Research Reports 25

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Technology Business Research Center

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Editors: Mikko Pynnönen, Mika Immonen and Tuomo Kässi

# Smart homes as service platforms

## Research report of

## "Competitive advantage from customer value"

## ÄLYKOP sub-project

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## FOREWORD

This report summarizes the findings of a Technology Business Research Center research project "AKI - Competitive advantage from customer value". This is a sub-project of a larger consortium "Älykop - New health care products and services by means of forest industry expertise". The funding of Älykop consists of ERDF, municipalities and private funding. The main objectives of AKI sub-project are:

- Forms overall insight into the needs of customers (end-customers) and needs of service providers concerning the support of living at home, and turns these needs into the features of the future product and service concepts.
- Analyses the existing product and service concepts in markets which could be utilised as parts of wider service concepts and business models.
- Produces analytical value network and business model descriptions of new product and service concepts around the support of living at home.

The research findings of the project has been reported continuously in articles and and reports. This report is summarizes the main points of the project's separate publications. The report presents the emerging new market in the intersection of health care, ICT, forest and energy industries. We hope you enjoy reading the report.

The Editors

# ABSTRACT

Editors: Mikko Pynnönen, Mika Immonen and Tuomo Kässi

**Smart homes as service platforms**
Research report of ÄLYKOP sub-project "Competitive advantage from customer value"

Research Reports

Lappeenranta 2011

55 Pages, 14 Figures, 11 Tables

In this report, we summarize results of our part of the ÄLYKOP-project on customer value creation in the intersection of the health care, ICT, forest and energy industries. The research directs to describe how industry transformation and convergence create new possibilities, business opportunities and even new industries.The report consists of findings which are presented former in academic publications. The publication discusses on customer value, service provision and resource basis of the novel concepts through multiple theorethical frameworks.

The report is divided into three maim sections which are theoretical background, discussion on health care industry and evaluations regarding novel smart home concepts. Transaction cost economics and Resource-Based view on the firm provides the theoretical basis to analyze the prescribed phenomena. The health care industry analysis describes the most important changes in the demand conditions of health care services, and explores the features that are likely to open new business opportunities for a solution provider. The third part of the report on the smart home business provides illustrations few potential concepts that can be considered to provide solutions to economical problems which arise from aging of population.

The results provide several recommendations for the smart home platform developers in public and private sectors. By the analysis, public organizations dominate service provision and private markets are

emergent state at present. We argue that public-private partnerships are nececssary for creating key suppliers. Indeed, paying attion on appropriate regulation, service specifications and technology standards would foster diffusion of new services. The dynamics of the service provision networks is driven by need for new capabiltities which are required for adapting business concepts to new competitive situation. Finally, the smart home framework revealed links between conventionally distant business areas such as health care and energy distribution. The platform integrates functionalities different for purposes which however apply same resource basis.

*Keywords:* health care, ICT, forest, energy, industry, public-private partnerships, value networks, business models, customer value, service management.

# TIIVISTELMÄ

Toim: Mikko Pynnönen, Mika Immonen ja Tuomo Kässi

**Älykodit palvelualustana**
Tutkimus raportti ÄLYKOP hankkeen osaprojektista “asiakasarvosta kilpailukykyä”

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55 Sivua, 14 Kuvaa, 11 Taulukkoa

Raportti on yhteenveto AKI/ÄLYKOP projektin tuloksista, jossa tutkittiin asiakasarvon syntymistä terveydenhuollon, ICT-, energia- ja metsäteollisuuden yhtymäkohdissa. Tutkimuksen tavoiteena oli kuvata miten uusia liiketoimintoja syntyy toimialamuutosten ajamina. Raporttissa esitetyt tulokset on koottu useammista projektin aikana julkaistuista tieteellisistä julkaisuista, jotka käsittelevät asiakasarvoa, palveluita ja uusien konseptien rakennetta kukin omasta teoreettisesta näkökulmastaan.

Raportti on jaettu kolmeen osaan, joita ovat teoreettinen tausta, terveydenhuollon toimiala analyysi ja älykkäiden kotiteknologioiden arviointi. Tutkimuksen teoreettinen tausta perustuu transaktiokustanunsteoriaan ja resurssipohjaiseen näkemykseen yrityksestä. Terveydenhuollon toimiala-analyysi kuvailee palveluiden kysynnän muutosta ja pyrkii tuomaan esille niitä tekijöitä, jotka synnyttävät uusia liiketoiminta mahdollisuuksia. Raportin kolmannessa osiossa kuvaillaan tuote- ja palvelukonsepteja, joilla voidaan ratkaista väestön ikääntymisestä syntyviä ongelmia kuntien ja valtion taloudelle.

Tulosten perusteella voidaan löytää muutamia suositeltavia toimintatapoja älykkäiden ratkaisujen kehittäjille. Tällä hetkellä julkiset monopolit muodostavat suurimman osan palvelutarjonnasta ja yksityinen markkina on hajallaan ja tehoton. Havaintojen perusteella kumppanuus mallien käyttöönotto voisi ratkaista tehokkuus ongelmaa osittoin, jos

muutamis avain toimijoita saataisiin luotua. Lisäksi päätöksenteossa tulisi painottaa järkevää markkinoiden sääntelyä, teknologian stasdardointia ja palveluiden selkeää määrittelyä, jotta uudet käytännöt leviäisivät käyttäjien keskuudessa. Muutokset verkostossa johtuvat uusien liiketoiminta mallien vaatimista kyvykkyyksistä, joita tarvitaan toiminnan sopeuttamiseen uuteen kysyntään. Älykkäiden konseptien tarkastelu paljasti myös uusia linkkejä toimialojen välillä, joita löytyi mm. terveydenhuolto ja energia sektorilta. Nämä yhteydet syntyvät, kun laajoissa tarjoomissa lanseerataan toimintoja eritarkotuksiin, mutta ko. toiminnoilla on samat resurssivaatimukset toteutuksessa.

*Avainsanat:* Terveydenhoito, ICT, metsä, energia, toimiala, julkisen ja yksityisen sektorin kumppanuus, arvoverkot, liiketoimintamallit asiakasarvo, palvelujohtaminen.

## SISÄLLYSLUETTELO



**APPENDIXES**

## ORIGINAL PAPERS

The report has been edited from the folloving original articles:

1. Immonen, M., Pynnönen, M. & Kytölä, O. "Strategic management of forest industry transformation", *International Journal of Strategic Change Management*, In Press.
2. Kytölä, O., Pynnönen, M. and Immonen, M. "Future Medical Supply – Challenges for Business Concept Formation", *International Journal of Business Innovation and Research,* In Press.
3. Immonen, M., Pynnönen, M., Partanen, J. and Viljainen, S. (2010) "Mapping future services: a case on emerging smart energy metering business", *International Journal of Business Innovation and Research*. Vol. 4, No. 5, pp. 491-514.
4. Vanhala, A., Immonen, M. and Pynnönen, M. (2011) "Developing an assistive service offering for aging citizens", *Innovative marketing.* Vol. 7, No. 2, pp. 71-80.

# 1 INTRODUCTION

Industry transformation and convergence create new possibilities, business opportunities and even new industries. This report summarizes the findings of a two and half year research on customer value creation in the intersection of health care, ICT, forest and energy. The research findings of the project has been reported continuously in articles and and reports (see Appendix I). This report is summarizes the main points of the project's separate publications.

Many factors can be identified as reasons for transformations in industry branches in international level. The change drivers include e.g. fast growth and development of international trade and growth, participation of very different countries with various cost levels in international change and trade, quick evolution of international logistics and tremendous changes in information change and transmission and fragmentation of value chains to value networks. Particularly in small countries the clusters have fragmented and even their parts have been unbundled to pieces in different counties as part of globalization.

On national level fragmentation and unbundling are striking features in transformations of industries. When each company or network on international level seeks for a most favorable structure or position compared to the actors or networks of other countries, the national actors or networks seek besides for competitive advantage also efficient cost structure compared to competitors via network structures. When considering value networks the attention is often paid only to material and service flows. However, the functioning of the value networks requires also capabilities, rules of games and procedures of actions from different parties of the network, and economical aspects from point of view of each partner of the network.

In this research, especially elderly care, heath care, electricity distribution and intelligent concept have been discussed. Quickly observed, these are very different and heterogeneous group of activities. The common factors in these fields are the networks, their build-up and management.

In this research two theoretical frameworks, TCE and RBV, have been used to analyze the prescribed phenomena. In addition empirical materials from different fields have been received for the analysis in the research. As results the report has some fresh observations and recommendations which are linked to the search for good practices in the studied fields. The results have evidently a great practical relevance as they have many economical impacts as well as human and societal impacts.

# 2 THEORETICAL BACKGROUND

## 2.1 Resource-based view and Transaction cost economics

Transaction cost economics ("TCE") and Resource-based view of the firm ("RBV") are discussed in this section for providing background to analysis of value creation in business networks. In this section, we aim to explain dynamics the requisite capability basis of organizations and tranformation of value networks. TCE provides theoretical background for developing tools for evaluation of re-structuring options, and RBV offers an insight into long-term impacts of the decisions. The assumptions and statements of theories are summarized in Table 1.

Table 1. Theoretical assumptions of TCE and RBV

| | **TCE** | **RBV** |
|---|---|---|
| *Basic principles* | Allocation of resources over boundaries of the firm. | Recognizing and collecting valuable resource configuration. |
| *Behavioural assumptions* | Opportunism and bounded rationality in inter-firm relationships. | Bounded rationality to value and asymmetries in knowledge. |
| *Objective* | Achieving cost efficiency through governance structures. | Increasing long-term value and achieving competitive advantage by managing, developing and exploiting resources. |
| *Management regime* | Coordinating and developing production within the firm and within the value chain. | Identifying and exploiting attractive strategic options or production enhancements. |
| *Constraints on strategic options* | Asset specificity and small numbers of bargaining in a supplying industry. | Immobility, causality, and path dependence of resources. |
| *Limitson size of organization* | Loss of top management control and increased managerial opportunism in large organizations. | Managerial diseconomies due to distinctive capabilities in a portfolio and comlex structure of an organization. |

Transaction costs are costs caused by prioritizing a market option in coordination of activities (monitoring and contracting costs etc.) rather than producing goods in-house (refers to the costs of internal management). Overall, failures in the price mechanism are the main reason for choosing hierarchical governance modes, and

it explains existence of organizations (Riordan and Williamson 1985; Williamson 1973). On the other hand, transactions costs depend on *specificity of assets*, which refers to the threaths of lock-in between transacting parties and risk of opportunism. Transaction cost economics investigates appropriate resource allocation options between markets and hierarchy or hybrid modes (Blomqvist, Kyläheiko and Virolainen 2002; Tsang 2000). The approach addresses the efficiency impacts of boundary decisions on a static environment, where the most impressive factor for a distinct resource allocation decision is the minimizing costs within the production system (Tsang 2000). The theory assumes that the hierarchical management of an activity produces an optimal cost structure if it is unlikely to achieve complete, and unambiguous, contracts between parties. Hence, the transferability of a resource is limited to specific conditions (Riordan and Williamson 1985). However, the transaction cost theory points out that market will always offer the lowest costs for production of a good, if the asset specificity is low and the asset specificity is the major cause for the differences in the transaction costs.

