people's and organisation's willingness to pursue or not pursue something.

In step 4 the relationships between members of the network are described. These relationships or links between nodes can be called network influences. The amount of influences is an important indicator of how much attention the providers need to give to the network participants when creating their business model. As an influence counts anyone that has an impact on the perceived value of behaviour of a participant.

In the last step, step 5, the value network is visualized to present a clear overview of the network and makes it possible to draw quick conclusions about the various roles and participants within the network and shows where the value is created. Moreover, it shows how every participant is interlinked.

3.4 Assessing the impact of technology on the business model

In this study we are interested in understanding the influence or impact of technology on the business model components. Petrovic [46] proposed a methodology that is based on the change of business model in the context of technological innovation that will provide the structured approach in this step. This stage in business model change focusses specifically on the assessment of the influence of technological innovation on the business model and the identification of the missing roles in the value network.

The first step is to assess the influence of the technological innovation through identification of benefits and impacts that a given technological solution brings to key elements of the business model and a specification of the changes imposed on the current BM's structure.

In the second step, we identify the roles that are missing missing to fulfil the service. This requires the identification of the requirement of one or more new roles that accomplish new business functions, and a description of the activities and the functions of each of these roles. This step calls for a systematic approach towards identifying the missing competencies so that the right partnerships can be formed.

4. Results

As discussed in section 3, the value network configuration method will be used to analyse the architecture of the dementia care network.

4.1 Current value network configuration of dementia care

A study of a value network configuration generally starts off with the identification of the main business roles and their activities in an industry. To describe the results from the interview, each node in the value network is modelled according to the following unified modelling language (UML) notations: actor, role, activity, service interface, and monetary interface.

By looking at the process of dementia care the following roles become apparent: the patient with dementia that is at the receiving end of dementia care delivery, the informal caregiver that is providing basic care to the PWD, and the dementia care provider that delivers dementia care and treatment to the patient. In practice, other roles in dementia care are critical in ensuring that care is delivered to the PWD including the general practitioner which is the first point of contact of the citizen; the insurance company that provides funds to dementia care, and other complementary services generally offered by partners can be considered key to dementia care. Healthcare in which network partners collaborate to provide healthcare to patients is characterized as integrated care, where in this case the dementia care provider brings different organisations that are organised around the same medical condition together to combine different capabilities and expertise. By connecting more and different partners, the value network can improve efficiency and effective and can lead to better health outcomes for the patient. However, integrated care is not yet general. In this paper, these services are regarded as non-critical to the core dementia care delivery process and therefore fall outside the scope of further analysis.

Patient with dementia

At the centre of dementia care is the patient with dementia (PWD). The role of the PWD is defined as citizen. The activities of the PWD can be described by the act of receiving medical treatment, care and support from the dementia care provider and its informal caregiver(s). An additional activity attached to the role is the payment of insurance for the dementia care.

Informal Caregiver

Close to the patient with dementia are family and friends that play a crucial role in sustaining the life of the patient. In the current setting of dementia care the role of the informal caregiver is also described as citizen, however in some cases, as for our case company, the role of informal caregiver (IC) has become more active and formal and could already be described as healthcare provider, however in general the IC in dementia care is described by the role of citizen and provides only basic care and assistance to the daily life of the patient.

Health Care Provider

In the current setting of dementia care the health care provider is described by the organisation of different dementia care specialists that manages the patient with dementia, coordinates the delivery of healthcare that is focussed on the treatment of dementia. The role of the health care organisation is defined as healthcare provider.

