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Visions and realities: developing 'smart' homes for seniors in Sweden

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Abstract
The smart home concept with its vision of embedding technology in houses or apartments gained much interest during the end of the 20th and the beginning of 21st century. Although the vision remains, the enthusiasm has diminished somewhat with the one exception: senior housing. Smart homes for seniors have been touted in recent years as the means of enabling 'aging at home' and so relieve the pressure on health systems. This research examines the players, issues and current state of development of technology based services in the senior housing sector in Sweden. It is underpinned by the theories of development and innovation and the use of qualitative methods such as observations and in-depth interviews with a broad cross section of players in the sector. This research reveals some of the shortcomings of the approaches used in developing smart housing for the senior population. These include the focus on the technical possibilities rather than solving the every day problems of end-users, the narrow scope of projects, lack of multidisciplinary involvement and insufficient resource.

Keywords: Smart housing, assistive technology, aged care informatics, smart technology, health informatics

1. Introduction

Sweden and many other western countries are increasingly adopting policies supporting the notion of 'aging in place' [1]. There are many visions about how the use of new technologies could support this by making homes more adaptable to the changing needs of their dwellers. 'Smart' or 'life time homes' and similar concepts envision embedding technology in housing and "connecting" the household to external parties such as the inhabitant's family or community nurses [2-4]. However, in Sweden and many other European countries, the supply of "smart" senior apartments or houses, or readily implemented "smart home packages" for senior housing is essentially non-existent [1, 3, 5, 6, 7, 8]. The sector is facing a situation characterized by latent needs and technological potential, but few available products capable of changing housing pathways of elderly individuals in the long-term. Although there is research into the feasibility and cost-effectiveness of isolated products and components, such as specific electronic health services [5], few studies have taken a broader, long-term perspective. This paper adds to and enhances the understanding of the smart senior housing sector and is based on empirical data gathered from this emerging sector in Sweden. Using insights from the new service/product development literature, it elucidates and analyses the strengths and weaknesses of new products and innovation in the sector.

2. Insights from the literature

2.1 Developing smart home or aging in place technologies

Changing needs among senior dwellers are typically responded to with *physical housing adaptations* [3]. *Assistive technologies* such as grab rails and lifting aids also provide support for seniors with their activities of daily living [3]. While assistive technologies are typically mechanical, *electronic enhanced assistive technologies* can be regarded as "smart" technologies because they are embedded with information technology/ in-

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telligence. Electronic enhanced assistive technologies can learn about, adjust to and communicate with humans as well as with other technologies [9, 10]. Examples are electrically powered door opening that continually adjusts to the speed of the dweller, remote control of furniture and home electronics, digital reminders that offer health advice or support relevant to the particular individual [4].

Telecare or telehealth supplements these solutions, connecting the household to external parties, such as remote caregivers or alarm centres, by means of telecommunication technology. The role of telecare in senior smart homes is to monitor crucial health parameters of the dweller and to provide "early warnings" of health problems [2, 3, 4]. It can also enhance the capacity of care providers to respond to emergency situations occurring in the home. Barlow and Venables [3] maintain that the development of architectural designs, technical devices and service processes should not be viewed as isolated elements, because it is only in combination that they can constitute smart housing solutions that can truly change housing pathways for seniors. Smart senior housing solutions therefore are a "complex product system" [11] because typically they consist of numerous components; have multiple interactions across different components and levels; are non-decomposable and cannot be separated without degrading performance.

The concept of "interfirm modularity industries" [12] is relevant in this context as different firms are responsible for developing the subsystems of the industry's product that must interface and interact seamlessly with each other to have value. It is argued that innovation in this sector needs to be managed at three levels; the *component* or subsystem level, the *interaction* level where the components interact with each other and the overall *system* or *integration* level [11, 12] and these are discussed further here.