High asset specificity may cause decreased bargaining in an industry, and lead to weak incentives for the effectiveness of a supplier. Thus, specificity of assets has serious implications for the attractiveness of a market option. The bargain power shifts to the supplier in the conditions of a low level of rivalry between competitors. In such conditions, the supplier may not be willing to share the efficiency enhancements with the customer, and the buyer suffers from the ineffectiveness of the supplier (Holcomb and Hitt 2007). By TCE approach, performance issues of suppliers are caused partially by *bounded rationality* due to incomplete information. Bounded rationality is understood in the TCE approach as an inability to create complete contracts, if the contracting object and the objectives are complex. In summary, the TCE shows that the risk of opportunism is an unavoidable consequence, if the market functions imperfectly, or the market governanace option of an activitiy incorporates latent features, which cannot be precisely agreed upon (Tsang 2000).

The aspect of resource transferability and effectiveness of the governance structures of TCE lacks however view into the future value of resources. The

RBV directs to explain value of resources and emphasizes competitiveness of a singular organization and its alternative strategic choises to increase value creation potential. Thus, the RBV is a relevant approach to explain dynamics of value networks and role of the organization in industry (Holcomb and Hitt 2007; Arnold 1999; Watjatrakul 2005). The RBV states that the organizations survive in competition, if it is capable to achieve competitive advantage by resources that are valuable, rare, inimitable, and non-substitutable.

Resources are assets, capabilities, processes, and knowledge that enable implementing strategies to improve efficiency and effectiveness in relation to market needs (Barney 1991; Galbreath and Galvin 2008).The resources of the organizations can be divided into three main groups (Galbreath 2005):

(i) tangible resources (financial and physical assets),
(ii) intangible assets (intellectual property assets, organization and reputation assets), and
(iii) intangible resources (skills and capabilities)

The resources are for instance brand names, in-house knowledge of technology, employment of skilled personnel, trade contracts, machinery, efficient procedures, capital, etc. The differences between the skills and abilities, which are managed by the focal organization lead to differences in returns and performance of implementing strategies and gaining revenues. Therefore, it is a necessity to find and choose strategies, which most completely exploit their individuality and uniqueness (Barney 1991). In sum, RBV can be used as s means to explain a firm's competitive differences and ability to launch superior strategies in imperfect competition by heterogeneity of available resource portfolios (Fahy 2002; Barney 1991).

In summary, TCE and RBV are partially overlapping theoretical approaches. TCE explains the efficiency of exchange of goods and governance structures that are dependent on the market framework and asset specificity (Tsang 2000; Holcomb and Hitt 2007). In the other words, the TCE describe boundaries of optimal governance modes of activities within the given industry framework (Blomqvist et al. 2002). Transaction costs occur always, when opportunism and bounded rationality in inter-firm relationships become evident due to uncertainties in price

mechanism and specificity of assets (Holcomp & Hitt 2007; Williamson 1973). Thus, TCE emphasizes profitability of "make or buy" decisions in the short term. It is notable that TCE presumes the supply markets static and it lacks contribution to the decision-making when fundamental changes take place in industry (Galbreath and Galvin 2008; Jacobides and Winter 2005; Jacobides and Hitt 2005). The RBV is relevant, when the value of resources to a firm's competitiveness, compared with structural factors of an industry, is admitted (Galbreath 2005). The resource-based view states that the firm can survive in competition, if it is capable to achieve competitive advantage by resources that are valuable, rare, inimitable, and non-substitutable (i.e.VRIN attributes). Resources can be defined as including assets, capabilities, processes, and knowledge that enable the company to implement strategies to improve performance in relation to the customer needs (Galbreath 2005). Therefore, RBV fundamentally explores the differences between organizations through competitiveness of resource configurations, where the basic metric for effectiveness is determined by its capability to create sustained competitive advantage over it competitors.

## 2.2 Value networks

*The industrial network approach* evaluates the value creation potential of an activity through its interactions to other activities involved in the production process (Dubois and Pedersen 2002). Interdependence of activities occurs in several ways. Activities can be sequentially interconnected (stages of production), pooled interconnected (uses common resources), or reciprocally interconnected in which case two activities have to be harmonized by their outputs, resources or co-ordination levels (Dubois, Hulthén and Pedersen 2004). What, then, do interactions mean for management of organizations? Evaluating activities through their network interactions provide two directions for activity or supplier categorization. First, activities can be divided into peripheral activities and hubs by the amount or quality of interactions. Peripheral activities have weak connections to the surrounding networks, whilst hubs connect multiple network entities creating control points in the supply networks (Merminod, Paché and Calvi 2007). Second, activities can be divided into specialization clusters by the exhibited technological resources or capabilities which provide a basis for the

consolidation of organization management (Roseira, Brito and Henneberg 2010). Both of the activity clustering methods provide tools to anticipate a supplier relationship when organizational boundaries are determined within the portfolio. The quality and amount of interactions in an activity indicate the potential of coordination issues in an externalized function regarding appropriate value generation, and resource or capability clusters depict the areas to which development actions should be targeted within the focal organization.

### 2.3 Service dominant logic

The core arguments of S-D logic are constituted of several rules; (1) service is a fundamental basis of exchange, (2) products are distribution mechanisms for service provision, (3) value is delivered through co-creation between the firm, the customer and networks, and (4) intangible capabilities, skills and knowledge are the primary source of competitive advantage (Vargo, Maglio and Akaka 2008). Service in this context is understood as a process of doing something for another party in collaboration by integrating internal capabilities into external ones to co-create value (Vargo and Lusch 2008). Focusing attention into service processes unavoidably impacts on the competitive basis of a firm. Competing by a service is much more than including value-add features into products; rather, the competition shows in the customer's willingness to pay for the integrative capabilities of the firm in this view (Lusch, Vargo and O'Brien 2007).

A service system can be divided into two parts: (1) the service infrastructure and (2) customer service operations (i.e. the implementation of a service process) (Flieβ and Kleinaltenkamp 2004). The infrastructure determines the firm's capability to manage operations for required outcomes. The service process and the supporting and processing resources constitute the service business model, which integrates external resources into a complete service product (see Figure 1). During service operations, the customer contributes to production by offering information, rights and physical objects. Processing and supporting resources are built on the firm's internal resources and the external value network (suppliers) of the company (Fließ and Kleinaltenkamp 2004). The service process itself is an

intangible entity that comprises technology, know-how and intellectual properties, and aims to the integration of resources (Tadelis 2007).

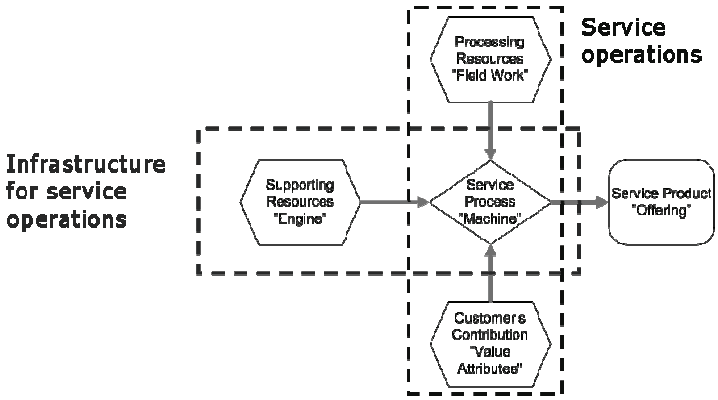


Figure 1. Service production model (adapted from Flieβ and Kleinaltenkamp 2004, Tadelis 2007)

The service production models merge activities which may be operated by external actors. Our argument is that designing service models is always searching for appropriate value networks at the same time. S-D logic expects that some prime service integrators are included in the service provision networks, which have power to steer offerings. The literature suggests that such integrators should avoid high rates of investments in manufacturing processes to retain responsiveness, and the successful actors should have directs link to the market place and customers (Lusch, Vargo and O'Brien 2007). Overall, it is probable that retailers become the pivotal link in the value network which makes them potential prime integrators in service provision.

### 2.4 Structureof the public service provision

In the public sector, it is important to consider that the roles of the buyer, client and supplier need to be clearly differentiated. Local authorities have to identify the characteristics of the provided services and to match those with the needs of citizens, who are paying for the services directly or through taxation. The key point of actions is translating the specific needs into technical specifications to be included in contracts (Ancarani 2009). Therefore, the development of service provision is a complex interconnected multi-stakeholder system in which service

providers, authorities and clients communicate with each other. The system is illustrated at a general level in Figure 2.

