Towards Influencing Factors on Business Models of Ambient Assisted Living Systems

An Analysis of the German Health Care Markets

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***Abstract* — The aim of this paper is to close the research gap by combining state-of-the-art theory of value chain characteristics, business model definitions and financing options in order to realize profitable business with Ambient Assisted Living (AAL) systems. Relating to value chain characteristics, three main categories of elements are detected when comparing several approaches. In terms of AAL business models, a suitable definition is derived which is able to describe the creation of value in a multi-company environment. In order to conduct profitable business, both German health care markets are compared with their specific advantages and disadvantages. Due to the high burdens of Governmental restrictions in the primary health care market, AAL business models should focus on the secondary health care market in the near future. However, further research is required how to integrate service companies, whose daily business is to care for older people, into a business model as distributors of AAL technology.**

Keywords-Ambient Assisted Living; AAL; Business Model; Financing; Value Chain

I. INTRODUCTION

Demographic ageing as an aspect of demographic change is one of the global mega trends in the 21st century [1]. One of the most affected countries is Germany whose population will be one of the oldest in the world by 2035 [2]. By the middle of this century, more than half of Germany's inhabitants will be older than 50 years and the proportion of people aged 60 years and over will increase from 26 per cent in 2011 to 38 per cent in 2050 [2] [3]. Analogically, the group of the over eighty-year-old will triple to more than 10 million people [4]. Although ageing is not automatically equivalent to the need for care, the majority of the elderly increasingly relies on assistance, support and medical care with advancing age. In consideration of demographic change, this will lead to massive costs associated with care giving [5].

To counter this process, new care delivery models supported by information and communication technologies (ICT) are being developed under the name Ambient Assisted Living (AAL) [6]. Despite its tremendous market potential, the AAL branch is yet to make a mainstream breakthrough [5]. Although many devices and systems have been developed in the past years, there is a lack of comprehensive and commercialized AAL-solutions which truly meet customer demands [7].

In connection with this finding, the main problem is seen in the unwillingness of customers to handle the complexity of coordinating different partial solutions. Thus, the customer process must be comprehensively supported by a network of enterprises, offering an all-inclusive, easy-to-handle solution. This also means, from the view of organizational studies, the necessity to develop new forms of collaborative service delivery as well as sustainable and viable business models for enterprise networks [4] [7]. Although present business models of AAL projects are based on governmental or semi-governmental funding, many of these projects have not yet achieved permanent financing [8]. Due to this fact, missing business models are almost unanimously considered to be the greatest market obstacle to a broad implementation of Ambient Assisted Living systems [5]. Therefore, this paper gives an overview of influencing factors on AAL business models and analyzes how they stick together in order to run a profitable business.

II. BACKGROUND

In recent years, Ambient Assisted Living has developed into a decisive factor for scientific and market-oriented research into ageing populations [5]. AAL refers to a situation whereby an electronic environment reacts sensitively and responsively to the presence of people and provides assistive propositions [1]. These solutions can take the form of assistance for daily activities, health and activity surveillance, access to social and medical emergency systems as well as easing social contacts [8]. Accordingly, the AAL market can be divided into the four segments "Health & Homecare", "Safety & Privacy", "Supply & Household", and "Social Environment" referencing the definition of the German Federal Ministry of Education and Research [9].

Since AAL was notably promoted on the political level, most innovative products and services based on technological developments instead of customer demands [10]. In this context, a study by Steinke et al. [11] proved a strong significant correlation between attitude toward a product or service and purchase intention. This means that

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the elderly are willing to pay for AAL products and services when customers' demands are truly met. Thus, from the perspective of innovation literature, AAL solutions rather refer to the term “technology push” than “demand pull” [10]. This trend mainly resulted from the early focus in scientific research on the development of technology without considering the business side [12]. In this process, several authors such as Osl et al. [13], Balasch [14] or Rosales Saurer et al. [15] examined customer requirements from different perspectives in order to give an integrated view on customer requirements for the development of holistic AAL solutions.

Although suitable products and services were created subsequently, many were not introduced into the market since the projects were often discontinued at the end of the funding period due to missing business models [8]. This is why the German AAL Congresses emphasized AAL business models in order to set foundations to ensure sustainable business success without governmental funding. Therefore, three interrelated topics were figured out to be most important: Value chain characteristics, business model definitions for value networks and financing options.