Insurance Company

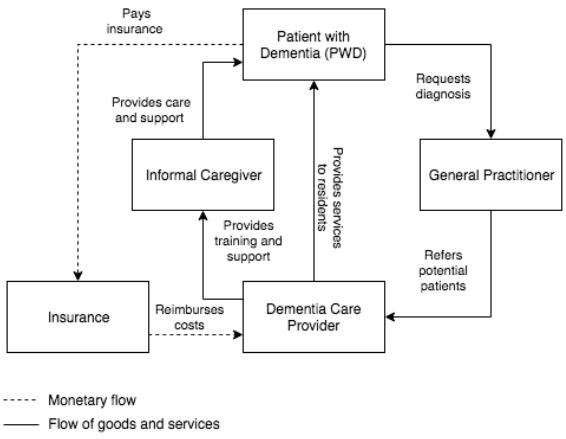
Critical to the operability of the healthcare system is the insurance company. Generally found in Western healthcare is the compulsory healthcare insurance company that provides the necessary financial support for the treatment of patients. Similar to other healthcare sectors, this organisation collects the healthcare insurance fees paid by the citizens and reimburses the costs incurred by the dementia care provider.

General Practitioner

Essential to most Western healthcare systems is the first point of the contact of citizens with healthcare that is embodied by the general practitioner (GP). At the presumption of dementia by a citizen, the general practitioner is contacted to discuss the situation. In case the GP assumes dementia, the patient is referred to the dementia care organisation where a clinician will diagnose the patient.

Dementia care's value network (Table 1)

Actor	Role	Activity
Patient with dementia	Citizen	Receives medical treatment, care and support Pays insurance fee
Informal caregiver	Citizen	Provides basic care and assistance to daily life activities
Dementia care provider	Health care provider	Provides medical treatment and care to patient
Insurance company	Finance provider	Provides funding for medical services
General Practitioner	Health care provider	Refers patient to dementia care organisation



(Figure 1. Current value network configuration)

4.1.2 Future dementia care value network configuration

In section 4.1 the main roles of the current value network of dementia care and their activities and relationships have been described. Next, we will assess how the identified roles are affected by SHAAL and whether existing roles can support SHAAL in dementia care.

The current role of technology in dementia care is mostly limited to the usage of information management systems and not technology that is directly related to the delivery of dementia care. Assuming that the level of technical knowledge required for operating SHAAL is comparable to the existing systems, training of existing employees would suffice for the organisation to be able to integrate SHAAL on operational level. However, as the current phase of SHAAL in dementia care can currently best be described by being in an experimental phase, the role dementia care provider is not sufficient in order to be able to integrate SHAAL as it is currently.

In order for SHAAL to succeed, SHAAL needs to become an integral part of dementia care. This requires that the role of dementia care needs to change.

With knowledge and capabilities in dementia care the dementia care provider will play a crucial role in the development and testing of SHAAL. Together with existing digital health product providers, the dementia care provider will also become a co-creator of digital health products.

The dementia care provider will not become the seller of digital health products but mere co-owner. In conclusion, the existing role of healthcare provider must evolve from solely providing dementia care to the patient towards a role wherein technology is an integral part of the organisation. The dementia care provider will think along with development and the actual development of digital health products.

Informal caregiver

The transition in healthcare lead by technologies such as SHAAL will provide more capabilities and knowledge to the informal caregiver. Through training provided by the healthcare organisation and with support of SHAAL, the informal caregiver will take on more activities of dementia care. In this transition, the informal caregiver will take on a more active and sometimes even formalised role of healthcare provider. Together with the dementia care organisation, the informal caregiver will take care of the patient.

Patient with dementia

Not only the informal caregiver will become more active in the care of the patient. Also the patient itself will take a more active role in ensuring the improvement of his or her own situation. The dementia care organisation will provide training to the patient and supported by SHAAL the patient will be able to manage and improve their lifestyle.

In conclusion, we can see that the roles of the patient, informal caregiver and the dementia care provider will evolve with SHAAL. The stages in the transition are characterized as 'caring for' ('zorgen voor') that evolves to stage of 'caring with' ('zorgen met').

Dementia care that is initially solely provided by the dementia care organisation, all other mentioned roles will take on a share of the care delivery, where the dementia care organisation will take on a more supportive role in which it will transfer knowledge and expertise to the patient and their informal caregiver. The role of the dementia care organisation can, however, still be described as healthcare provider.