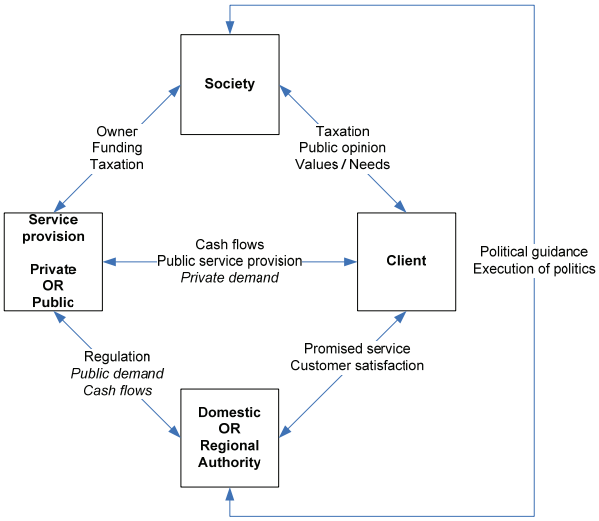


Figure 2. Roles and interactions of actors in public service provision, adapted from (Ancarani 2009; Walker, Knight and Harland 2006; Aschhoff and Sofka 2009; Edler and Georghiou 2007)

The two most important elements of the model are interactions between the end-user and the authority, and the authority and service providers. Regulation projects the needs of end-users (e.g. consumers), creating signals for monopolies to develop product and service offerings toward society's expectations, which may change the premises of operations. In the future, public monopolies are expected to operate in a more service-oriented manner. Thus, the integration of offerings from multiple service providers becomes a focal operation principle (Vargo, Maglio and Akaka 2008; Janssen, Joha and Zuurmond 2009). Public organizations need to orchestrate sources of supplies in the new operation environment when it operates as the core actor of the service provision network (Vargo, Maglio and Akaka 2008). Managing such trends is a topical issue in European countries in multiple spheres of authorities. However, mechanisms for the controllable creation of private market offerings are still obscure, which may lead to a significant risk of opportunism.

# 3 THE EMERGING NEW HEALTHCARE INDUSTRY

The aim of the health care industry analysis is to describe the most important changes in the demand conditions of health care services, and to point out the features that are likely to open new business opportunities for a solution provider. Using the logic, we are able to determine the potential application areas in which the actors of the forest industry may have opportunities to contribute to service development. The data for the industry analysis was collected from Finnish public databases maintained by national bureaus. The health care data was gathered from statistics reports provided by the National Institute for Health and Welfare (2009), and population related facts were gathered from the databases of Statistics Finland (2009). The data content in the applied reports follows European standards for the compilation of statistics enabling comparability in an international context.

Medical expenditure in 2007 in the Finnish health care system was nearly €2.5 billion of which prescription pharmaceuticals for outpatients amounted to €1.8 billion, which is over 70% of the total expenditure of medical care (see Figure 3). The growth in the expenditure has been significant. The statistics indicate that the medical costs were two and a half times higher in 2007 compared to the situation in 1995. The medical expenses presented here are not the whole truth about latent problems, because administration, logistics and other indirect cost categories are not included in the figures. It is notable that a great amount of growth is focused on the prescription drugs of outpatients which are the potential users of novel technologies. The indentified changes point out that the outpatients are an important segment to which performance improvements can be targeted also in the case of pharmaceutical supply. Therefore, health care actors are calling for new solutions for medical care management creating attractive potential for offerings which improve medical care management at present.

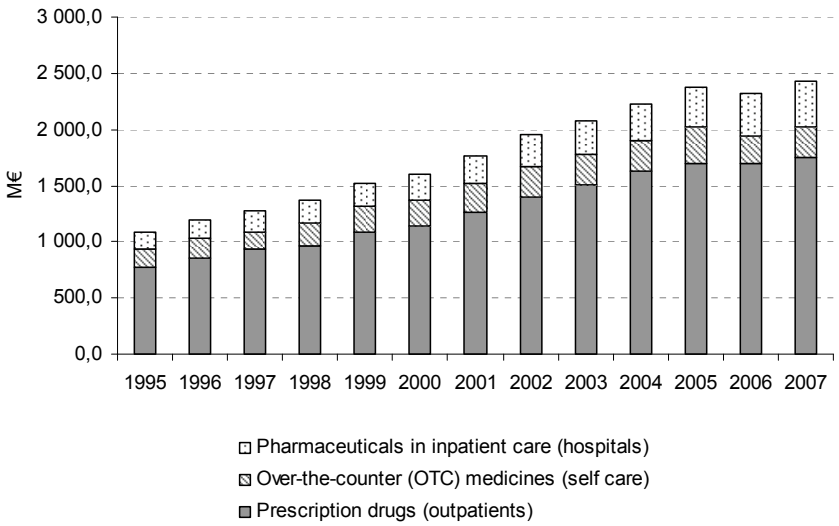


Figure 3. Medical care expenditure in Finland 1995–2007 (National Institute for Health and Welfare 2009)

In Finland, the number of aging citizens has grown from 780 000 in 2001 to up to 880 000 (12%) in 2007. The growth of older age segments has been faster than the average growth of the population, which has led to an increasing proportion of the age segment of over 65-year olds from 15.2% to 16.5% of the population (see Figure 4) and consequently to the growing demand of elderly care services from approx. 111 000 clients to 129 000 clients. At the same period, the expenses of elderly care have grown by 35% from €1 157 million to €1 492 million (see Figure 5) even though the growth of demand has been 13% which significantly exceeds the changes in the aging population, growth of demand and rate of inflation. The unsynchronized growth may indicate latent structural issues in the Finnish elderly care system. Moreover, the growth of demand in elderly care services has not been evenly distributed between the caring structures because municipalities have pressure to create cost savings through less expensive home care which means a shift of emphasis toward the higher independence of clients. Two major shifts can be recognized. First, one half of the growth occurs in regular home care in which the number of clients has grown, and, second, the demand of sheltered housing with 24-h assistance has almost doubled during the same period, while the number of clients in ordinary sheltered care has remained at the same level. However, the clients of home care in most of the cases require

more services and constant assistance at the later stages of their lifespan which means a shift to sheltered housing in existing conditions. Altogether, the structural change of elderly care may indicate that clients with a rather high need of assistance will get care in homelike environments in the future.

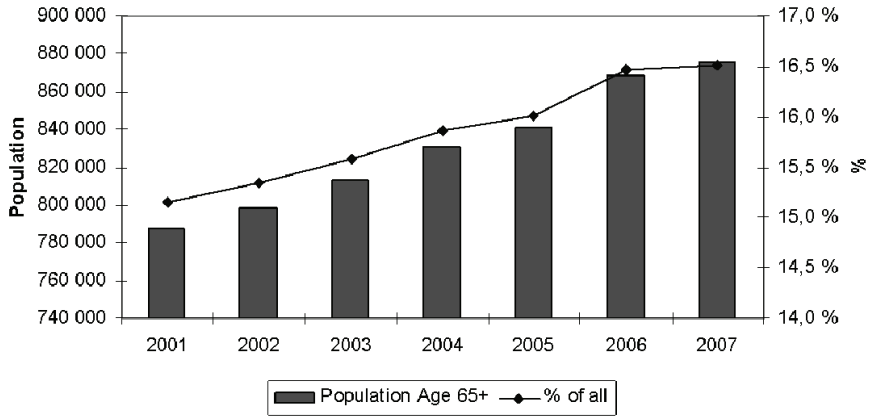


Figure 4. Aging people in Finland (years 2001–2007) (Statistics Finland 2009)

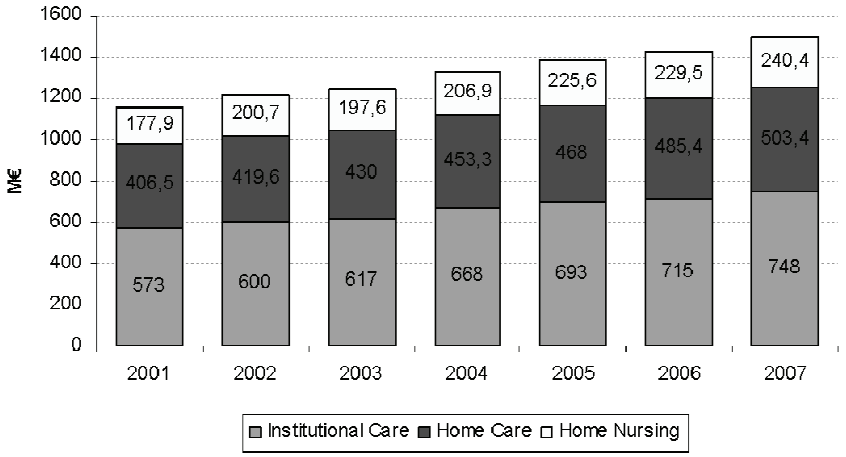


Figure 5. Expenses of elderly care in Finland (2001–2007) (National Institute for Health and Welfare 2009)

The shifts in caring plans have several implications on the operative level of elderly care. Firstly, safety and monitoring have to be assured for clients in home care. Secondly, the cost efficiency of sheltered housing should be improved focusing the efforts of the workforce on the activities that have direct effects on the welfare of clients. Other concerns are associated with the management of day-to-day caring processes in home care. Overall, an increasing volume of home care

will change human resource management significantly, because novel practices will require efficient fieldwork management and properly working interfaces between all actors within the caring network. Particularly, information gathering and sharing among a network of organizations involved in the implementation of caring plans will require significant renewals from the supporting infrastructure. Therefore, innovations should focus on the systems of supported home living, which enable cost efficient practices in elderly care. Particularly, these new solutions should yield proactive effects. For instance, applying novel technology platforms and ambient intelligence in home care may offer attractive opportunities (Sintonen et al. 2008). The transformation of elderly care, however, requires adopting new capabilities for orchestrating operations in the future as well as developing a broad home living concept that should be forged through co-operation among firms from various industries.

### 3.1 Smart homes as service platforms

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). 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 & 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 collection of complementary and substitutive resources possessed by different firms (Kothandaraman and Wilson 2001, Barney 1991).

In this report, 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 6.

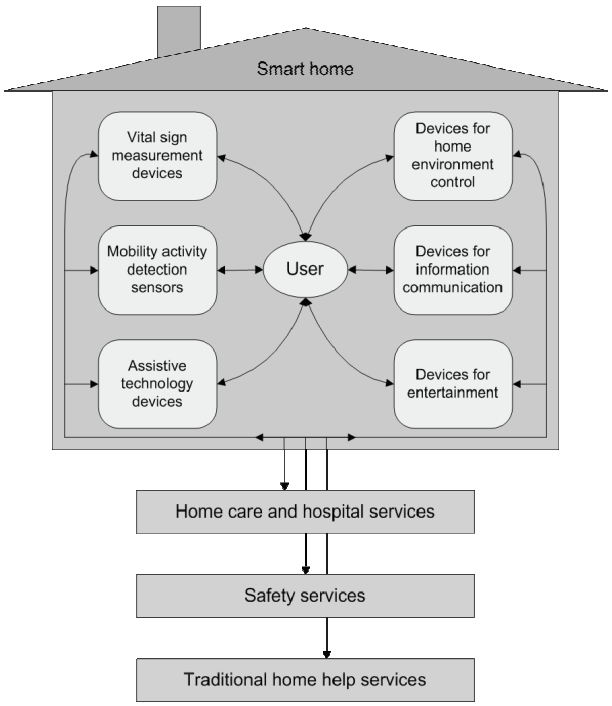


Figure 6. Illustration of a general smart home construct (adapted from Chan et al. 2009)

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. The analyzed functionalities and their relative contribution to customer value generation are presented in Table 2.

