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AUTHORS	Antti Vanhala Mika Immonen Mikko Pynnönen

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Antti Vanhala (Finland), Mika Immonen (Finland), Mikko Pynnönen (Finland)

Developing an assistive service offering for aging citizens

Abstract

The article proposes a demand-based evaluation of a smart home construct for elderly care solutions. The aim of the paper is to provide method for managing the development of customer driven services. Needs of aging citizens are positioned in the center of the study to which services conducted. For this purpose, it is essential to analyze the constructs as bundles of functionalities rather than technical features and devices for particular purposes. The authors use the Quality Function Deployment (QFD) process to assess the service offering. The method is potential for framing constructions from rich data sets which combines qualitative and quantitative data. The QFD method can be used to convert customer needs into product designs by systematically deploying the relationships of customer demands and product characteristics. By the findings, the smart home concept must be more than a plain technology-based solution. The impact on the well-being of aging citizens depends on services which solve issues related to limited functionality. Customers must also be involved in implementing the systems to ensure the appropriateness of offerings. Furthermore, the role of cross-industry networks is growing in the future when comprehensive smart home service systems are implemented.

Keywords: customer need, customer segmentation, service management, service offering, smart home, Quality Function Deployment.

Introduction

This article proposes a demand-based evaluation of a smart home construct for elderly care solutions. The aim is to provide a framework for managing the development of a service driven by customer needs. In this article, the needs of individual users and aging citizens are positioned in the center of the study. When developing services based on customer needs it is essential to analyze the constructs as bundles of functionalities rather than technical features and devices for particular purposes. This distinguishes the article from reported studies on the subject.

We approach the topic from the perspective of service-product offerings that improve security at home, prevent loneliness by fostering the social contacts of elders and support the health care system to develop appropriate performance. The selected research approach connects this research to the topical question of how aging affects the viability of welfare societies. Most Western countries are aging at an increasing pace which makes funding public services a major concern. Especially, social and health services will play a major role in the total expenditure of municipalities and states in the future when the share of retired citizens grows.

Smart homes have been seen as a partial solution for issues emerging from aging population, because health care systems in many states are searching alternatives for institutionalization (Skubic et al., 2009). Assistive technologies would lengthen the span of independent living among the elderly in the near future if the concept provided appropriate functionalities in relation to user demands. Before the visions are realized, the decision makers must understand the value creation logic behind smart systems. The development of systems and services should be directed not only to cut costs but also to enhance the comfort and well-being of the elderly in general, which may have more longstanding impacts on the control of public finance.

The resource-based view of the firm and business networks provide theoretical models on which the service model analysis is based (Kothandaraman and Wilson, 2001; Barney, 1991). Overall, the service is a unified business model of a network where several actors produce value to the customer and to each other. Value is created not only inside a single firm but also in the networks among several firms. The firms are assumed asymmetric regarding their resource basis, because of the path dependency and immobility of resources among firms. In this situation, no single actor is able to construct a complete service model. The reason is the value generation logic of the service which requires a collection of complementary resources possessed by asymmetric firms and the co-creation of value between the network and customers.

Two types of data, qualitative and quantitative, were applied in this study which directs to determine smart home solutions for elderly care. At first, quantitative data was gathered using structured interviews. We applied the quantitative methods for explorative purposes which provide basis for segmentation of customers. In the second phase, we use the Quality Function Deployment (QFD) process to assess the service offering in this paper. The method was selected because of its potential to frame constructions from rich data sets which may include results from statistical analyses, interviews and Delphi studies. The QFD method can be used to convert customer demands into quality characteristics and to develop product design by systematically deploying the relationships of customer demands and product characteristics (Lee and Ko, 2000).

The study shows that the smart home concept must be more than a plain technology-based solution because the impact on the well-being of aging citizens depends on services which solve issues related to limited functionality such as cooking and running errands. However, the technologies have an important role in maintaining functional ability and mental health if the target of the solutions is to promote health as well as foster and maintain social networks. Customers must also be involved in implementing the systems to ensure the appropriateness of offerings which varies between segments. Furthermore, the role of cross-industry networks is growing in the future when comprehensive smart home service systems are implemented. Thus, information exchange ought to be one of the most crucial points at the design and implementation stage of smart home networks. The sellers of solutions must think outside the box and consolidate their marketing message at the network level, as well as recognize the value generating elements of the smart home systems.

1. Smart home solution in elderly care

Finland is one of the countries where the transformation of the population structure has been significant. In 2008, 54 percent of the total expenditure in Finnish municipalities was caused by social and health services (Statistics Finland, 2009). Growth in the total expenditure of social and health services has been 34.6 percent (from over EUR 13 billion to over EUR 17.5 billion) from 2003 to 2008 (Statistics Finland, 2009). This kind of expenditure growth in just five years could tie even more funds to social and health services during the next decades. This will happen at the cost of other services, if no other service solutions are found.