In this context, Balasch [14], Gersch et al. [16] as well as Sassen et al. [17] developed value chain models to provide a framework for the creation of hybrid products in AAL enterprise networks. All of them came up with related groups of actors needed for viable business models. Since there was no commonly agreed definition of business models for value networks in the context of AAL, researchers defined specific elements. In addition, various financing options were analyzed and linked to existing business model definitions. However, the interconnectedness of these three topics has not yet been clearly demonstrated. Hence, the research question reads as follows: How are state-of-the-art theory of value chain characteristics, business model definitions for value networks and financing options interrelated in order to realize profitable business with AAL systems?

Hence, the structure of the paper reads as follows: The introduction and background sections outline the need for AAL and explain why, despite working technology, financial aspects are needed to make a mainstream breakthrough. From the perspective of the value chain, the third paragraph gives reasons why only networks of specialized providers are suited to offer customer-oriented solutions. In the fourth segment, a suitable business model definition for hybrid value creation is derived. The fifth part outlines the financing options of AAL technology and services in both German health care markets. The sixth section concludes that practitioners should concentrated on the second health care market and the last paragraph reveals how still missing distribution partners and sophisticated revenue models may help to implement AAL solutions in the market.

III. VALUE CHAIN CHARACTERISTICS

The implementation of AAL solutions via a fully integrated business model cannot be realized by a single protagonist. The social and the health care systems require new combinations of resources and competencies which cannot be found in any existing corporation [16]. Thus, value networks consisting of legally independent, but interdependent organizations are necessary which have the potential to resolve the conflict between a high level of specialization and a broad range of services [8]. Only several partners will be able to create solutions consisting of a variety of products and services, which meet the conditions of hybrid products. These solutions have to be developed with reference to hybrid value creation. As hybrid value creation applies in the context of a single company, the creation of value in terms of AAL can be considered as an advancement of traditional hybrid value creation [18]. In the course of this, the various services need to be bundled in accordance with the long established principle of “one-face-to-the-customer”, via the use of the customer process of business-to-business (B2B) relationships [19]. This means that a global solution for the customer with a comprehensive support of customer processes is essential [13].

Since there is the necessity of enterprise networks to implement AAL solutions, a new or at least modified value chain compared to value creation in single companies is required. New and innovative solutions are created partly by changing and combining the existing elements used for value creation of different protagonists and partly by adding new components. Hence, Balasch [14], Gersch et al. [16] as well as Sassen et al. [17] provide new value chain models with various elements customized for the added value of AAL. Despite some varieties, their models only differ marginally. With the exception of one missing element, all of them differentiate between three main categories as illustrated in table 1: Infrastructure providers, several types of organizers and different kinds of suppliers or providers. For a clearer understanding of the expressions used, the first two models are explained in detail below (since Balasch [14] did not provide a description).

TABLE I. COMPARISON OF THREE MODELS OF AAL VALUE CHAIN ELEMENTS

Balasch [14]	Gersch et al. [16]	Sassen et al. [17]
Infrastructure Providers	Infrastructure Providers	Infrastructure Providers
-	Orchestrators	Network Manager Platform Operator
Suppliers of Sensors/ Devices Service Providers	Components Suppliers Specialized Suppliers Industrial Service Providers	Providers

According to Gersch et al. [16], *Infrastructure Providers* make the platforms and services, needed for the interaction of all protagonists involved in the solution, available. When considering the associated investments, the provided platform should be used by many users for diverse activities and implementation scenarios. *Orchestrators* coordinate value networks as a user of the provided platform. The main task of an orchestrator is to identify and choose the best specialists within the different value chain steps, to initiate

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their cooperation in a value network, and to coordinate their activities with the objective of creating competitive advantages for the whole service offering. *Components Suppliers* provide functional components or end devices, which work either as a standalone device or are linked to other components and devices. *Specialized Suppliers* focus on service provision for one component integrated in the offering of the network. This service is independently marketable at the same time. Users of the services supplied by orchestrators may be end-users as well as focused suppliers, which also demand services from *Industrial Services Providers* to realize their own service offerings.

In accordance with Sassen et al. [17], the *Network Manager* provides services to the client with its own name or brand. It acts as general contractor and is liable to the customer. The providers, in turn, are liable to the network manager. The cooperation between all the suppliers is set by the network manager. The *Platform Operator* determines the cooperation strategy and executes all operational activities. It defines the processes of the providers offered on the platform. Furthermore, it takes orders from customers who hired a service provider, issues invoices and receives complaints. The *Infrastructure providers* offer the platform as a system. It is crucial for them to use the infrastructure in many application areas. *Providers* offer services to customers. In this process, many different service providers take over the role of the provider.

In addition to the definition of the elements in an AAL value chain, there is the need to investigate how large-scale networks of heterogeneous enterprises are able to do business which is profitable for all participants [7]. Therefore, the following section discusses various business model definitions and explains how an appropriate AAL business model definition has to be built-up.