Table 2. The smarthome functions

| Functionalities of a smarthome service concept | |
|---|---|
| $F_1$ | Delivery of pharmaceuticals |
| $F_2$ | Safety phone connection |
| $F_3$ | Fall monitoring |
| $F_4$ | Monitoring daily activities |
| $F_5$ | Video and voice surveillance |
| $F_6$ | Automatic voice connection |
| $F_7$ | Fire/Water/Burglar alarms |
| $F_8$ | Automatic doors and locks |
| $F_9$ | Remote control of devices |
| $F_{10}$ | Automatic status updates |
| $F_{11}$ | Video calls |
| $F_{12}$ | Chat service |
| $F_{13}$ | Peer support forums |
| $F_{14}$ | Memory maintaining solutions |
| $F_{15}$ | Social network services |
| $F_{16}$ | Cleaning service |
| $F_{17}$ | Catering |
| $F_{18}$ | Repair/Maintenance service |
| $F_{19}$ | Installation/Assembly service |
| $F_{20}$ | Laundry service |
| $F_{21}$ | Walking service |
| $F_{22}$ | Garment care |
| $F_{23}$ | Errand service |
| $F_{24}$ | Health care service |
| $F_{25}$ | Support for caring close relatives |

These service functions are analysed as part of larger service consepts in Section 4.

### 3.2 The service needs of the aging customers

Generally the segmentation of customers is grouping the customers with similar needs together. 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 the Table 3.

Self-care Instrumental Activities of Daily Living ("IADL") scale, Self-care Activities of Daily Living ("ADL") scale and Quality of Life factors provide

descriptive factors to clustering model which explains background for remerging needs of assistive services of the elderly. In general, IADL and ADL scale describes one's ability to perform independently basic daily activities (etc. preparing meals, shopping and managing money) and the most basic physical and personal care activities (etc. eating, dressing, walking and maintaining hygiene). 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.

*Table 3. Description of the observed population (Vanhala et al. 2010)*

| 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 |
| **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 |

***Person lives: A = alone, S = with a spouse, O = with someone other than a spouse**

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. 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 the lowest at 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.

Applying IADL provided us 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. 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. The requisite assistive services in the study were (Brokel, Cole and Upmeyer; Wherton and Monk 2008; Finlayson, Mallinson and Barbosa 2005; Monk et al. 2006):

- Running errands
- Light housekeeping works (e.g. dish washing)
- Maintaining personal health and hygiene
- Small repairs at home
- Heavy housekeeping works (e.g. cleaning)
- Cooking
- Maintaining social contacts
- Improving safety at home (e.g safe phone, health monitoring, burglar alarm)

We used a expert panel to rate the importance of these needs. The panelists 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 of the study is an average of the ratings of its elements. The result of the evaluation for customer groups is presented in Table 4.

*Table 4. Importance of assistive services to the customer groups*

| ***Service*** | ***Overall importance*** | | |
|---|---|---|---|
| | ***Group A*** | ***Group B*** | ***Group C*** |
| Running errands | 6.1*** | 2.4* | 1.7* |
| Light housekeeping works | 3.9* | 2.2* | 1.8* |
| Maintaining personal health and hygiene | 5.5** | 4.2* | 3.7* |
| Small repairs at home | 5.8** | 4.7* | 3.0* |
| Heavy housekeeping works | 6.5*** | 2.9* | 2.2* |
| Cooking | 4.3* | 2.4* | 1.9** |
| Maintaining social contacts | 6.4*** | 5.5** | 5.0** |
| Improving safety at home | 6.5*** | 5.5** | 5.0** |

*) low importance
**) moderate importance
***) high importance

# 4 SMART HOME BUSINESS MODELS OPENED

The emerging new industry and home centered thinking enables several new business models and simultaneously challenges the old ways of doing business. Some additional services have been formed to support the network, such as information services that assist the patients in their treatment. However, the rising costs of health care drive the government and municipalities to seek ways to save costs with service automation and processes. There are a few potential concepts that can be considered to solve this problem.

We introduce analysis of three evolving concepts which are based on the smarthome service functions (Table 2) and could support the development of this service platform. The evaluated cases are:

1. The intelligent medical management concept
2. The analysis of pharma supply business models
3. The smart energy metering

## 4.1 Intelligent medical management concept

The current pharmaceutical delivery in Finland is arranged basically with two concepts: the first one is the "traditional pharmacy" concept and the other is the "home care" concept which also needs the pharmacies. The ultimate difference between these concepts is the logistics of the medicine to the end customer. In the pharmacy concept the end-user picks up the medicines and in the home care concept a nurse delivers them to the customer's home. We mapped the case of "traditional pharmacy" (current medical delivery) and "home care" implemented with the medical management concept to capture the bigger picture of the medical delivery concept. The mapped business model of the intelligent medical management concept is shown in Figure 7.

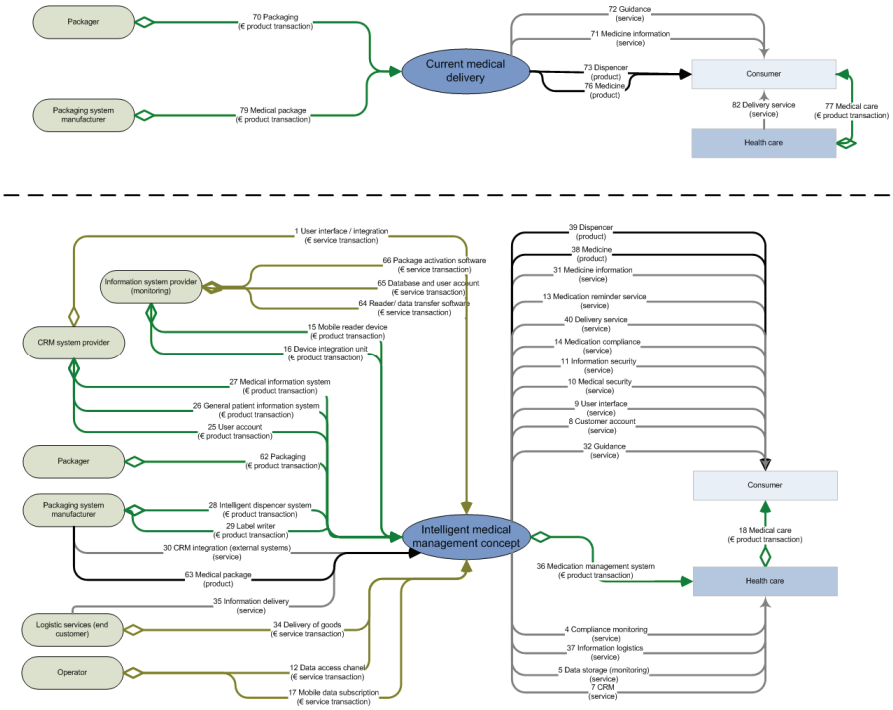


Figure 7. The business models of current medical delivery and intelligent medical management

The business model map is an input-output map where the output is the offering to customers. The input comes from the value network as a form of resources provided to make the concept work. In this analysis the concept is not necessarily an operating entity but in many cases it could be. In this business model there are two customer groups the concept has to serve simultaneously: the consumer of the medication and the health care organization providing the medical treatment to the consumer. Both customer groups have special needs that the concept should fulfill. The needs of the consumer are commonly related to the low price and trust towards the medical services. The needs of health care organizations are related to efficiency and quality. The offering should be designed so that it has relevant value streams that can deliver these values to the customer. Also, it should be noted that the consumer is not willing to pay for a fancy package even with some extra features such as a reminder. Currently consumers pay a fee for home services to the health care organization which the government is subsidizing. The real benefits of this concept are realized in the health care organizations. Table 5 clarifies the elements of the offering.

Table 5. The offering for customers.

| *ID* | *Offering element* | *Definition* | *Current* | *New* |
|---|---|---|---|---|
| 76, 38 | Medicine | Physical goods of the treatment | x | x |
| 73, 39 | Dispenser | Packing of all medicines of the treatment in a single package | x | x |
| 40, 82 | Delivery service | Transportation of goods to the customer | x | x |
| 77, 18 | Medical care | Medical care services | x | x |
| 72, 32 | Guidance | Pharmacies give guidance to patients for assuring appropriate use of medicines. | x | x |
| 71, 31 | Medicine information | Product information about medicines for care staff and patients | x | x |
| 37 | Information logistics | Data storage and transfer | | x |
| 4 | Compliance monitoring | Use of medicine as prescribed | | x |
| 5 | Data storage (monitoring) | Data of used medication | | x |
| 7 | CRM | Customer information system. User rights for privileged interests groups into patient information | | x |
| 8 | Customer account | Information of the customer and the history of transactions | | x |
| 9 | User interface | Allows the user to interact with the system | | x |
| 10 | Medical security | Medicines checked for authenticity and accuracy | | x |
| 11 | Information security | Protecting data to only those who are authorized of accessing it | | x |
| 13 | Medication reminder service | Reminds the patient to take the medicine at the right time | | x |
| 14 | Medication compliance | The dosed medicine is right for the condition and for the patient | | x |
| 4 | Medication management system | Keeps track of patient medication to aid health care personnel | | x |

To operate, this concept needs certain resources as inputs from the suppliers. The resources of the concept are the products, services and complementary elements of actors in the network. The actors we identified are Information system provider (monitoring), CRM system provider, Dispenser system manufacturer, Packager, Logistic services (end customer) and Operator. The Dispenser system manufacturer role provides the dispenser system and the intelligent package. The resources of this network are combined to form the offering of the intelligent medical management concept to the target customer. The resources of the concept are described in Table 6.