2.2 The new service/product development literature

The literature acknowledges that an organisation may initiate new product or service development projects for different reasons. It may be for new product lines, additions to existing product ranges, improvements to existing products or "new-to-the world products" [12, 13, 14, 15, 16]. Johne and Storey [17, p. 193] also discuss a new style product development that involves "taking a long and hard look to see how an existing market might be better served". They reveal that doing this successfully reshapes a market. This is an important issue to explore here, as it is the successful reshaping of senior housing market using 'aging in place' technologies that is the focus of the current research.

2.3 Success factors

Brown and Eisenhardt's [15] review of research outlined the factors related to the successful development of new products. The markers for success were based on revenue, profitability and market share. They categorised the success factors into the internal organisation of a developing firm; the *intrinsic product* (quality and cost advantages as well as a clear product concept); and the *market conditions* (high growth markets with little competition). Brown and Eisenhardt [15] concluded that, the *fit* of the product

Factor	Description
Cross-functional team working	Engaging in internal communication across the organisation's functional departments [15, 18, 19, 20, 21].
Involving front-line employees	Operating service workers have unique knowledge about customer requirements [15, 17, 21].
Devoting resources	Explicitly assigning employees to the development project as this gives a sense of ownership to the project [20].
Climate	Creating a climate promoting continuous innovation in the organisation [17]
Strategic vision and autonomy	Providing a strategic focus, and clear goals for new service development programs balanced by autonomy within the development team [15].
External communication	Taking a network approach to incorporate a range of inputs from external parties during the innovation process [19].
Engaging a product champion and gatekeeper	Engaging a project leader or product champion, who persuades opponents and mobilises resources [15, 17, 20]. Engaging a gatekeeper, who gathers, translates and facilitates external information [15, 21].
Involving consumers	Innovations generated by a user in their own environment are more likely to contain those features that companies seek but which are difficult to identify [22].

Table 1: Factors associated with successful development projects in new product/service development studies.

and the firm's competencies and market needs, shaped the financial success of the product. Similarly, Johne and Storey [17] found that new service development programs needed to fit with the overall strategy and resources of the firm, and that new services should be developed for a clearly identified target market.

In general, the new service/product literature suggests that several internal and external actors should be involved in development processes for a project to be successful. Some of these factors are outlined in Table 1.

Although Table 1 provides the unambiguous success factors others that are unclear such as those surrounding the 'How' of implementation that may provide direction in regard to the importance of rigid, formalised processes versus other models.

2.4 The development process

In early research, the development process is depicted as passing through 'crucial steps", beginning with the strategic formulation of new product/service objectives and ending with full-scale launch [16, 23].This implies that innovations pass through discrete stages. However, recent research criticises sequential models, which do not account for the informal, overlapping and back-and-forth activities that have been observed in development processes [20, 21, 24].

Stevens and Dimitriadis [21] found that new services and innovations are produced in a number of ad hoc ways; by trial and error, by the development team or as a response by a front-line employee to something unexpected. Rather than a sequence of formal steps, they conclude that development processes typically include: 1) solution building in *response to a conflict* encountered by an individual and a reaction of the individual to this; 2) the informal *transfer of this experience* to others, followed by the creation of a formal development group, who formulates the resources and rules that are needed in the production of the new service; and 3) the introduction of the new service procedure, which implies that front-line personnel learn the proposed rules and *adapt them to the local context*. Subsequently, explicit knowledge is transformed into tacit knowledge and the new procedure becomes routine. According to Stevens & Dimitriadis [21], this is when the service development process is over and the new service is implemented.

This conceptualisation of development differs from other models as it views the initial introduction phase as part of the development process. Hence, it acknowledges the influence of the consumer in the development process, usually during the initial stages of implementation. It also seems reasonable to assume that developers consider the input of customers when adapting the proposed service rules to the local context because innovations generated by a user in their own environment seem more likely to contain those features that companies seek but which are difficult to identify [22].

The concepts discussed above are valuable and applicable when analysing innovation in smart home development from the perspective of a single organisation. However, they are less useful in an interfirm modularity industry such as the seniors' smart home industry, which is where a large number of firms, producing different components, are involved. Firms operating in this environment face unique challenges when developing new products or services according to Tripsas and Tucci [12]. The challenges in seniors' smart housing developments in Sweden are provided by the current research.