Missing role in the current value network

As mentioned before, the dementia care organisation will co-create SHAAL with digital health product providers. This role is missing in the current context of dementia. SHAAL technology can be divided into software and hardware, while assuming that the digital health product provider is specialised in both, we will assume that this role is sufficient for SHAAL technology. The organisation that takes on the role of digital health product provider will also provide installation and maintenance services to the dementia care organisation.

It is unclear whether the role of the general practitioner and the insurance company will be impacted, however it is safe to say information technology like SHAAL will provide opportunities for both to improve their services e.g. the GP can have more insight in its patients and detect dementia in earlier stages and the insurance company could find new reimbursement policies coupled with the information collected by SHAAL.

Future value network configuration

The previously identified missing actor, role and its activities (tab. 5) will be combined with the roles that were identified to be critical to the current dementia care network (fig. 1) to form a new value network configuration, which is displayed in figure 2.

SHAAL value network roles. (Table 5)

Actor	**Role**	**Activity**
Patient with dementia	Citizen	Receive medical treatment, care and support Pay insurance fee
Informal caregiver	Health care provider	Provide basic care and assistance to daily life activities
Dementia care provider	Health care provider	Provide medical treatment and care to patient
SHAAL developer	Digital health product provider	Provide SHAAL software and hardware

		Installs and maintains SHAAL
Insurance company	Finance provider	Reimburse the SHAAL services
General practitioner	Health care provider	Refer patient to dementia care organisation

Extending the current value network with the missing role of digital health product provider and update the existing roles, the future value network is configured as follows:

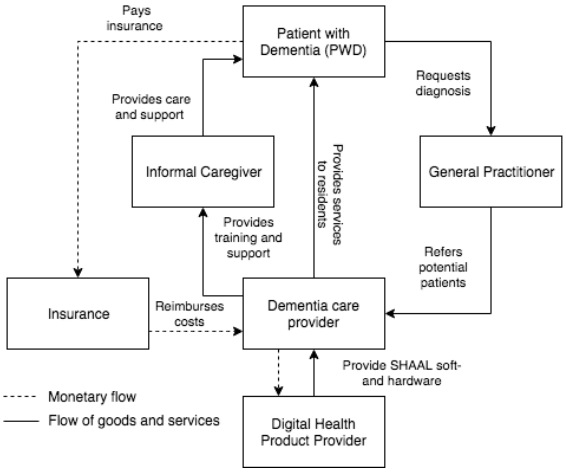


Figure 2. Value network configuration of dementia care with SHAAL

Further evolution of dementia care

Further transitioning of dementia care continues the decoupling of the dementia care organisation from the care delivery process. Dementia care will transition to a stage characterized as "ensure that" ('zorgen dat'). In this phase, the activities of the dementia care organisation will only include dementia care that can be described as highly specialised treatments, if these activities are not already outsourced to external specialists. Activities that can be now considered at the core of the organisation are those activities that will ensure that the informal caregiver and the patient can perform most of all the activities necessary to improve health outcomes from medication to treatment. Through focussing on training and educating the PWD and the IC, and having developed core capabilities and knowledge in technology, the role will be a combination of digital health product provider and health educator or advisor.

4.2 SHAAL and Business Model

In this section, we will analyse the business model of the dementia care provider according to the business model canvas framework. As described in section 3, the case study of Geriant provides the data for this analysis.

4.2.1 Dementia care business model analysis

The **value proposition** of a dementia care organisation is described by providing the client a supportive environment that enables the client to live longer at home independently and increasing the overall quality of life from the first presumption of dementia until decease. Moreover, the dementia care provider educates and supports the client's informal caregiver. Identification and understanding of the **customer segment** is a key business model element. Any organisation needs to determine the different targeted customers' needs and wants in order to fit its products and services to the customer. The value proposition of dementia care is described as the creation of a supportive environment that enables people with dementia to live at longer at home, while sustaining the life of both its clients and their informal caregiver.