Table 6. The resource inputs of the concept.

| *ID* | *Resource* | *Definition* | *Current* | *New* |
|---|---|---|---|---|
| 70, 62 | Packaging | Packaging of the medicines to the dispensers | x | x |
| 79, 63 | Medical package | Carton based package | x | x |
| 30 | CRM integration (external systems) | Information logistic services over the system interfaces between actors | | x |
| 35 | Information delivery | Includes all information that is needed for delivering products to the right locations | | x |
| 15 | Mobile reader device | Device for gathering data from dispensers | | x |
| 16 | Device integration unit | Tools for activating dispensers and sharing information regarding packaged content between databases | | x |
| 25 | User account | User rights for privileged interests groups into patient information | | x |
| 26 | General patient information system | Patient information database to which health data (including care plans, prescriptions etc.) is stored | | x |
| 27 | Medical information system | Particular storage for medical care plans and prescriptions | | x |
| 28 | Intelligent dispenser system | Intelligent package for medicines | | x |
| 29 | Label writer | Device for sealing dispensers and writing user information on package tops | | x |
| 65 | Database and user account | Data storage and user rights into usage monitoring information | | x |
| 66 | Package activation software | Set-up software for dispensers | | x |
| 64 | Reader/ data transfer software | Applications for gathering data from RFID chips and sending it to the servers for storage | | x |
| 1 | User interface / integration | A platform to consolidate information from various independent databases | | x |
| 12 | Data access channel | Cable or mobile broadband connection | | x |
| 17 | Mobile data subscription | Broadband service agreement between users and operators | | x |
| 34 | Delivery of goods | Transportation of finished dispensers to end-users from local pharmacies | | x |

The current medical delivery concept is quite simple when compared to the intelligent medical management concept. On the offering side, the biggest difference is that the current concept is designed to serve the customers and it provides very little value for the health care organization. From the packaging perspective the current medical delivery offers just a bulk market for carton.

The intelligent medical management concept has two customer groups: the consumers and health care organization. The concept offers cost savings for the health care by enabling the remote monitoring of medical care, efficient logistics of medicines and efficient medication management for the customers of home care. Consumer customers save in their home care costs and get, for example, a reminder service and increased medical and information security. The intelligent medical management concept needs several resources to be implemented, and it is currently a collection of different resource providers with very little coordination.

## 4.2 Business concept of intelligent pharma supply

New solutions to the increasing problems have been searched for from the innovative use of technologies to assist the elderly to live at their homes instead of the need for institutionalization. One important part of the whole system is to rethink the pharmaceutical supply chain and home care: allowing the re-organizing of the supply chains through regulatory changes and increasing the use of technologies to assist the patients in home care.

In this chapter we discuss about a scenario projecting a change in the regulation to allow the restructuring of the pharmaceutical supply network and the technology is used to its fullest to assist and monitor the treatment of elderly patients with limitations on picking up the medication from the local pharmacy.

### 4.2.1 Pharma supply

In developed countries the pharmaceutical supply network is well regulated and the participants and their roles well-known. This mostly forms the environment in which to operate. As the regulation has been quite unchanged, the roles and business models of individual participants have stayed mostly the same after their formation: the competition within the network has mainly come from inside the value network and there have not been pressures from outside the network. Some of the additional services have been formed to support the network, such as the information services that assist the patients in their treatment.

The cost side is mainly driven by the governments' will to decrease the costs or at least restrain the rising costs. Also, the government is willing to keep control of the medicine supply, especially the prescription medicines. On the other side the customers want to get better services and the health care personnel strive to improve the monitoring of the patients' treatment. To fulfil the requirements and development needs of all the parties, the whole pharmaceutical supply network faces challenges and all the participants in it try to match their offerings (individual business models) in the best possible way to fit the needs and the environment.

The current model moreover tries to be one-for-all, without paying any real attention to the customers and their needs. One of the issues with the current model is also that the resources available are in the wrong use: for example, home care personnel driving around or a pharmacist waiting for the next customer are wasted resources inasmuch as they are not doing what they are trained for. Also, the technologies affecting the health care value network can be easily utilized in other countries as well. These factors create a good starting point for studying the scenario further, and we suspect there are lots of efficiency improvements to be gained by splitting and reorganizing the current system.

The supply network is assisted with the Smart Home concept that adds the technological assistance and monitoring to the health care and treatment of customers. On the left hand side of the figure is the manufacturing side and on the right the customer – material thus flows from left to right from the manufacturer to the wholesaler, then possibly through a dispenser to a drugstore, where either the customer picks it up or home care obtains it to deliver to the customer.

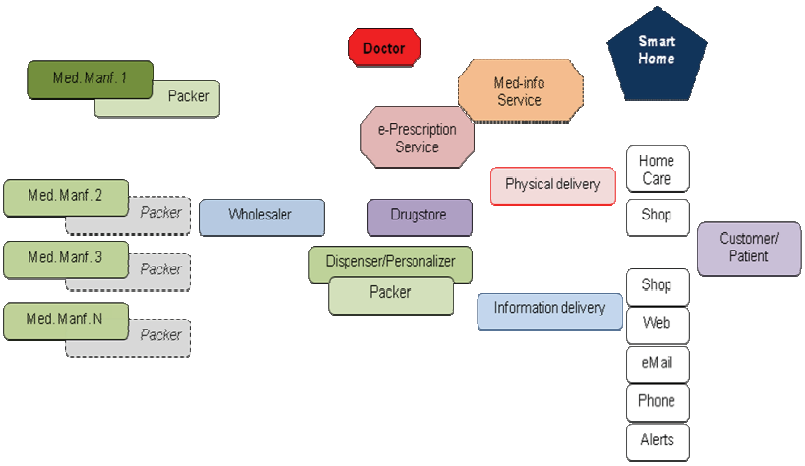


Figure 8. Pharmaceutical Supply Network with the Smart Home Concept.

Currently drugstores are in a central position in the material, information and cash flow of prescription pharmaceuticals. Limiting the possibilities of delivering prescription pharmaceuticals to the shop (pharmacy) or public health care professionals (home care), the current legislation also demands that information be delivered to the customer (patient) about the prescribed medicine as to how to use them and about their effects by either of the two.

The basic assumption in our analysis of the scenario is that current regulation is changed to allow a better optimized network structure for pharmaceutical supply and treatment.

The current pharmaceutical delivery in Finland is arranged basically with two concepts. The first one is the “traditional pharmacy” concept and the other one is the “home care” concept which also needs the pharmacies. The ultimate difference between these concepts is the logistics of the medicine to the end-customer. In the pharmacy concept the end-user picks up the medicine and in the home care concept a nurse delivers them to the customer’s home. The aim at this point was to create potential alternatives for the pharmaceutical supply. As the current situation has two different realization models which can be seen as the opposite ends of the “execution of supply” axis, we chose the logistics execution as one differentiator axis. The other differentiator axis we used was the “execution of service”. This elaboration of the potential concepts formed two new business

concepts, namely, *Self-service medicine store* and *Medicines through postal services*. The business concept derivation is presented in Figure 9.

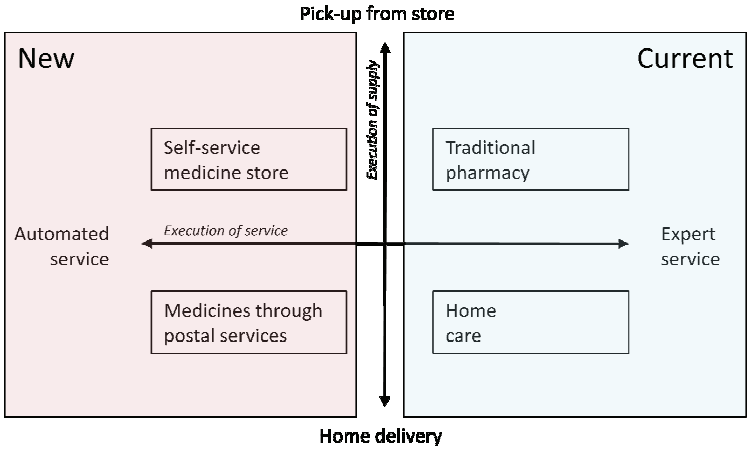


Figure 9. *The business concept derivation.*

The main issue in the new concepts is how the services are executed: by utilizing automated services that are enabled by the technology to replace most of the work of the health care professionals. In the *Medicines through postal services* concept the medicines prescribed by the doctor(s) are packed by the dispenser in a personal package which is then delivered by secured mail directly to the customer. The package contains the different medications, the compatibility of which is automatically checked before packaging, as well technologies to link the package and its contents to information databases to guide the usage, including alerts and monitoring. The *Self-service medicine store* concept relies on similar technologies to assist and monitor the usage, but the package itself has to be picked up from a store or kiosk where the vending machine recognizes the customer by an electronic ID and fetches the prescriptions from the database and gives the medicines to the customer.

These new concepts create possibilities for new business which utilizes information and knowledge storing and sharing by different communication methods. To make the concepts even possible there are also opportunities for the system providers, which need to build the systems for these purposes replacing the old ones and connecting them all to a working concept. The most threatened

single business in this scenario seems to be the traditional pharmacy, as many of its current tasks and functions are either shared or moved to other operators or businesses. One such business could be the medicine information service that provides the customers with 24-h service about the medication they are using. It is still more likely that the traditional pharmacies stay in the future as well, but they need to reconsider their role within the network and make the needed adjustments, e.g. improve their efficiency by concentrating on their core functions, to stay in business in the longer term.

### 4.2.2 Concept Dynamics

The individual business models inside the pharmaceutical supply network meet the differing requirements of the markets and the regulations that form the environment to operate in. On the general level we found that the dynamics within the pharmaceutical network are mainly formed by the governmental requirements (regulation), customers' requirements and the participants' abilities to respond to the differing requirements. We use AHP methodology (Saaty, 1999) to test the dynamics of these business concepts. The AHP model is presented in Figure 3.