3. Method

This research uses a combined deductive and inductive method of data analysis. It was driven both by the data and by the theoretical framework discussed earlier [25].

3.1 Data collection

Baseline data were collected over a four-year period; initially in 2002/2003 and then repeated in 2005/2006. This enabled the mapping of trends and it revealed the current state of developments, and the supply and demand for new 'aging in place' technology. Qualitative methods were used and these included in-depth interviews with informants from the housing company sector, technology providers, health care sector, academic research environments and funding parties. The interviews were recorded, transcribed and analysed by the researcher who undertook the interview. This ensured that the transcription was faithful to the recording and that the environmental factors were negated. Ten of the informants were also contacted again to clarify issues arising from the transcripts or the field notes.

Data were also collected by observation and by participating in various relevant political and academic meetings and seminars held in Sweden between 2002 and 2006. Notes from conferences and participation in panels discussing smart housing developments have also informed this research.

3.2 Analysis

In the first phase of analysis the data were themed by identifying the key aspects in each interview and similarities in the responses of the interviewees noted. The coding of data in this research used the quasi-inductive categorisation method as opposed to the conventional methods described by Strauss and Corbin in 1990 [26]. During the coding process, the author consulted the categories presented in italics and outlined previously in this paper. The findings were presented and discussed by informed peer-researchers in a strategy similar to that used by Lincoln and Guba [27] to enhance the credibility of the analysis.

4. Results

This analysis supports some of the extant theoretical themes described in the literature and identified some important new dimensions to the current seniors' smart housing situation in Sweden.

4.1 The aging in place system currently in use

Many seniors "age in place". That is, they grow old in homes that were originally built by house building companies. Incorporated into these homes are entertainment, maybe communication technologies and some kitchen appliances. In Sweden, when a senior experiences difficulties in managing their everyday life at home, a care professional visits the home and typically recommends changes to the environment. Various parties provide the products and services and the provision of these is relatively formalised. Homes are often adjusted by carpenters and added to with various assistive technologies and telecare services such as an emergency response alarm (the only telecare technology widely used to date in Sweden). It seems reasonable to assume that all these technologies impact on the seniors' capability to age in place and for this reason this paper refers to these as "aging in place technologies".

These technologies are part of an overall 'aging in place system' that also includes the service components that are supplied by their care providers, for example, the formal protocols for dealing with emergency alarm signals sent by seniors. This is a complex product and service system [9] in which no single company is active in producing all the products or services that constitute a complete system. In fact, it is serviced by disparate sectors such as the construction, consumer electronics, telecommunications, healthcare service, and security sectors.

The data revealed a small number of actors involved in the development of *new* aging in place technology at component, interaction and/or system level. These were the housing industry, care providers, the technology industry and the academic sector. Their roles will be discussed further here.

4.2 Development of aging in place technology and services at component level

Industry

Interviews and observations indicate that, in Sweden, large firms in the construction, electronics, and automation industry are not directly active in the development of new smart senior housing solutions. Many tried in the 90s and experienced market failures. However, industry has financed the development of technical components and interactive technologies including movement sensors, communication protocols, wireless subsystems and so on that represent potential resources in the development of these smart senior housing systems. Nonetheless, few companies in Sweden have adopted these developments or integrated them into 'aging in place' systems.

In the late 90s Alleato, an industry player, proactively marketed smart senior housing packages. Their vision was to create innovative solutions that would bring enhanced safety to senior households and home care employees by integrating the available smart home technologies, assistive devices and telehealth equipment. This usually required some software development, but even more challenging was operating in an environment that has few standards. Alleato had further invested heavily in learning from the user and customer (patients and front-line employees) and had even employed former care professionals. Although they implemented some of their ideas by engaging in a few funded smart housing pilot projects, Alleato faced a non-existent market.