The development of assistive technologies would provide solutions to elongating the period of independent living of the elderly in the near future. Assistive technologies can be used to build up a home where technology is ubiquitous, that is, a smart home. The smart home has been seen as a potential solution to cut the costs of social and health care in modern societies by deferring institutionalization, increasing the efficiency of home care and empowering families to care for their elders (Chan et al., 2008; Skubic et al., 2009). However, cutting costs is not the only advantage brought about by technology; it also enhances the comfort and well-being of the elderly in general (Skubic et al., 2009).

To adjust these different needs of the health care provider and customers it is essential to have a coherent view about the needs of customers and then design the service to fit these needs. Organizations have to develop a *customer driven business model* by integrating customers into their R&D and innovation processes (Thomke and von Hippel, 2002). Creating customer driven business models requires capabilities to innovate and redesign the business model, i.e., *business model innovation* capability (Chung et al., 2004). Only after this the service offering should be fitted to the needs of the organization itself. If a firm is to provide value and remains competitive in the eyes of the customer, it faces the major strategic challenge of managing the fit between its competences and customer value (Gardner, 2001; Normann and Ramirez, 1993). Business models most often fail because they are based on wrong assumptions about customer behavior (Magretta, 2002).

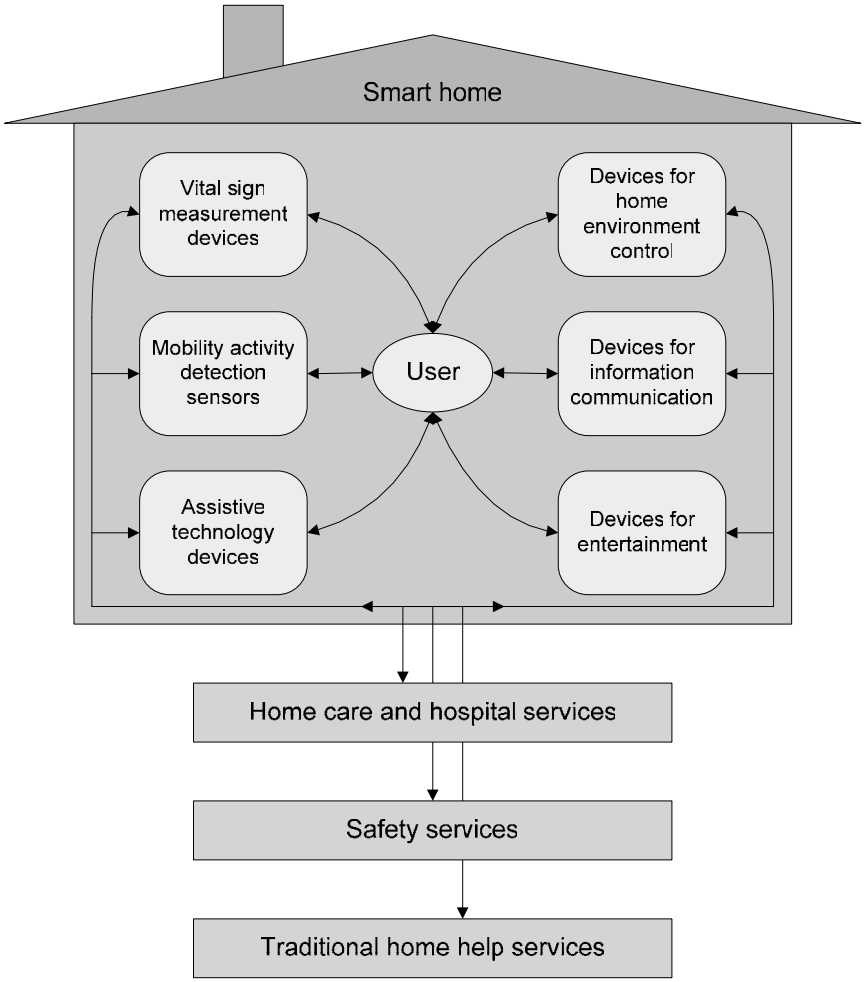
Regardless of the buzz around the smart home and ubiquitous solution, no common definition for the business model exists at the moment. Smart homes can be approached from at least two views. The concepts are often defined either as intelligent solutions at homes to support daily living or as solutions the primary purpose of which is to provide a comfortable life for residents in a home environment. Furthermore some authors have provided more specific definitions regarding the features of the smart home concept:

- Any living or working environment that has been carefully constructed to assist people in carrying out required activities (Chan et al., 2008).
- Acquires and applies knowledge about the environment and its inhabitants in order to improve their experience in that environment (Cook and Das, 2007).
- Built entities in which various products and services interoperate by means of Information & Communication Technologies (ICT) to constitute a product environment (Peine, 2009).
- Uses sensors and other devices and telecommunication features to enhance residents' safety and monitor their health and overall well-being (Demiris et al., 2008).
- Monitors the activities of the person within their own living environment along with how they interact with home automation devices, and based upon these interactions and their current sequence of activities the ambient environment can be controlled and adapted to provide an improved living experience for the person (Nugent et al., 2008).

By definition, the smart home concept should be considered a bundle of technologies, services, and information and service provision resources which constitutes an intricate environment, i.e., a value network of firms with different resources which provides value for its common customer. The resource-based view sees the value network as a col-

lection of complementary and substitutive resources possessed by different firms (Kothandaraman and Wilson, 2001; Barney, 1991). Value is created not only inside a single firm but also in the networks between several firms (Normann and Ramirez, 1993; Barney, 1991; Fjeldstad and Haanaes, 2001). The service system can be understood as the unified business model of a network where several actors produce value to the customer and each other (Normann and Ramirez, 1993). Although there are several definitions for the business model, we have applied the general definition by Timmers (1999) who defines the business model as architecture for product, service and information streams between actors.

In this article, we approach the topic from the perspective of service-product offerings which improve security at home, prevent loneliness by fostering social contacts, and support home care providers to develop appropriate performance. A general construction of the studied concept is presented in Figure 1.



Source: adapted from Chan et al. (2009).

Fig. 1. Illustration of a general smart home construct

Applying novel concepts in service provision in elderly care and, especially, general health care also requires changes in the operation culture among practitioners. Traditionally, the face-to-face meetings of the caring staff and patients have been seen a necessity for health assessments and medical care (Skubic, 2009). The mindset has, however, led to increasing institutionalization regardless of the opportunities provided by novel technology. The issue is twofold. On the one hand, health care providers lack knowledge regarding alternative solutions, technical features and requisite functionalities, as well as their potential benefits. On the other hand, the smart concept has been ambiguously communicated to customers. The marketing of smart homes has concentrated on the single functionalities and technical features of solutions, lacking a wider construction that provides benefits for the customer.

2. QFD as the research method

We developed a process for applying the Quality Function Deployment (QFD) to asses the value of smart home offering for customer. The process aims to combine the customer needs to the smart home platform which consists of multiple service elements

and technology-based solutions. This way it is possible to assess the relative importance of the elements in the firm's offering in contrast to customers' value preferences. The process begins from segmentation of customer basis ending with evaluation of different smart home service constructs through four main phases:

1. Structured interviews and segmentation of aging consumers.
2. QFD – expert panel for assessing customers' needs for assistive services.
3. QFD – workshop for assessing correlation between services and functions of smart home offering.
4. Assessing fit of smart home construct to customers' needs.

The background study is based on data from structured interviews which contains 1392 responses of elders of age over 75 years. The interviews were carried out on a single city area in Southern Finland during the period from 2005 to 2009. This data was used to form the customer segments consisting of elders with similar demand profiles to assistive services.

QFD is a method for converting customer demands into quality characteristics and for developing product design by systematically deploying the relationships of customer demands and product characteristics (Lee and Ko, 2000). The prioritized customer value attributes from the service model are connected to the functions of the smart home construct by applying the QFD matrix (see Figure 2).