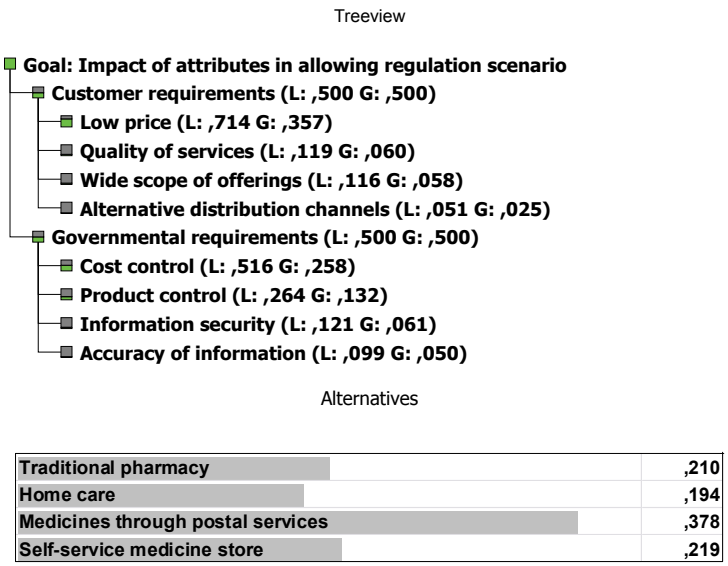


Figure 10. The AHP model of the allowing regulation scenario.

In the dynamic performance analysis of the AHP model it was noticed that the balance between the parent elements *Governmental requirements* and *Customer requirements* did not affect the performance of the concepts. Therefore we concentrated on the analysis of the single elements inside the parent elements.

First we looked at the *Customer requirements* parent element (Figure 10). Inside this element the *Medicines through postal services* concept realizes best the elements and the *Home care* concept performs worst. The *Medicines through postal services* concept has the best fit with all the other elements except the *Quality of services*. Also, it seems that the relation between the *Home care* concept and the *Quality of services* element is quite high.

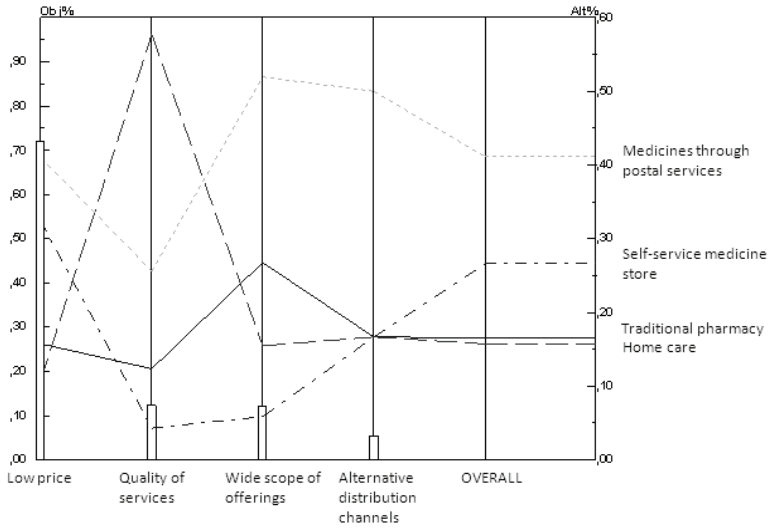


Figure 11. Performance of concepts inside the Customer requirements element.

We tested the sensitivity of the *Quality of services* element and found out that when this element is preferred (weight over 50.9%), while other assessments are not changed, the *Home care* concept starts to perform better than the *Medicines through postal services* concept. The *Self-service medicine store* does not support the customer requirements in any case. An interesting implication is, however, that the *Traditional pharmacy* concept does not fit well in any of the customers' preference variations.

Also inside the *Governmental requirements* the *Medicines through postal services* concept realizes best the elements (Figure 11). The worst performer is the *Self-service medicine store* concept. The *Medicines through postal services* concept has the best fit with *Cost control* and *Information security* elements. However, the *Home care* concept has the best fit with the *Product control* and *Accuracy of information* elements.

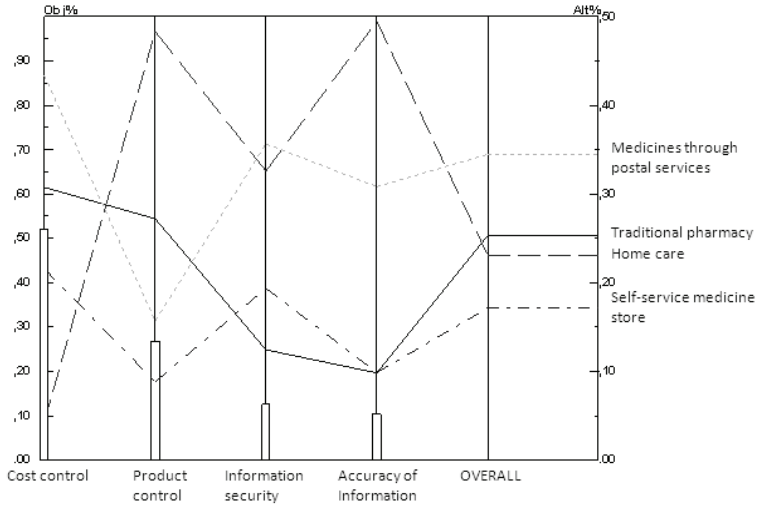


Figure 12. Performance of concepts inside the Governmental requirements element.

We tested the sensitivity of *Product control* and *Accuracy of information* elements. The *Home care* concept starts to perform better than the *Medicines through postal services* concept when the *Product control* is preferred over 45.4% or the *Accuracy of information* is preferred over 44.1%. Again the *Self-service medicine store* and *Traditional pharmacy* do not support the governmental requirements in any case.

### 4.3 Smart energy metering

The primary aim of the study was to increase and harmonize understanding about the future challenges in the field of energy metering and related services. This study introduces the future oriented analysis of smart energy metering services that are using the smart home platform. The results are based on a group dedision process arranged with energy specialists. The most important drivers were proposed as follows.

- Climate change and progressive demands for efficient use of energy
- Demand for increased functionality of electricity markets
- Distributed energy production and virtual power plant
- Advanced technologies – support for intelligent customer interfaces
- Increased use of energy and raised unit prices

The second target of the research was going beyond from the state of the art to define the key characteristics of future business systems. One important goal was to find out the potential roles of installation and maintenance service providers and increase understanding about the architectures of competitive service concepts. The collected ideas consist of both larger service systems and single services, but also characterize the key resources and capabilities of services. The service ideas were gathered under identified changes and they are presented in Table 7 which lists the entire set of ideas without prioritization.

Table 7. Ideas generated at the innovation session

| *Driver* | *Concepts, Services and Resources* |
|---|---|
| 1. Climate change and progressive demands for efficient use of energy | Reporting about the consumption of energy<br>• Metering database<br>• Reports and comparison energy of usage<br>• Life cycle accounting for energy usage<br>Guidance for the consumption and saving of energy<br>• Energy usage profiles for real estates<br>• Support to designing and optimized structures<br>• Guidance for optimized energy usage<br>Real time monitoring and pre-paid energy |
| 2. Demand for increased functionality in the electricity market | Controls for energy consumption<br>• Price signal driven energy usage<br>• Integration to home automation systems<br>• Frequency driven energy usage and reserve power<br>• Energy quotas<br>• Automatically optimized energy usage<br>Services<br>• Interactive user participation in the energy market<br>• Short fixed-term energy agreements and offers<br>• Real time balance services for network companies<br>• Managing fault situations and notifying the customers<br>• Integrated data transfer and electricity subscription<br>• Maintenance and connection services |
| 3. Distributed energy | • Virtual power plant |

| | |
|---|---|
| production and virtual power plant | • New energy production in rural areas<br>• Maintenance services<br>• Fuel distribution |
| 4. Support for intelligent customer interfaces | • Non-interruption electricity<br>• Open interface intelligent home systems |
| 5. Increased use of energy and raised unit prices | • Discharge management services<br>• Campaign services for saving energy |

A further analysis of the ideas reveals three groups of services which have a fairly unambiguous relation to targets set by the regulator, and which will unavoidably have impacts on distribution network companies. The selected categories, on the other hand, create the most significant concerns for electricity distribution companies. The most remarkable service categories are:

- Reporting of energy consumption
- Ruidance for consumers of energy
- Consumption control services

The recognised services will also challenge the distribution network companies in the future to develop appropriate models to merge requisite functions or services into their routines. On the one hand, distribution network companies are capable to develop particular services locally with public support. On the other hand, energy metering services will not belong in the core functions of companies. Thus, the services would possibly be offered by specialised operators. The most important advantage of the latter option is the fact that services would be developed reasonably to meet customer needs without the limitation of local monopolies. In any case, the service concepts will be outlined similarly, despite the production structure or involved value network actors. The form and scope of smart energy metering services depends on three things: firstly, the decisions of distribution network companies, secondly, the given incentives by legislation, and, third, the development of technical standards. Different forms of service concepts are outlined in the following chapters, where service ideas are analysed in the light of optional scenarios.

### 4.3.1 Business scenarios of energy metering concept

The structure of the future business environment in the energy sector mainly depends on political decisions (sanctions, guides, standards, etc.) as well as technology selection among the network companies. Those factors, finally, determine the demand for new services and market branches for new actors. Government policy is an especially important factor, because distribution network companies operate on secured monopoly positions without the threat of substitutes, which leads to low bargaining power for customers and insensitivity to customer needs. Therefore, it is necessary to develop such policies that reflect real customer preferences and protect customers against the misuse of monopoly positions.

Due to the high number of variables, even an optimization model is hard to create. Therefore optional business structures have been created and studied through two mini-scenarios, which are defined based on market studies available and arguments from specialists. We chose the political factor as the scenario axis that determines the future business landscape in the industry. The axis is used as a differentiator of the political environment that drives the market evolution. The opposite ends of the axis are loosening and tightening regulation of markets. In this study we make an assumption that regulation dominates all the other market driving factors that can be influenced in the near future.

The future business environment is presented through optional developments of political, economic, social, technological and environmental factors in relation to electricity markets. Political factors describe the influence of national governments and authorities which consists of legislation, subsidies, and directives and standards. Economic factors focus on aspects that are mostly related with business economics views such as productivity and corporate strategies. Social factors concern the demand side of services in which the voice of electricity consumers is especially pointed out. The technological view of the business environment highlights the aspects that are critical for technical connectivity and adaptability of different systems. Environmental factors

constitute general trends and characteristics about the living environment such as climate change.

Each aspect of the business environment was characterized by pre-defined measurements to enable the comparability of different scenarios. The measurements describe critical events or state of affairs, which would have favorable or restrictive impacts on emergent business networks. The breakdown of measurements is as shown in Table 8.