Today, this company cooperates with academic researchers who evaluate their solutions and they act as a distributor of a few selected stand-alone "smart" or electronically enhanced assistive technology devices, which they sell as independent products. This market is somewhat larger than the smart senior housing market, but still very slow. Alleato management believes that there will be no demand for these products until there is more evidence about the monetary benefit of installing smart home solutions and a better indication as to which party will enjoy these benefits. Currently, there are only a few employees left at Alleato and they are all technicians.

The current research has also found that firms producing assistive technologies (and medical technology to a large extent) primarily conduct incremental innovation. They generally improve their existing product lines rather than integrate their products with other components to create innovative systems. Many providers are very user oriented, and weigh the input from users highly. However, as users are not demanding integrated solutions, no one is driving providers towards more radical cross-sector innovations.

The University Sector and Care Personnel

The University sector has initiated many projects dealing with aging in place technologies. Most have focused on home telehealth components, developing stand-alone devices for communication between patients and remote caregivers, wearable sensors for monitoring cardiac patients, handheld devices for improving home healthcare documentation and so forth. Discipline-specific researchers from medicine, nursing, medical informatics, computer and systems science often manage these projects; typically they work with front-line employees. Few university-based research projects have resulted in market launches or large-scale implementations in regular settings. Rather, the vision of these projects has been to develop prototypes and feasibility studies. Therefore, the *implementation and adaptation to the local context* which according to Stevens and Dimitriadis [21] is crucial for a successful development processes, has not been part of the plan.

Few university-driven pilot studies are integrated into practical situations and there are various reasons for this. Typically, the projects are externally funded for a limited period and there is a lack of engagement from top management. Everything then relies on a product champion who often becomes overloaded. No formal service components are developed prior to imple-

mentation which leads to inappropriate use of the technology. For example, the technology may be over-used that is, it takes up too much of the care professional's valuable time, or under-used and therefore not realise its full potential. This leads to evaluation results that are questionable.

In general, the data suggest that most of the Swedish players participating in the innovation of new aging in place technologies conduct development projects at the component level. Few try to enhance the interaction between components or create overall systems. However, two projects did, and they provide this research with insights into the issues and challenges for the sector.

4.3 Two examples of development projects at system level

The @home and Vallgossen projects were undertaken with collaboration between housing companies, technology providers and care personnel. Using different approaches and technologies, they integrated and combined various products and services to develop innovative smart homes.

@home

The @home project began with a clear vision: to develop technology that better supported disabled and elderly who live in their own homes, to support medical and care staff monitor the rehabilitation process and to better target therapies and rehabilitation programs. The project was also interested in other potential application areas, as it aimed to combine and further refine technological components that had been previously developed within the industry or in academia, rather than to develop new technologies or components. Two occupational therapists from Danderyd's Hospital and an integration consultant designed the overall system. It was a combination of technologies that were integrated into the project's apartments for the use of occupational therapists and pre-discharge patients.

This resulted in an integrated system comprising many smart technologies. The stove, fridge, water tap and other standard house components were connected to an in-built European Installation Bus (EIB bus) system; a system making it possible to control, regulate, measure, switch, service and monitor connected devices. A range of services can be designed based on this technical platform. The occupational therapists and integration consultant decided to include a "leave-the-home-safely" service component that had been developed during a previous project. This component ensured that before the dweller left the apartment the stove was switched off; water was not dripping and so forth. It is activated by use of a 'bye button' or by locking the door. This button automatically turned off certain electricity outlets that could constitute a risk and activate an alert if a window was left open. Further, the 'wired' components in the house could be logged and monitored from a distance by paramedics at the hospital. The use of this system indicated the dweller's capacity to perform activities of daily living and became part of the overall pre-discharge decision support service.

Some components integrated into the apartments, for example the standard EIB system, were high-quality off-the-shelf products. Other components were not. For example, the 'bye-buttons' were prototypes from a previous project. The @home team collaborated with technicians from the Alleato Company, who refined the physical design of these buttons.