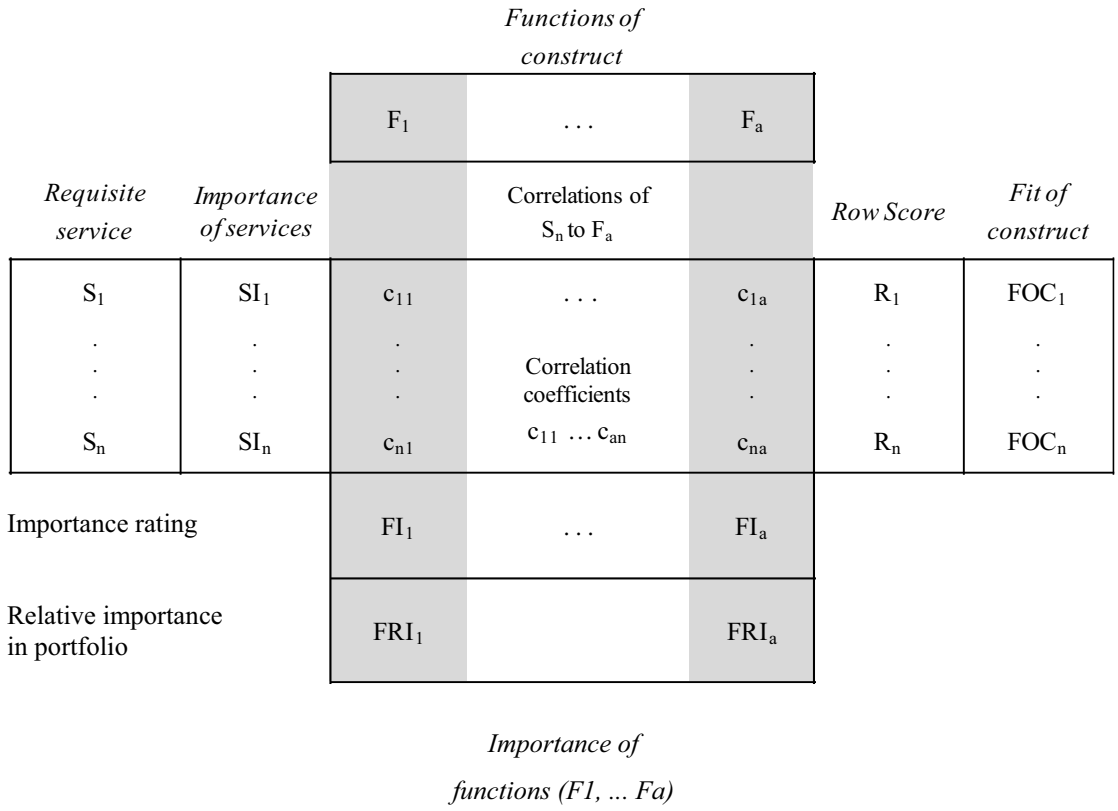


Fig. 2. An illustration of the QFD matrix for assessing service offerings

The requisite services (S_n) were derived from recent academic articles on IADL and ADL which represent nursing science discipline (Freedman et al., 2008; Brokel, Cole and Upmeyer, 2011; van Hoof et al., 2010). The first QFD expert panel directs to assess the importance of requisite assistive services (SI_n). We sent a questionnaire to 60 potential panellists which were told to rate each assistive services using scale 1 (not important) to 7 (very important) in relation to expected needs of recognized customer groups. The questionnaire was answered by 12 panellists (response rate 20%). The second QFD workshop was held with four business and technology experts who focused on assessment of applicability of smart home services and solutions to the specific service needs. The analyzed functionalities were generated through literature review on articles which represent mainly technology and marketing perspectives on the smart home concepts (Heart and Kalderon, 2011; Stowe and Harding, 2010; Wherton and Monk, 2008). The functions of the smart home construct used in the QFD process are based on the following categories (derived from Chan et al., 2009): monitoring, security and safety, social media, home care, and traditional home services.

Correlations (c_{na}) between the each assistive service (S_n) and the functions (F_a) of the smart home concept were evaluated using four step scale (0 = none

1 = low, 3 = medium, 9 = high). The four step scale was selected for increasing resolution power of analysis and for lean analysis process. At the final phase of the analysis we calculated relative importance ($FRI - \%_a$) to each functions and fit of smart home construct to customer needs ($FOC - \%_n$). FRIs (Equation 1) were calculated in order to analyze position of each function in value generation to customer. FOCs (Equation 2) describe the focus of analyzed concept in relation to the manifested customer needs. The importance rating (FI_a) presented in the QFD-matrix is column score index for single function which is needed to determining FRIs. The row score (R_n) is needed to determining FOCs.

Equation 1. Calculating relative importance of a function in relation complete offering:

$$FRI - \%_a = \frac{FI_a}{\sum FI_{1-a}} \times 100. \quad (1)$$

Equation 2. Calculating fit of construct ratings for the analyzed offering:

$$FOC - \%_a = \frac{R_n}{\sum RI_{1-n}} \times 100. \quad (2)$$

Equation 3. Calculating importance of function ratings (column score):

$$FI_a = \sum (SI_{1-n} \times c_{(1-n)a}). \quad (3)$$

Equations 4. Calculating row score indexes:

$$R_n = SI_n \times \sum c_{n(1-a)}. \quad (4)$$

The attributes of the service are the value streams from the main actor to the customer (e.g., delivery of pharmaceuticals or cleaning service). The result of this analysis is the relative priorities for the customer value streams in the business model. The relative importance of a single element in an offering producing value for the customer can be revealed by connecting the weighted value attributes of profiles to the elements of the offering with the QFD process. The importance of a value stream is calculated by multiplying the correlation value in a single column in the matrix by the importance rate of the value attribute. The relative importance of an element is the sum of a column of "preference weighted" correlations. The QFD analysis also reveals the most sensitive value attributes in contrast to the elements of the offerings. The sensitivity is calculated by multiplying the sum of a row with the importance rate of the value attribute. The most sensitive value attributes seem to be convenience and the number of features.