IV. BUSINESS MODELS

The origin of the business model term as a concept in practice or science has not been conclusively resolved as of today [19]. Since it was mainly discussed by practitioners and investors, it was seldom defined explicitly [21] [22] [23] [24]. Wirtz [25] refers to the long conceptual development of the business model concept which was repeatedly shaped by various trends and connected with different schools of thoughts. This has been supported by other authors such as Samavi et al. [26], Osl et al. [7] and Osterwalder et al. [27] who explain various business model categories and approaches. On the basis of their research, Osterwalder et al. [27] defined the business model term as follows: "*A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams.*"

Unfortunately, most business model definitions – including the one portrayed above – were developed for the application on focal firms only. Since value creation in the context of AAL needs to take place within a multi-company environment, a business model for a network of several companies has to be chosen. Hence, numerous authors have also developed definitions for value networks, focusing on the aspect of cooperation and business networking by defining specific model components, such as "network of actors", "network of partners", or "value network". Yet, these concepts have not gained widespread recognition in literature since other elements also depend on the company's inter-connectedness with its business partners as well. Hence, Osl et al. [7] suggest not adding cooperation as a separate component, but rather emphasizing a collaboration perspective within the other items.

Thus, the Business Model Canvas developed by Osterwalder et al. [28] seems to be appropriate to design a business model for AAL systems. Although it was not developed for a multi-firm context, it has a strong focus on relationships between different actors. Further advantages are its intuitive character as well as the possibility to illustrate the Building Blocks graphically. Thus, the Canvas is able to describe the creation of value for AAL solutions referring to the logic of [7]. The Business Model Canvas consists of nine "Building Blocks". The names of the Building Blocks read as follows: The Customer Segments Building Block, the Value Propositions Building Block, the Channels Building Block, the Customer Relationships Building Block, the Key Partnerships Building Block, the Key Resources Building Block, the Key Activities Building Block, the Revenue Streams Building Block, and the Cost Structure [28].

V. FINANCING OPTIONS

For health care and nursing related products and services – as developed in the context of AAL – there are two markets for financing: the primary and secondary health care market. Gersch et al. [10] call them "arenas" for AAL business models. The primary health care market is the core of the German health care system along with its institutions and medical providers. It is characterized by the medical treatment of all ICD-10 indications and corresponds to the mainly solidarily financed partition in the context of standard care [16]. It includes medical care provided by contributions from the legal and private health insurance, the nursing care insurance as well as from other social security systems and government grants [10].

Besides the primary, a secondary health care market with mainly privately funded health-related products and services has been established [16]. In contrast to the primary, the secondary health care market focuses largely on privately financed, health-related services [10]. Thus, it is characterized by much stronger market potential. Social acceptance and increased value of AAL solutions can be realized if the independent customers, who wants to provide for their old age, or that of their relatives, is addressed.

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Here, the willingness to pay is directly correlated with the significant added value for users and customers [14].

Although the primary health care market with its institutions and providers is still the core of the German health care system (output volume in 2008: 221 billion EUR or 77.5 per cent), the secondary health care market gains in importance (total size 2008: 64 billion EUR or 22.5 per cent). Due to the reduction of funds in the publicly funded sector as of several health care reforms, the secondary health care market has been registering high growth rates (in recent years already 5.5 per cent). At the same time, the growth in the solidarity-funded health care spending was significantly lower (only 2.1 per cent in the same period).

Despite the apparent differences of the primary and secondary health market, a general trend can be observed that the primary and secondary health care markets are growing together and will complement each other in the future. With the aid of AAL solutions, a so called "third health site" will be established alongside existing outpatient care and in-patient service provision [10]. In combination with the primary and secondary health care market as well as the three different health sites – in-patient care, out-patient care and care at home – six segments for health related services can generally be targeted with AAL solutions as depicted as shown in table 2.

TABLE II. SIX SEGMENTS IN COMBINATION OF TWO HEALTH CARE MARKETS AND THREE HEALTH SITES MODIFIED FROM GOLDSCHMIDT ET AL. [29]

Health care markets	Secondary health care market	IV	V	VI
	Primary health care market	I	II	III
		Second health site	First health site	Third health site
		In-patient care	Out-patient care	Care at home
		Health sites		

Besides the basic types of potential revenue models for the primary and secondary health care market, products and services developed and offered at the interface between these two markets can also be observed. These hybrid models try to combine several basic types of potential revenue models and financing systems of both health care markets. The best known of these hybrids are co-payment and deductible models. In addition, there are also a number of different premium, saving and apportionment models. Premium models mostly complement state-funded primary care, as the utilization of additional offerings has to be paid privately. Within the scope of saving models, partially funded health care financing is discussed. Apportionment models are insurance models which work similarly to the current social security system. In accordance with the principle of risk sharing, a direct redistribution of the group of payers to benefit recipients is fulfilled [10].