The technology was implemented and evaluated by the researchers based on interviews with front-line employees and the consumers (patients). This fed back into re-designing and refining of the system for implementation into standard housing. There was much enthusiasm and one of the enthusiastic, responsible managers at Danderyd served as the *product champion*.

@home was used for several years. Patients with cognitive and motor impairments lived in the apartment and were monitored by care professionals for a week before discharge. According to interviewees, this gave a more accurate picture of the capabilities of the patient to function independently. Further, issues such as the need for larger displays, larger text, more light and so forth, surfaced. The occupational therapists reported many technical problems and poor, but very expensive, technical support. They found it very difficult to know who to call when one of the components failed, and frequently called several people before help arrived. Then, when the product champion became indisposed, management at the Danderyd Hospital was no longer willing to finance the technical support as they were not convinced that the project was economically sound.

According to research participants, the major problem with the project was the lack of evidence about the financial consequences of implementing the technology, including the long-term effects on the community care, county council and hospital budgets. These parties were not willing to invest in new technology because of these uncertainties and each thought that the other should fund the development of the project. Understandably, consumers did not have the capacity to fund the project and, although the project used many of the factors required for successful development and implementation discussed earlier, it was not a success.

Vallgossen

The Vallgossen project was a collaboration between a house building firm, a hospital and a technology/integration firm. The project initially received some external funding and two new apartments were built. These made use of "smart" technology similar to @home and X10 technology, which allows compatible products to talk to each other using the existing electrical wiring in the home. It also had advanced telehealth components that enabled video communication with care providers and the use of equipment that allowed patients to measure and transfer health parameters such as blood glucose and blood pressure.

There was a clearly defined target user group: individuals with spinal cord injuries. The strategy was to implement and test smart home technology for the disabled in regular apartments, which could then be sold by the house building firm in larger volumes. Although the technology was accepted by all users, the telehealth equipment was not used because few routines for using it were developed and there was little need among the dwellers for this type of service. Further, just as with the @home project, support was very costly and, because much untested technology was used, there were many failures. End user involvement also proved difficult, as it was initially very difficult to recruit test persons. After two years, the external funding was consumed. Neither the hospital involved nor the house building company was willing to pay for the running costs of this smart home package. Consequently, some of the telehealth technology was removed from the two apartments and they were sold to non-disabled private individuals.

Based on the fiscal measures of market share and profit, this project did not succeed. However, the participant interviews undertaken during this research suggest that many valuable insights were gained during this project. It demonstrates the redundancy of some features and the potential of others. Today the construction firm involved with the Vallgossen project markets the alarm and safety subsystems as stand alone packages.

5. Discussion

This research found that in Sweden the development of new "aging in place" systems or smart senior homes is very fragmented and at best emerging, that there is low activity in the sector and few suppliers are explicitly devoted to finding solutions. It also revealed that any continuous innovation was mainly taking place in sectors other than healthcare and in a number of pilot projects. The development projects to date have not produced the expected outcomes while the components and systems developed have not been implemented on any significant scale. No changes in housing pathways can be attributed to these new technologies.

The literature on service and product development depicts a large number of factors that if neglected reduce the chance of success (see fig 1). These will form the framework for discussion here.

Involving front-line employees. If assuming that the end-consumer is the senior and the front-line employees are those delivering care services and selling products to this person, several groups of end-consumers and front-line employees were involved in these projects. One easily identified group of front-line personnel was occupational therapists who were involved in many of the development projects, from start to finish. However, a serious weakness was exposed in some projects when home health aides, who are employed in community-based long-term care and who have valuable insight into the everyday life of seniors, were not involved until the development process was almost complete. With the benefit of hindsight, their expertise should have been harnessed in the idea generation phase.

Employing a "product champion". This study questions that assertion. Observations indicate that employing a product champion tends to make others rely completely on this person, and hence, makes the development process quite vulnerable. There is rather a need for an overall commitment to the development project, including top management. This increases the chances for sustainable financing of the project, and the chance of the project receiving the time it needs for completion instead of being interrupted before it is evaluated.