3. Results of the study

3.1. Assessing demand for assistive solutions. Generally the segmentation of customers is grouping the customers with similar needs together. We use the Two Step Cluster Analysis method to form the segments. The Two Step Cluster Analysis procedure is an exploratory tool designed to reveal natural groupings (or clusters) within a dataset that would not otherwise be apparent. The segmentation model includes different variables that describe the customers and the formed groups. In this study we use gender, housing type, morbidity and mode of living as variables to conduct the segmentation. The results of the cluster analysis are presented in Table 1.

Self-care Instrumental Activities of Daily Living ("IADL") scale, Self-care Activities of Daily Living ("ADL") scale and Quality of Life factors (Freedman et al., 2008; Brokel, Cole and Upmeyer, 2011; Finlayson, Mallinson and Barbosa, 2005) provide descriptive factors to clustering model which explains background for remerging needs of assistive services of the elderly. In general, IADL and ADL scale describe one's ability to perform independently basic daily activities (e.g., preparing meals, shopping and managing money) and the most basic physical and personal care activities (e.g., eating, dressing, walking and maintaining hygiene) (Finlayson, Mallinson and Barbosa, 2005). The Quality of Life factors describes extent of positive perceptions and uncomfortable feelings of elders to their current life circumstances which may cause insecurity, social issues and limit elders' ability to continue living at home (Brokel, Cole and Upmeyer, 2011). The issues related with the indicators of ability to independent living were registered during the interviews which allow assessing probable demands for assistance.

Table 1. Description of the observed population

Segment	Person/-s*	Housing type	Size of the segment N (%)	Need for assistance
1	Woman (A) (low morbidity)	Apartment	299 (21.5)	Small repairs and heavy housework
2	Man/woman/couple	Row	59 (4.2)	Small repairs and heavy housework
3	Woman (A) high morbidity)	Apartment	130 (9.3)	Health, insecurity, depression, tiredness, small repairs and heavy housework
4	Woman (O)	Detached/apartment/row	60 (4.3)	Small repairs, heavy and light housework and shopping
5	Woman (A)	Detached	106 (7.6)	Insecurity, loneliness, small repairs and heavy housework
6	Woman (S)	Apartment	133 (9.6)	Small repairs and heavy housework
7	Woman (S)	Detached	124 (8.6)	Small repairs

Table 1 (cont.). Description of the observed population

Segment	Person/-s*	Housing type	Size of the segment N (%)	Need for assistance
8	Man (A)	Apartment	81 (5.8)	Loneliness, small repairs and heavy housework
9	Man (S)	Apartment	173 (12.4)	Heavy and light housework and preparing food
10	Man (A/O)	Detached/apartment	66 (4.7)	Small repairs, heavy and light housework and preparing food
11	Man (S)	Detached	161 (11.6)	Light housework and preparing food

Notes: *Person lives: A – alone, S – with a spouse, O – with someone other than a spouse.
Source: Vanhala et al. (2010).

We recognized during further evaluation of the segments generated through cluster analysis that demand profiles regarding service offering between eleven segments were partly overlapping. Therefore, we simplified the model analytically re-evaluating segments by the focus of service demand and urgency of assistance in each group. Simplifying the original segmentation model provided two benefits. First, the regenerated grouping provides more coherent and understandable view to the service needs amongst aging people. Second, analyzing eleven segments in QFD process is too complex research setting which we expected to provide poor results in relation to effort for accomplishing study. The analytical re-evaluation of the segments led us to build three customer groups in which demands for services delivered at home were consistent. The definitions for the groups are:

- *Group A* (original segments 3, 5 and 8) consists of women living alone in detached houses, women with high morbidity living alone in apartments and men living alone in apartments. The average age in this segment is the highest at 83.2 years. In this segment there are people who have needs that differ significantly from the needs of other segments. Loneliness and insecurity caused by living alone, and severe diseases in some cases, are the major problems in this segment that can possibly be resolved by means of smart home technology.
- *Group B* (original segments 1, 4, 6 and 7) consists of women with low morbidity living alone in apartments and women living with a spouse or someone else. The average age of people in this segment is 82.8 years. The main need in this segment is for repair services probably because the segment consists of women who traditionally are not used to doing any kind of repairs because their husbands usually do or did all the required repair work. From the point of view of smart home technology this segment is challenging as it cannot be significantly helped through any existing technologies, and thus concrete services supplied by a physical service provider are required.
- *Group C* (original segments 2, 9, 10 and 11) is comprised of men living with a spouse, people living in row houses and men living alone or with someone other than a spouse mostly in detached houses. The average age in this segment is 82.1 years. The individuals in this segment are not in immediate need of any services. Future services needed are mainly focused on housekeeping that has probably been done by the wives of the men in this segment.