The **channels** element describes how the product or services is communicated with the customer segment to deliver the value proposition. The dementia care organisation finds its clients through its partnerships with the general practitioners. In case of the presumption of dementia by the general practitioner, the client is referred to the dementia care provider. The **key activities** element describes how value is added to the product or service by describing the required activities for delivering a service. Three key activities can be considered as crucial to dementia care. Case management plays a central role in coordinating activities with external network partners. The second key activity, counselling; training, and support of informal caregivers provides the informal caregiver with the knowledge and skills to provide basic care and support for their relative, but also educates the informal caregiver on dealing with the stress and other activities related to the patient's situation. To ensure care continuity and alignment across services both at strategic level and professionals' daily care practices, care integration is an important activity of a dementia care provider. Dementia care is provided in collaboration with its **key partners**. The key partners' element describes the relationships with other organisations such as suppliers and buyers, but also strategic partnerships around the creation, sales and or delivery of the product or service. Generally key partners of a dementia care organisations are the general practitioner, hospital, care home, informal caregiver, nursing home, home care and social care organisation.

The resources required for the execution of the activities are described described by **key resources**. Key resources of a dementia care organisation are its building(s) in which it operates and houses its other key resource, its employees. The clients' informal caregivers can also be considered a resource, because they are engaged as partners and are included in the inter-organisational care teams from the beginning of the care trajectory. All key costs incurred by delivering the service are described by the **cost structure.** The cost structure is build up from salaries of employees, and other operational costs such as rent, and hardware and software. The **revenue stream** describes how revenue or profit is generated with the

product or service and cover previously described costs. Revenue is generated by the reimbursement of the healthcare services' costs by its clients' health insurances. **Customer relationship** element describes the nature of the relationship between the customer and the product or service. The relationship of the dementia care organisation with the customer can be characterized as a personal, long-term relationship that offers dedicated personal assistance on a recurring basis that is according to the changing characteristics and needs of the clients and their informal caregivers.

4.2.2 Potential benefits for key network roles

The first step in analysing the impact of SHAAL on the dementia care business model, as described in section 3, is the identification of potential benefits of SHAAL to the key roles in the value network, found in section 4.1.2 (see table 1.)

Patient with dementia

For the patient with dementia, SHAAL has the potential to improve the quality of life. [50] Memory loss is a main symptom of dementia due to cognitive impairment. In daily life, PWDs can lose keys, TV-remotes and other frequently-lost-objects (FLOs), which can compound the frustration and depression of the PWD. SHAAL offers solutions that can help the patient in daily life activities e.g. locating frequently lost object and reduce the negative emotional impact of dementia related to memory loss. The major reason for patient displacement to care homes is the high risks associated with the patients' independent living. For example, the risk of falling and not being able to get help or the patient forgets that he is cooking and leaves the fire on creates a highly unsafe environment for the patient and their surroundings. With SHAAL the patient can be notified and reminded of potential hazardous situations e.g. that the stove is on or the notifying of the informal caregiver or a health care organisation that the patient has fallen and requires help. This will reduce risks associated with dementia by creating a controlled environment for the patient, allowing the PWD to stay at home for a longer time. [50, 53]

Informal caregiver

The benefits for the informal caregiver result from the increase of the PWDs wellbeing and safety. The informal caregiver equipped with SHAAL technology can become aware in case of emergency or to check on the patient reduces the stress associated with not knowing what is going on with the PWD. [51] The burden of the informal caregiver associated with stress is a main reason for admission to a nursing home. [47] With SHAAL the informal caregivers' quality of life can increase.

Dementia care provider

For the dementia care provider, the benefits of SHAAL include the ability to monitor the patient remotely, take better informed decisions based on this data, and have a quicker response to emergency situations. [51, 53] With SHAAL, the dementia care provider could provide these services and increase the quality of care.

Table III: Potential benefit in SHAAL

Role	Benefit
Patient with dementia	Self-care and lifestyle monitoring Automated notification during incidents
Informal Caregiver	Remote monitoring of patient Increase of quality of life
Dementia care provider	Ability to collect data on patients' situation Remote monitoring of patient Active risk and incident management Improved decision making quality

4.2.3 Impact of SHAAL on business model elements

In the previous sections the potential benefits of SHAAL for the PWD, the informal caregiver and the dementia care provider are described. Based on Petrovic's approach described in 3.4, the impact of SHAAL on the existing business model, analysed in 4.2, will be analysed.