Table 8. Measurements of the business environment

| *Factor* | | *Measurement* |
|---|---|---|
| *Political* | 1) | Demand of new services |
| | 2) | Focus of financial support |
| | 3) | Standards and guidelines |
| *Economic* | 4) | Flexibility of the system |
| | 5) | Price of technology |
| | 6) | Existence of market competition |
| | 7) | Potential for outsourcing |
| *Social* | 8) | Supply and demand of services |
| | 9) | Influences of monopolistic behavior |
| | 10) | Goals of the society |
| *Technological* | 11) | Specification of system requirements |
| | 12) | Functionality of meters |
| | 13) | System integration |
| | 14) | Standardization |
| | 15) | Maintenance and technical support |
| *Environmental* | 16) | Climate change |

The state of future service concepts and business models may depend on the actions of domestic and European regulators, and the appropriate focus of economic support on service development (Strbac, 2008). Basically, two possible scenarios can be outlined for future business environments on the energy sector: (i) the market environment, which is incoherent and does not offer efficient service platforms and standardized technologies; and (ii) the purposefully regulated environment, where standards and system interfaces have been developed to support system integration, customer needs are recognized and service platforms offer wide support for flexible concepts and the regulator supports new service business creation (Kärkkäinen et al., 2006; Kirjavainen & Seppälä, 2007). The scenarios are described in Table 9.

Table 9. The smart energy metering business scenarios

| **Pessimistic view:**<br><br>**Technology and business models stay unconsolidated and business branches are driven by local monopolies.** | **Optimistic view :**<br><br>**Advanced technologies, consolidated standards and open business networks will become dominating regime.** |
|---|---|
| *Political* | |
| Demand for frequent reading of metering data.<br><br>National financial support is focused to development of local solution to respond demands from the regulation.<br><br>Regulator set ambiguous standards for functionality of meters and system interfaces. | Demands for frequent reading of metering data.<br><br>Financial support is focussed to restructuring and developing market interfaces from broader viewing angle.<br><br>Support for open interface product platforms and appropriate standards.<br><br>Public sector offers database facilities for metering business that is developed from European standards. |
| *Economical* | |
| Closed protocols and technologies hold on. Prices per metering unit stays high and lock-in situations are typical.<br><br>Lack of widespread standards and tailored solutions are obstacles for competition and restrains emergence of new services around metering.<br><br>Service markets stays fragmented and local. Thus, domestic service concepts cannot be created. | Standardized electronics launch price erosion of metering systems.<br><br>Installation costs can be still be a hindering factor for diffusion of concept.<br><br>Operator business around metering grows and function will be increasingly grown |
| *Social* | |
| Service supply increases moderately.<br><br>Customers became payers of the mistakes in technology selections. (increased energy consumption, higher transfer tariffs and energy price)<br><br>Environmental goals will not be reached. Short-term emphasis on decision making of monopoly companies dominates. | New service concepts offer remarkably higher service level for customers and enable participating in the energy saving programmes and electricity trade. |
| *Technological* | |
| Distribution network companies set their own specification for AMR-systems and use partially optimized, which fractures metering system markets and benefits of mass production cannot be reached.<br><br>Functionality of the meters is rather low, and meters are independent devices. Connections to broader automation concepts are not recognized. Interfaces between systems are complex and integration is not supported. Standardization directs to closed protocols.<br><br>Maintenance and support became difficult, because of dependence on single suppliers and variety of systems. | Selected metering technologies supports open system interfaces and metering devices offers wide range of services. Devices enable connection to surrounding systems. Especially, IP-based protocols should be supported.<br><br>Self-diagnostics of the system is advanced level and there is direct support for distant controls and identification.<br><br>Metering is part of home automation systems, not an independent device, which enable demand flexibility of electricity supply and price-driven controls. |
| *Environmental* | |
| Climate change drives continuously increasing demands for efficient use of energy | Climate change drives continuously increasing demands for efficient use of energy |

Scenario 1 represents a pessimistic forecast for the development of Finnish national and Nordic smart energy metering activities and related service markets, which can come true if recognized threats become dominating in the Nordic electricity industry. Metering systems are not harmonized, and the monopolistic

behavior of the distribution companies directs the development of the energy markets. The major reasons behind this development can be found from small distribution network companies which have no incentives to renew their network data systems due to relative high investments. At the same time, a lack of standards and uniform national system requirements hinder the development of metering technology and services.

This leads to a situation, where a lot of parallel systems are utilized and network companies are in a risky lock-in relationship with suppliers. On the other hand, the incoherence of technologies keeps unit prices on a high level and, partially, prevents the exchange of metering data between market actors (Kärkkäinen et al., 2006). Thus, the future government actions in the Nordic countries have a critical role, when the flexibility of electricity markets will be developed.

Scenario 2 presents an optimistic view of the future developments in the electricity markets, which has been created by decreasing the influence of the recognized threats and reinforcing opportunities offered by intelligent metering.
The main result of this scenario is a description of the competitive environment, where most of the obstacles for marketplace development and competition are removed. Thus, the following future states have been realized: The regulator has redefined standards, and the national system requirements for smart energy metering have been released, which enables harmonizing the systems and decreases problems at the interfaces. The focus of financial support also has a role in directing the development. Renewing processes and utilizing purchased services in the network companies should be supported, if metering service markets are to be emerged.

The harmonized technology platforms decrease network companies' dependency on suppliers and the unit prices of smart energy metering because of faster development of new solutions and the more efficient markets of technology. The development creates, together with renewing of operations, a fertile ground for growing service business, which is not bound to the local or national level but is international business, where operators are able to implement generic service platforms. System integration between smart energy metering and home

automation systems is an important aspect of this scenario, because it enables a method to control energy consumption and intelligent solutions for energy saving among small consumers. There the development gap is rather high and rules of competition differ radically between ICT and the energy sector, because energy business is regulated and ICT companies are competing in the open markets, where end users are determining the demands. Therefore, operators for home systems are the core resources, when system integration is implemented.

### 4.3.2 Future value chain analysis

This chapter discusses the implications of the two scenarios on the future service market which is developing more or less appropriately to improve energy efficiency. The analysis is conducted through two streams. First, the effects of different scenarios on technology platforms and service contents are analyzed, and, second, crude estimations about future value networks is presented in the end of the chapter.

The major distinctions between Scenarios 1 (Confusion) and 2 (Consolidation) are the responsibilities of market actors who have a significant role in the final service offering. In Scenario 1, the dominant market actors are distribution network companies, which may develop smart metering for their primary purposes. If this is the situation, development toward customer driven markets is threatened. Scenario 2 describes the other extreme of development in which the service offering and technical platforms are aligned appropriately with higher level goals. In this case, actions are targeted to support consumers' energy conservation actions, which requires open business structures. Customer orientated operations are still underdeveloped in the energy distribution industry. Hence, if the business environment adheres to follow Scenario 2, it will lead to radical changes in both the corporate strategies of distribution network operators and industry structures. In this case, new actors may have prospects of co-developing an integrated electrical delivery and control system (Strbac, 2008).

Each scenario affects differently the future contents of generated service ideas and the applied technical platforms for metering. This is evaluated in 3 in which the service idea or technological feature is ranked as *not impacted by the environment*,

*limitedly developed*, or *reinforced by a development pattern*. It is notable that the development of the energy distribution industry may have an important role in the diffusion of energy efficient habits among consumers, because the awareness of consumer segments depends on both the offered solutions and available information. Thus, a strong interrelation exists, particularly, between the reporting and guidance services.

Scenario 1 (Confusion) directs the responsibility of development actions to distribution networks companies. Local monopolies have right to define the applied technology platform and offered energy conservation. Minimum requirements are expected to be fulfilled in the metering and reporting systems due to regulation that requires frequent monitoring of energy consumption. The most important differences between metering and reporting services may be found in usability which may differ significantly depending on the supplier. Fragmented practices in services may, on the other hand, also have serious impacts on the adoption rates of services, which may be stagnated on a low level due to lack of information about opportunities. Another implication of an incoherent service system pertains to guidance services and information sharing. Guidance for energy conservation depends on local distribution network companies in Scenario 1, which includes risks of lacking easy access to accurate and necessary information.

Scenario 2 (Consolidation) relies on the assumption of open business networks that are adapted for user friendly operations. Advanced metering and reporting services are expected to be developed, because the main responsibility of providing them is given to specialized companies that compete in open markets. At present, such service market on a large scale exists neither in metering solutions nor in reporting services. Major energy companies (e.g. www.fortum.fi and www.vattenfall.fi) have begun to share information about efficient energy usage, but information for consumers from public sources is sparsely offered. Recently, research proposals have been launched about smart metering platforms by the Finnish energy industry. Thus, it is expected that some major platforms may emerge in the following years. Still, considerable investments are required for home system integration which is required to achieve the full potential of

energy efficiency improvements. Indeed, appropriately directed incentives and financial support for development is the critical factor for the emergence of service markets, which lead to the consolidations of offering.

Table 10. The effects of scenarios on services and technology platforms

| *Concepts and Services* | *Scenario 1 (Confusion)* | *Scenario 2 (Consolidation)* |
|---|---|---|
| **Reporting energy consumption** | | |
| Metering database | 0 | + |
| Reports of energy usage | * | + |
| Life cycle accounting | * | + |
| Real time balance services | 0 | + |
| Fault situation management | 0 | + |
| Non-interruption electricity | * | + |
| **Guidance for energy consumers** | | |
| Energy usage profiles | * | 0 |
| Designing optimized structures | * | 0 |
| Short fixed-term energy agreements | * | 0 |
| Guidance of energy usage | * | 0 |
| **Consumption control services** | | |
| Price signal driven energy usage | * | 0 |
| Frequency driven energy usage | * | 0 |
| Energy quotas | * | 0 |
| Automatic control of consumption | * | 0 |
| Campaigns for saving energy | * | 0 |
| **Integration in real-estate systems** | | 0 |
| Integrated home automation systems | * | + |
| Intelligent open interface systems | * | + |
| Integrated data and energy subscription | * | + |
| **Others** | | |
| Small scale electricity energy markets | * | 0 |
| Virtual power plant | * | 0 |
| Maintenance and connection services | * | 0 |

0 = not impacted by the environment
* = limitedly developed
+ = reinforced by a development pattern

An in-depth analysis about the implications of different scenarios reveals that steering the energy industry to support consumers' energy efficiency achievements is a complex task that requires bundling numerous expedients. Incentive schemes from legislation is the first step toward the business architectures of intelligent metering which need appropriate technical standardization, anticipatory specifications for service contents and rigorously planned subsidies for innovations. Otherwise, customer support and proper integration of real-estate systems may be rejected resulting in unnecessarily overlapping systems, poor usability and inability to adapt systems during their life cycle.