VI. DISCUSSION

Recapitulating, innovations in the primary health care market need the mobilization on the political level as they are dependent on changes in regulation [30]. The advantage of a solution for the primary health market is that only a few institutional payers have to be convinced instead of many individual customers with low willingness to pay [31]. In contrast, innovations in the secondary health care market are driven more by market demand. These innovations can better evade governmental regulation, but clearly rely on visible value propositions and value-added architectures in order to successfully establish on the market [30]. However, there is also the possibility to reach large customers, such as housing associations. In doing so, each client generates considerably more revenue instead of many small and individual customers and it is more likely to reach the critical mass faster.

Nevertheless, a business model in the primary health care market is not preferable at the moment. Particularly health as well as nursing care insurances only pays for products and services in case an immediate savings potential – which means within one year – can be proved. Since innovations in the context of AAL have scarcely been able to prove this requirement as the amortization period normally lasts distinct longer, the potential to implement a cost-effective business model in the primary health care market has been low. In terms of a business model in the secondary health care market, customers' willingness to pay needs to be analyzed in detail for a specific solution to be successful in the market. The requirements for this are the outcomes from several studies. Whereas some detected a general low willingness to pay, especially in relation to product supporting services [32], others pointed out that the willingness to pay increases significantly if the offers exactly meet clients' requirements. And others again came to the conclusions that the price represents a secondary criterion from the customer perspective. According to this, it only becomes important if the consumer is not able to find any difference in the quality between certain services [13].

By implication, this means that there is considerable demand potential for quality-reduced low-cost offers with respect to services. In order to reach this target, differentiated offerings for price-sensitive customers as well as quality-oriented customers with higher willingness to pay have to be designed [13]. On the one hand, this can be realized by the cross-linked implementation of AAL solutions into integrated care processes [16]. On the other hand, cross-subsidization in the context of hybrid products are necessary elements to offer cheaper products for the mass market similar to many other industries financing forms [16].

VII. CONCLUSION AND FURTHER RESEARCH

Due to demographic change, the development of new solutions to assist the elderly in their daily routine is of high

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economic importance. Despite the Government funding of 18 research projects [33] and the development of suitable products and services, there is still a lack of comprehensive solutions as well as interlinked business models for value networks [5].

With reference to business models and the recommended solution for the secondary health care market, it might be reasonable to consult companies such as Caritas or Diakonie, whose daily business is caring for the elderly, and convert them as distributors in a large value network. Since nursing and even more medical services evade in many parts from the objective assessment of lay people, the setup of medical reputation requires branding. In doing so, a professional appearance and distribution as well as sustainable quality management and quality communication has to be implemented [34]. Therefore, a business model or revenue model, respectively, including brokerage fees for these companies has to be designed. Since these companies are often operated not-for-profit, further research is needed to investigate how these firms can yet be integrated into the creation of value in the context of AAL.

Further research is also required for an optimal pricing of hybrid products developed and distributed in a multicorporate context, such as AAL. Whereas basic approaches for focal firms are described by Burianek et al. [35], their model needs to be transferred to value networks. In view of hybrid products, the clients do not pay for certain components of products, but rather for the functionality of a solution. Thus, pricing should be aligned to the proportion of value added for the customer and pricing systems by applying usage based pricing, performance based pricing or value based pricing. However, there is still a research gap how to apply these pricing systems to a value network, especially with respect to direct cross-subsidization and potential to create a lock-in situation, which bases on products and services of different companies.

In addition, AAL offerings are typically characterized by a variety of economic anomalies which influence the diffusion process in the market directly or indirectly. First, there are uncertainties between special vendors and the demand side. Second, high investments with regard to potentially imbalanced fixed costs and related business risks have to be compensated by the involved companies. Third, the need for cooperation of several actors of the supply and demand side exists. In this context, the development and coordination of complementary division of labor structures each contributing to individual services or business processes in order to implement a comprehensive solution needs to be established. In addition, there is the need to price AAL in accordance with the legal framework of the primary and secondary health care market. Lastly, individual AAL offers may need a critical mass in case the benefit for each adopter depends on the number of additional users connected to the system [10]. Concluding, these issues must be resolved in order to establish viable and sustainable business models in the context of AAL.

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