In the previous section it is stated that both the patient's environment is safer and quality of life can be improved with SHAAL. The **value proposition** of the dementia care provider should reflect this. The current value proposition states 'creating a supportive environment that allows the PWD to stay home longer', SHAAL increases the safety of the environment and allows the patient to prolong their stay at home. As the value proposition already includes the latter, but doesn't reflect the safety aspect, the value proposition is adjusted. SHAAL also reduces the burden of the informal caregiver and thus improve their quality of life, but this is already explained in the value proposition. The new value proposition is enhanced with the safety aspect and reads: 'Creating a supportive environment that enables safe ageing-in-place for people with dementia, while sustaining the life of both the patient and the informal caregiver.'

The **key partnerships** element as explained in the business model analysis described the partnerships with the value network partners identified in 4.1. In the previous part, we identified that the role of *digital health product provider* is missing and will be required in the value network to be able to integrate SHAAL in dementia care. SHAAL calls for strategic partnership(s) with organisations that can develop and provide SHAAL-software and -hardware.

The new activities related to development and usage need to be reflected in the **key activities** element. The dementia care provider is now able to actively and remotely monitor the patients' situation, but this would require additional business activities including management of this activity, but also the coordination of the development and maintenance of the necessary soft- and hardware.

Whether **revenue streams** will change is not yet clear. Research describes opportunities for new revenue models such as the 'Shared Savings' model where each value network partner will share in the costs of healthcare proportional to their costs savings through SHAAL.

The **customer segment** of the dementia care provider can be extended by SHAAL. For people with other health conditions that are limited in daily life activities including people with mental disadvantages or elderly people in general, SHAAL can provide solutions to issues related.

Depending on the SHAAL solution offered by the dementia care provider, the communication **channel** and the **relationship** with the **customer** can be impacted. With sensors installed in the patient's house the dementia care provider will indirectly be more present in the house and the relationship will be more intimate. Some SHAAL solutions can be used by the care provider to communicate directly with the patient. Assuming that SHAAL offered by the care provider will include direct communication and remotely monitoring the channels and customer relationships element will change.

The current **key resources** element doesn't reflect the important role technology in future dementia care. The existing **cost structure** also does not include the costs related to technology. The investments costs related to the development, but also operational, and maintenance costs of SHAAL technology will be a significant part of the future cost structure in dementia care.

Bridging the gap

Evolving from the current role of dementia care provider to one that fits with the potential future value network of dementia care requires determining what future role is desirable for the organisation and its overall strategy. Given the degree of knowledge and capabilities in the development of digital products, a trade-off has to be made between acquiring new knowledge and capabilities related to digital product development and a strategic partnership with an existing digital product provider, or a combination of both. In any case the identification of local digital product providers for potential partnership, but also the required knowledge and capabilities for digital product development is necessary to support this decision making. In this assessment, the transaction and opportunity costs, and other costs including the development of new knowledge and capabilities related to the different methods of developing the organisation in the new market can provide useful insights to the dementia care provider in this potential transition.

5. Conclusion

A value network analysis on the current situation of dementia care has given insight into the current existing roles in dementia care. By understanding the current roles and their activities and those that are required for the potential integration of SHAAL in dementia, the absence of the digital health product provider role was identified. Moreover, the role of dementia care provider will change as she will take on additional activities related to SHAAL, but also activities related to training of the informal caregiver and the patient as its role transitions towards a more supportive one. Another important change in an existing role is that of the informal caregiver. With training and support from SHAAL the informal caregiver is able to take on more responsibilities in taking care of the patient. With more capabilities and knowledge, the role informal caregiver evolves to a more direct and active, and sometimes even formalised role of healthcare provider.