### 4.3.3 Future value networks of smart metering

Optional value networks are constructed to achieve the requisite capabilities to perform actions related to specific services. It is expected that the requisite performance level of an actor has a crucial role for market openings if industry evolution creates capability gaps to incumbent firms.

In practice, distribution network companies aim at long-term asset management strategies that rely on an assumption of stability in the industry. Improvements in the business processes and structures are mostly expected to be incremental. Indeed, the risk of dramatic changes in the industry is usually low because of the monopoly position of distribution network operators. Thus, firms have low dynamic capabilities, because established positions only allow concentrating on incremental improvements. Thus, if requirements to reduce the service level radically occur in the industry, it may lead to significant structural changes and the emergence of new business branches. The final implications of energy metering for the industry architecture in energy distribution depend on features which may be materialized in the service system. The expected industry architectures in Scenarios 1 and 2 are presented in **Error! Reference source not found.**11.

Table 11. Expected industry architectures

| *Concepts and Services* | *Scenario 1 (Confusion)* | *Scenario 2 (Consolidation)* |
|---|---|---|
| **Reporting energy consumption** | Business owner | Business owner |
| Metering database | DNO | SP |
| Reports of energy usage | DNO | DNO |
| Life cycle accounting | DNO | DNO |
| Real time balance services | DNO | SP |
| Fault situation management | DNO | DNO |
| Non-interruption electricity | DNO | DNO |
| **Guidance for energy consumers** | | |
| Energy usage profiles | DNO | SP |
| Designing optimized structures | DNO | SP |

| | | |
|---|---|---|
| Short fixed-term energy agreements | DNO | SP |
| Guidance of energy usage | DNO | SP |
| **Consumption control services** | | |
| Price signal driven energy usage | DNO | DNO |
| Frequency driven energy usage | DNO | DNO |
| Energy quotas | DNO | DNO |
| Automatic control of consumption | DNO | DNO |
| Campaigns for saving energy | DNO | DNO |
| **Integration in real-estate systems** | | |
| Integrated home automation systems | - | SP |
| Intelligent open interface systems | - | SP |
| Integrated data and energy subscription | - | SP |
| **Others** | | |
| Small scale electricity energy markets | - | SP |
| Virtual power plant | - | SP |
| Maintenance and connection services | SP | SP |

DNO, Distribution Network Operator
SP, Service Provider

In Scenario 1 (Confusion), the basic level requirements for metering and guidance services will not require enormous investments. Therefore, Scenario 1 is not likely to lead the industry toward a reconstruction process, which indicates a strong position of the distribution networks companies as solution developers. Distribution network companies are likely to build services that are outlined based on the needs of a local monopoly company. This means less customer oriented actions, and probably poor opportunities for external service providers to develop generic business platforms. It can be expected that new services occur in the installation and maintenance of metering systems, which is current practice in distribution network companies in network construction for instance.

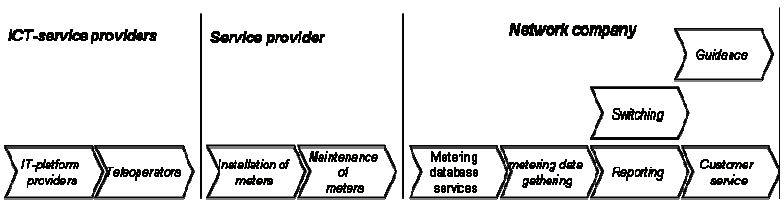


Figure 13. Expected value chain in Scenario 1

Scenario 2 (Consolidation) includes more radical change, when both the physical infrastructure (meters, software and communication) and the method of customer service may transform so remarkably that it creates prospects for new service providers in the field. The most important drivers for the described change are global service models, the authorities' aim at standardized technology platforms and complex interconnection between home systems. Such development pressures distribution network companies to redesign their architectures, because limited market areas of local monopolies tend to lead to financial limitations for investments in developing requisite services.

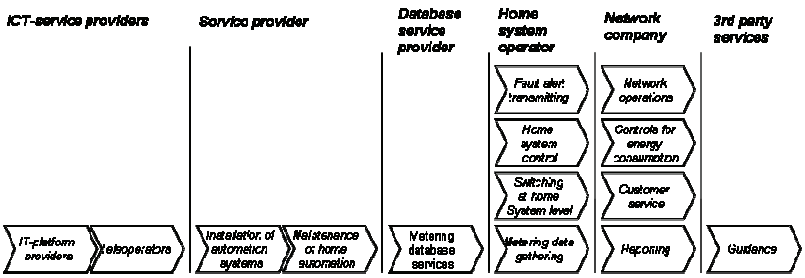


Figure 14. Expected value chain in Scenario 2

The most important architectural changes in the value chain may occur among the operating and maintenance activities of intelligent metering systems. New prospects emerge, especially, if some dominant platforms for the home system infrastructures are developed. The new market potential is opened for the actors that collect information from the integrated home system, and deliver it to different purposes for multiple actors. In this case, electricity distribution companies may outsource fault alert transmitting, energy saving controls (switching), systems control, and metering data gathering operations for specialized service providers. The divergence of metering operations (i.e. installation, data reading, maintenance, and customer support) may have a crucial role for the convergence of home technologies, because an external service provider is likely to develop generic platforms to gain revenues from global markets. Data base services for energy metering may provide options if domestic

authorities set unambiguous standards for storage information. On the other hand, metering information storages may hold such information that private ownership is not a convenient approach. The private information sources may limit information sharing for guidance and consultation purposes, which has a significant role in steering overall energy efficiency. In this, supporting service providers, public or private, to develop information sharing platforms have a role, because a sustainable change in customer behavior requires both technology platforms and accurate information to create personal incentives.

# 5 DISCUSSION

This report opens the emerging business area of home centered services. Especially we focuse on smart homes as service platforms and we use health care and energy services as examples of services that can use that platform. This study contributes mainly on service management literature (e.g. Vargo and Lusch 2008).

The smart home framework revealed links between conventionally distant business areas. Therefore, assessing actor networks of the smart home business was challenging, because available databases did not provide support the research. The business networks were researched from Finnish aspect using public information available on authorities and firm internet sites. The analysis presented that public organizations dominate service markets leading private markets very fragmented. The smart home technology market is on emergent state and clear key actors do not exist at present. Actual public procurement politics that directs to purchasing specific solutions and low price without considerations about spill-over effects into supplying industries was suggested one reason for fragmentation. The public actors (i.e. health care organizations, local and domestic authorities, and regulators) has important role in driving consolidation of the smart home business networks. Longer term partnerships with service providers for creating key suppliers, translating user needs into service and product specification, and appropriate standardizing of technologies are the expedients to increase competitiveness of service and solution markets. Indeed, national funding of technology development should be refocused from development of specific technologies to integrated platforms, which support diffusion of both home systems and related service businesses.

Governments are in the position to adjust the regulation and subsidies towards chosen objectives. In most industrialized countries prescription pharmaceuticals are controlled by the governments the whole way from the manufacturing to the consumption and even disposal. This affects the competitive dynamics of the whole value network and may even freeze competition allowing the rise of the overall costs of national health care, which fall on taxpayers, if subsidized like in many European countries. Therefore governments should investigate the different

possibilities to arrange the pharmaceutical supply as well as the subsidizing of the use of new technologies to assist and control the treatment to keep the increasing costs in control.

Allowing the restructuring of the pharmaceutical supply network would radically change the current dynamics within the network. Each individual participant of the network and their own business model would need to adapt to the new situation. The companies within the network need the capabilities to take advantage of emerging opportunities. This dynamics opens up possibilities for new entrances in the network, which fill up the roles required for the whole concept to work. Such are e.g. postal service providers, which possess the capabilities to transform their services to fit the traceability and security requirements, as well as information technology integrators, which can turn their existing capabilities to build the information systems for the assistance and monitoring of treatment. The old participants need the capabilities to either transform their former roles into new ones within the network, e.g. from a wholesaler to a dispenser, or to specialize further, e.g. from a pharmacy to medicine and treatment information services.

The smart home platform allows the management of different services and the energy services are a good example of this. The environment in which services contents are defined basis of end-user needs drives radical changes of energy metering, consumption control, and maintenance and fault situation management businesses. However, role of public sector and authorities should be analyzed carefully, because it may have impacts on service market functionality on long term. This concerns especially metering data storage, and other end-user information. For speculation, public owner of metering data may enable more open structures in the markets in which private sector utilize gathered data for service operations. Otherwise, fragmentation of user information may prevent successful implementation of optimization, monitoring and guidance services of energy consumption. Indeed, privatized metering data storage may lead situation in which a single firm create strong barriers for competition. In general, closed systems presumably lead higher prices, low functionality, and low diffusion of

energy saving services for threat of customer lock-in, which is important obstacle for market emergence.

Finnish energy industry has recently launch research programmes on intelligent power grids in which energy metering has its role. Energy metering is researched in those programmes from techno-economic perspectives where specific needs of energy distribution are in pivot. Linkages between specific metering service structures and general intelligent home concepts are probably not in focal point, because actual research drives monopoly driven services. Thus, risks of inappropriate systems designs and fragmented information exist from the customers' point of the view.

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APPENDIX I – PROJECT PUBLICATIONS

**Articles in international refereed journals**

1. Immonen, M., Pynnönen, M. & Kytölä, O. "Strategic management of forest industry transformation", *International Journal of Strategic Change Management*, In Press.
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2. Immonen M., Pynnönen M. and Kytölä O. (2010) New Growth of Forest Cluster - From Paper Based Products to Customer Value-Added ICT Services. Portland International Conference on Management of Engineering and Technology, (PICMET 2010), Phuket, Thailand, July 18-22.

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APPENDIX II – Researchers

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APPENDIX II – Project organization

Sub projects and their implementors:

AKI - LUT / Technology Business Research Center

Kopteri - Kymenlaakso University of Applied Sciences

Älypakkaukset - Kouvola Innovation Ltd.

Skenaario - TSE / Finland Futures Research Centre

Coordinator - Lappeenranta Innovation Ltd.

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