Involving the consumer [22, 28, 29, 30]. There is a recognised information asymmetry between developers and consumer: tacit and difficult to transfer information often referred to as 'sticky' or 'need' information' - resides with the customer, and the "solution" information lies with the firm [28]. This makes the involvement of the customer vital in the development process and, although most interviewees aspire to be customer-centric, seniors are seldom involved at that stage. There actually appeared to be a clear lack of knowledge about how to involve the customer and a paternalistic attitude towards the seniors existed. Projects enabling seniors to use technology and to generate new ideas for its use would most likely produce more original and valuable ideas for 'smart' housing. However, firms seem to reflect a short-term focus which may derive from their long wait in this tough market. They seem content if their products are accepted by healthcare managers alone, as presumably they have greater capacity to implement projects.

Another important area for consumer involvement and one that falls short in the current development process is the *implementation and adaptation to the local context* phase [21]. This applies to the development of components as well as overall systems, and is seen as crucial for successful development processes. Again it is not seen as part of the innovation process and consequently it does not include end users until later in the process.

Whether *formalisation* and rigid development processes are positive or negative is debated in the development literature. However, this research indicates that the formalised processes are by no means a guarantee for success. In many projects, the development of product components has often occurred in a formalised way. However, the development of interaction between humans and these components has typically been less well-defined. The *service components* have been developed in a less formal and often in an *ad hoc* manner. There has been a lack of service innovation and neglect of support services, leading to negligible gains in efficiency. For example, if service procedures and routines had been built for the many telehealth technologies implemented in the various pilot settings, these would be further advanced than they currently are. This has clearly affected the outcomes of development projects and their market success.

Using a *cross-functional team*. There have been many isolated development

projects that typically involve only one academic institution and one field of practice. To avoid re-inventing the wheel, smart home development would benefit from more horizontal collaboration with potential competitors and organisations offering complementary technologies, and vertical collaboration, with suppliers and customers. Truly multi-disciplinary teams should include members with knowledge of legal, policy, social, psychological, medical and nursing issues, as well as those with technical and economical expertise. Competence in construction (house builders), marketing and architecture seems to be particularly absent in these teams.

External communication. This is highly relevant in this setting. It is often difficult for clinicians to understand the technology and for technical officers to understand the nuances of healthcare. Both groups require either formal or informal avenues for education. As a minimum, front line home health employees should attend telehealth and smart home conferences, and technical support personnel and computer programmers should be sent on task rotation programs within the senior home care sector. Barlow's [5] proposal of systematic managerial and organisational change to facilitate a more innovative culture would also be valuable in this context, as it includes greater employee empowerment and the introduction of communication structures, which allow the leverage and transfer of ideas.

There is no *climate promoting continuous innovation* in the sector or amongst the players who have the knowledge to develop the next generation of aging in place systems. In general, one-off projects do not produce experts who continue in the area. The rigid organisational boundaries, division of financial responsibility, short-term budget and the rules imposed by various laws also impede innovation in the long-term care sector. Generally, there is little financial or political support for development and this appears to be related to the climate within the public senior care sector, which does not encourage high-risk investments. Similarly, interviews with the housing builders also reveal the lack of incentives for them to invest in these technologies. They were also negative about the possibilities of gaining a return on their investment even if they increased their prices.

This research dealt with university-based projects and small spin-offs from large companies, in other words participants without a large research and development budget: Large companies with such budgets are 'waiting' for the market to emerge. Unfortunately, many of these small projects have failed due to a *lack of long-term funding*, another factor for success. The Swedish Government seems to have fallen into a trap identified in the literature and have spread resources too thinly and across too many projects. Although it has funded several small component development projects on the same horizontal level, a greater investment and longer term investment in larger development projects is required.