The transition of dementia care enabled by SHAAL will add complexity to the value network. The transition from the current to the future value network configuration will see the addition of the new role of digital health product provider, but also change in existing role descriptions including the transition of the informal caregiver from citizen to healthcare provider. Suitable candidates that can fulfil this role would be those with both consumer and medical, and technical backgrounds. This new role enables new business opportunities and has a strategic position in the dementia care value network for which still a viable business model needs to be found. [54] A joint venture between a dementia care provider and a digital product provider could potentially bridge this gap.

It is likely that through the integration of SHAAL all elements of the business model will be changed. As mentioned before, partnership with digital health product providers is necessary to provide SHAAL solutions to patients. New costs, resources, and activities will add to the existing business model. The existing value proposition will be enhanced as SHAAL will ensure even more safety and aging-in-place for the patient.

With various SHAAL solutions the distance between the dementia care provider and the patient is virtually decreased a will open up new communication channels. By being more present in the life of the patient the relationship with the patient will be more intimate and this has raised concerns around privacy that need to be addressed first.

As SHAAL provides solutions to problems not only present in the dementia segment, the targeting of new customer segment can be explored by the healthcare provider. SHAAL can also provide solutions such as cost savings to other organisations and new revenue models such as the Shared Savings model can be considered in healthcare business model innovation with SHAAL.

In conclusion, SHAAL provides the opportunities to improve the current situation in dementia care and for the patient with dementia, their informal caregiver, and the dementia care provider, but this requires that technology becomes an inte-

gral part of dementia care, in how the value network and business models are designed. This requires a transition from the current to the future value network proposed in this paper, including the addition of new roles and the evolution of existing ones.

6. Theoretical and practical implications

The structured approach taken in this paper to evaluate the impact of health information technology on the business, both value network and business model, can be used in further research on business model innovation with technology. By taking a business model perspective that integrated a value network analysis the various challenges and opportunities related to technological innovation can be identified. The results show that through the potential integration of the technological innovation SHAAL dementia care will see the adding of new business activities, or changing roles of network partners which is described by Chesborough (2007) as business model innovation. Moreover, the results show opportunities for new business models which are explained by the new role of digital health product provider that would require the new formation or transformation of current health and/or technology-oriented organisations.

As e-health innovation tends to be focussed on the technology instead of actual value creation for the customers, the application of the business model in the research of health technology provides a new perspective that can potentially increase the viability of new e-health business models such as a SHAAL-based business model in dementia care. The results can provide an understanding of SHAAL technology to dementia care providers, but also offer insight for the integration of SHAAL into their business processes. Moreover, the results implicate both the potential business opportunities and the co-existing challenges of new and transforming roles in the value network of dementia that could provide insights to both the healthcare- and the digital products provider that could take a strategic position in the potential future value network of dementia care.

7. Limitations and discussion for further research

Due to the emergent stage of technology in dementia care and healthcare in general, studies on cost-benefit analysis were not found for this specific technology. The expert interview showed that cost-benefit studies still need to be conducted.

The viability of business models based on SHAAL needs to researched. The insurance company will play an important role in the commercialization of SHAAL in dementia care and will need to be included in the development as the deployment of SHAAL depends on whether the insurance company is willing to reimburse SHAAL services. Additional research on revenue models is required to design new business models or innovate existing ones to identify appropriate alternative revenue models for SHAAL.

Moreover, challenges surrounding healthcare regarding system interoperability, privacy and security concerns can impede the adoption of SHAAL. [51] To understand challenges around integrating the SHAAL technology with the existing IT architecture of dementia care providers a research is necessary to shed light on possible problems and or solutions of this integration and further support the adoption of the SHAAL in dementia care.

The study involves only one dementia care provider. Additional cases can strengthen the study's external validity. Although the expert interview provided insight into SHAAL technology in dementia care a real case study of a dementia care provider that uses SHAAL in their care processes would provide more valid results, however such a case was not found. This is due to the 'pilot-stage' of SHAAL in dementia care. A quantitative approach could have been interesting to research the current stage in the evolution of the value network. An insight into whether dementia care providers are developing new knowledge and capabilities to develop SHAAL-services or to what extent new startups are taking on the new role of digital health product provider.

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