Group A consists of elders that have the most acute need of services and assistance, but the other segments should not be forgotten while dealing with the most urgent problems. For Groups B and C anticipation is the most important matter to be able to secure the home living of the elderly for as long as possible. By means of anticipation, social isolation and the fast progression of severe diseases can possibly be prevented or at least postponed.

3.2. Evaluating the offering of the smart home. The analysis of the smart home offering began from literature review on service needs of the aging citizens. The literature considered articles in which IADL-scale was applied in service management context. Applying IADL provided us with coherent basis for building research design in relation to other scientific works. Indeed, the content of IADL-scale provides appropriate directions to be analyzed, because it directs to measures one's ability to function in home and community in everyday life from which services can be derived (Brokel, Cole and Upmeyer). The analyzed assistive services represents generic group of functionalities for elderly care which enable higher security at home and a platform to maintain health with support of the smart home solutions (van Hoof et al., 2010; Fänge and Ivanoff, 2009; van Hoof et al., 2011). The requisite assistive services (S_1 to S_n) in the study were (Brokel, Cole and Upmeyer, 2011; Wherton and Monk, 2008; Finlayson, Mallinson and Barbosa, 2005; Monk et al., 2006):

- Running errands, S_1.
- Light housekeeping works (e.g., dish washing), S_2.
- Maintaining personal health and hygiene, S_3.
- Small repairs at home, S_4.
- Heavy housekeeping works (e.g., cleaning), S_5.

- Cooking, S_6.
- Maintaining social contacts, S_7.
- Improving safety at home (e.g., safe phone, health monitoring, burglar alarm), S_8.

The panellists were asked to assess the importance of different assistive services using a continuous scale of one to seven in which the extremities were "not important" (1) and "very important" (7). The overall importance of each assistive service (S_n) of the study is an average of the ratings of its elements. The result of the evaluation for customer groups is presented in Table 2.

Table 2. Importance of assistive services to the customer groups

Service S_n		*Overall importance, SI_n*		
		Group A	*Group B*	*Group C*
S_1	Running errands	6.1***	2.4*	1.7*
S_2	Light housekeeping works	3.9*	2.2*	1.8*
S_3	Maintaining personal health and hygiene	5.5**	4.2*	3.7*
S_4	Small repairs at home	5.8**	4.7*	3.0*
S_5	Heavy housekeeping works	6.5***	2.9*	2.2*
S_6	Cooking	4.3*	2.4*	1.9**
S_7	Maintaining social contacts	6.4***	5.5**	5.0**
S_8	Improving safety at home	6.5***	5.5**	5.0**

Notes: * low importance; ** moderate importance; *** high importance.

Several observations on demand profiles can be made regarding Groups A, B and C. Group A has the most acute need for assistance in maintaining social contacts and health, and improving safety according to the experts and professionals of the health care sector as well. Indeed, the need for assistance in heavy housework was also identified during the interviews (Vanhala et al., 2010). Additionally, the need for repair services is high in Group A, because detached houses usually require a number of small repairs. However, some discrepancy was found in the analyzed material regarding Group A. The expert panel proposed that individuals in Group A are in urgent need of errand services. In contrast, the structured interviews in the background material indicated a very low demand for supportive services. Furthermore, the expert panel evaluated support in maintaining social contacts and health, and improving safety as the most important needs for Group A, whereas interviews did not indicate any loneliness or insecurity with the interviewees. There are three likely explanations for discrepancy. The interviewees either systematically had a good health status, or there were some psychological barriers to reveal the needs to the interviewers. Furthermore, the panel of experts which has a more general view on real needs in the field probably expresses more complicated demand conditions by their experiences among the aged.

The members of Group B mostly live in apartments and are still relatively healthy, so it is possible for them to meet friends easily when distances are short and functional ability is moderate. Because of their good health, they may not expect that something serious would happen to them. Small repairs and cleaning (heavy housework) are recognized as increased service needs in both, the survey and the proactive home visits data. Group C has almost similar, but not as urgent, service needs when compared to Group B. The members in Group C can usually deal with daily tasks together with their spouse. Nevertheless, health care experts and professionals express concern about maintaining social contacts and health, and improve safety of this segment as well.

3.3. Assessing the value creation potential of the smart home construct. The QFD method was used to identify the contribution of the smart home construct to customer value generation for customer groups A, B and C. For the QFD analysis, we analyzed the smart home construct into functionalities (F_1 to F_n) which included technical devices, technical solutions and supportive service. The analyzed functionalities and their relative contribution to customer value generation are presented in Table 3. The relative importance describes the position of the specific function (F_n) in the product portfolio as the proportion of value delivery potential. Thus, the analysis enables a cross tabulation of the functions of the portfolio with respect to customer demand and reveals the key activities of the offering.

Table 3. Relative importance of functions of the smart home to customer value generation

Functionality		Relative importance in portfolio, *FRI – $\%_a$*		
		Group A	*Group B*	*Group C*
F_1	Delivery of pharmaceuticals	3.8%	3.4%	3.3%
F_2	Safety phone connection	3.6%	4.1%*	4.3%*
F_3	Fall monitoring	3.6%	4.1%*	4.3%*
F_4	Monitoring daily activities	4.2%*	4.6%*	4.9%*
F_5	Video and voice surveillance	3.6%	4.1%*	4.3%*
F_6	Automatic voice connection	3.3%	3.7%	3.9%*
F_7	Fire/water/burglar alarms	3.3%	3.7%	3.9%*
F_8	Automatic doors and locks	4.3%*	4.2%*	4.3%*
F_9	Remote control of devices	3.6%	4.1%*	4.3%*
F_{10}	Automatic status updates	4.4%*	4.9%*	5.2%**
F_{11}	Video calls	4.3%	4.9%*	5.1%**
F_{12}	Chat service	3.6%	4.1%*	4.3%*
F_{13}	Peer support forums	4.2%*	4.6%*	4.8%*
F_{14}	Memory maintaining solutions	2.8%	2.8%	2.8%
F_{15}	Social network services	3.2%	3.7%	3.8%
F_{16}	Cleaning service	4.8%*	3.4%	3.1%

Table 3 (cont.). Relative importance of functions of the smart home to customer value generation

Functionality		Relative importance in portfolio, *FRI* – %$_a$		
		Group A	*Group B*	*Group C*
F_{17}	Catering	2.8%	2.1%	1.9%
F_{18}	Repair/maintenance service	6.8%**	5.6%**	4.5%*
F_{19}	Installation/assembly service	6.4%**	5.2%**	4.2%*
F_{20}	Laundry service	3.0%	3.0%	3.0%
F_{21}	Walking service	3.9%*	4.1%	4.1%*
F_{22}	Garment care	3.4%	3.3%	3.3%
F_{23}	Errand service	4.1%*	2.9%	2.6%
F_{24}	Health care service	3.9%*	4.1%	4.2%*
F_{25}	Support for caring close relatives	5.0%**	5.3%**	5.4%**
		100.0%	100.0%	100.0%

Notes: * Moderate importance (weight 3.9% - 4.9%); ** High importance (weight > 5%).

The most important services for Group A seem to be cleaning, social media and health-related services. For Groups B and C social media-related services seem to be the most important ones and, for example, cleaning service is relatively much less important than for Group A. For these two groups, security and safety, and health-related services are also important. Overall, security and safety, and social media services appear to be the most potential technology-based services available for the elderly today. Moreover, monitoring seems to have high importance in maintaining health and improving safety.

To see how well services can be used to satisfy the needs of the elderly, the suitability of the service offering can be calculated. The relative suitability of the service offering in need satisfaction is shown in Table 4. The relative suitability of the service offering was calculated by dividing the suitability value of the service offering in satisfaction of each need by the aggregate suitability value of the offering.

Table 4. Fit of the smart home construct (F_1-F_{25}) to customer demand (S_1-S_8)

Assistive service		Fit of portfolio to needs, FOC_n		
		Group A	*Group B*	*Group C*
S_1	Running errands	5.1%	2.7%	2.2%
S_2	Light housekeeping works	3.0%	2.3%	2.1%
S_3	Maintaining personal health and hygiene	22.3%*	22.7%*	22.8%*
S_4	Small repairs at home	5.9%	6.3%	4.6%
S_5	Heavy housekeeping works	9.7%	5.8%	5.1%
S_6	Cooking	2.2%	1.6%	1.5%
S_7	Maintaining social contacts	18.6%*	21.4%*	22.2%*
S_8	Improving safety at home	33.2%**	37.2%**	39.5%**
		100%	100%	100%

Notes: * Moderate fit to service needs; ** High fit to service needs.

As it can be seen, it is possible to respond to some needs in many different ways. Safety can be improved, for example, through personal contact, social media, alarm systems and monitoring. Correspondingly, more traditional services, like errand services and repair services, require certain ways of their performing. It is possible to conclude that many of the needs can already be satisfied by means of technology-based services, while some of the needs still require someone in person to deliver the service.

Discussion and conclusions

The service needs of the analyzed age segments were expected to be rather low based on the background material which indicates a high independence of interviewees. Especially, aging couples represented a group in which relatively good health, high functional and low or moderate need of assisting services are the dominant features. We expected that the interviews with the elders would be biased to represent the aged with higher independence, better health status and better functional ability. Therefore, we further evaluated interviews from the background material and conducted expert panel research to gain a more general view of the service demands of senior citizens and the dynamics of service needs during the life span. Overall, the expert panel respondents consisting of professionals in the social and health care sector emphasize the anticipation of the demand of services the aim of which is to maintain the independence, health and functional ability of the aged. In our further evaluation of the interview data, we generated three elementary groups from the service need profiles which are:

- *Group A* – women living alone in detached houses, women with high morbidity living alone in apartments and men living alone in apartments. This group represented issues related with loneliness, insecurity and severe/multiple diseases.
- *Group B* – women living alone in apartments with low morbidity and women living with a spouse or someone else. The main needs in this segment are caused by decreasing functional ability and cultural reasons. The needs are focused on, for instance, repair services.
- *Group C* – men living with a spouse, individuals living in row houses and men living alone or with someone other than the spouse mostly in detached houses. The service needs in this group are not immediate in any category. In future, service demand will focus on housekeeping-related categories.

Groups A and B have a higher demand for assistance in heavier housekeeping tasks (e.g., small repairs and cleaning) compared to Group C, and Group A indicates the most acute need. From the point of view of smart home technology, Group B is challenging as it cannot be significantly helped through any existing

technologies, and thus concrete services supplied by a physical service provider are required. The study shows that Group A is the most critical segment and Group C the least critical one for the elderly care system from the efficiency and demand reduction views. However, these groups are not stable and there is shifting, typically, from Group B to Group A. Thus, the urgency of needs tends to change over the years. According to the expert panel, needs for assistance in maintaining social contacts and improving safety seem to be the most important topics to all the groups. Within these categories, help is needed for continuous health monitoring, improving home safety, preventing social isolation and guidance regarding social support systems. Furthermore, support in maintaining health was considered reasonably important for all the segments because anticipation is critical in order to maintain good health and functional ability for as long as possible.

Regardless of the rapid development of smart home technology, devices and solutions during the last two decades, new processes and methods in elderly care are slowly emerging. However, demand for new care plans definitely exists in most of the Western countries which are struggling with growing expenses from the social and health care sector caused by the aging of population. Before the expenditure can be reduced in elderly care, the well-being of the aged should be improved by using appropriate technology-based services and enhancing traditional services as well. This study proves that the elderly people have needs which can be fulfilled partly by technology. Thus, it is necessary to incorporate traditional care services into the offering. The study indicates a relatively high value for services, such as cleaning, catering, repair, installation, assembling, bathing, walking, garment care, running errands and transportation which directly affect the customer's ability to continue independent living at home. The smart home service concept can best fulfill the demand of the following needs:

- Maintain personal health and hygiene.
- Maintain social contacts.
- Improve safety at home.

By the findings, we conclude, that the role of cross-industry networks is growing in the future when comprehensive smart home service systems are implemented. However, at present, both R&D and selling solutions for smart homes are too much concentrated on narrow scope functionalities or technologies, which has led to confusion among customers/buyers regarding the value generating elements of the smart home systems. This study shows that technology-based solutions would provide benefits through improved security at home, promoting health status and fostering and maintaining social networks. The technical solutions, however, lack wider effects on the well-being of the aged if services to solve issues related to limited functionality are left outside the offering. Overall, building an efficient smart home construct requires operations to increase the networking of actors for a better adaptability of offerings to the changing demands of elders. Hence, multi-level networking between private companies, the social sector and the third sector could be the answer in order to make building comprehensive smart home concepts possible. Customers should also be involved to ensure a successful implementation of systems. Information exchange ought to be one of the most crucial points in smart home networks.

When examining the results of this study, certain limitations need to be taken into account. First, using a fairly small expert panel in analyzing the customer needs can be seen as a risk for the validity of the needs. This issue can be taken into account by using a wider survey targeted to end customers (elders), health care experts and the relatives and family of the elders. Second, the QFD method was implemented by a small expert group. This could be done with wider groups focusing, for example, on one service at a time. Future research directions are related to the above-mentioned generality of this study.

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