New services should be offered with a *vision* and to a clearly defined market (with the paying party defined). This has not occurred in Sweden. Here there have been intangible and difficult-to-quantify visions such as enhancing the freedom and quality of life of the dweller and improving decision support to care professionals. This research reveals that demonstrating such benefits is not enough and that cost benefit analysis must be undertaken. Yet most projects have failed to produce high quality *evaluations* of the economic consequences of using the technology in smart housing. From a policy perspective, changing housing pathways and making these cost effective should be the goal of the projects. Therefore, quantitative measures of the benefit for specific parties such as the state, county council or the municipality are crucial.

The development literature refers to sectors with a large number of producers of components as "interfirm modularity industries" [12]. This is where the development of *standards* is crucial if the sector is to advance. However, this study reveals a lack of standards in several smart senior housing areas particularly at the level of component interactions. At this time, the telehealth components cannot communicate with traditional assistive devices, personal handheld computers or the TV typically installed in seniors' homes. They are independent products that can only be implemented as stand-alone units.

However, some participants did not view this as a problem because, in the absence of standards, they are able to differentiate their product. Today's system is far from the vision of the ambient, integrated smart home systems with many hidden automated functions, where the various components work seamlessly together to better serve the individual dweller. Perhaps this is why occupational therapists are so reticent to advise frail seniors to adopt new smart, aging in place systems into their homes.

The development literature suggests that, in general, the internal organisation of the firm, intrinsic product quality and market conditions determine the success of innovation processes. However, in this context and particularly when a large number of players are involved, this research suggests that the *internal organisation* of the firm should be changed to: "*the organisation of participating firms and their external relationships*". The findings from this research indicate that, too often in the assistive technology sector, each product division conducts its own development to support the existing products of established companies. This may have impeded development by making it difficult to develop new products based on technology fusion, which may demand new technology-product-market linkages and will require close collaboration between different divisions and with external parties [11].

Although players who have implemented structures built on loose alliances are still waiting for a breakthrough, more external collaboration would be beneficial for future developments. As noted earlier in this paper, not all the relevant parties have been involved in developments at this stage. This has impeded the introduction of more radical innovations that could truly re-shape the market.

The research data regarding *the intrinsic product* (including quality, cost advantages and a clear product concept) reveal that most industry players in Sweden agreed that there was no urgent need for innovation at the technology level. Rather, they regarded development at the interaction and overall system level as most necessary. Tidd [11, p. 308] notes that "almost all of the component technologies have been available for a decade, but few commercial products or services have been developed". This still seems to be the case.

In Sweden, the design of service components has been insufficient and the formulation of rules for employees using the technology is absent on many occasions. Hence, there is room for players who can integrate all the technologies, build services around them, and design systems that can be marketed. Labelling such systems and making their benefits clear is just as important. In short, someone needs to define the product or the complete service offering including identifying both a target market and a clear benefit for identified parties. This is also something that requires more attention in development processes.

This study suggests that the *market conditions* represent the factor most likely to impede the successful development of new 'aging in place' systems. In the current market, there is no willingness to pay for the technologies that have been developed, or for further development. The benefits generated by many of the innovations discussed earlier have been acknowledged by the participants at county, council and municipal level, but they would not appoint themselves as the "payer", or declare themselves the customer.

6. Recommendations

There is a need for smart home system developers to better define the 'purpose' and requirements of new innovations: They must

- accurately assess and describe the customers' needs (as the consumer relates them) or directly engage the customer with the development team;
- articulate the benefits for the customer in understandable terms and provide a cost benefit analysis and cost-savings assessment associated with the use of the service/product;
- define their innovation's technical and organisational resource requirements. In this way, developers can better plan and reserve resources that ensure the long-term survival of their project.
- better design the service processes or the chain of activities that must occur for the innovation to function. Technical support services are a crucial part of this.

In general, there is a need for actors who develop solutions at system level rather than component level. Competence in how to integrate existing technologies, build services around them, and design systems that can be marketed should be mobilised.

7. Conclusion

What emerges from this study is the realisation that smart senior housing development is languishing. This can be remedied but it will take goodwill, leadership and resolve to do so. All parties must cooperate to achieve this. Generally, the development of 'aging in place' housing and efficient systems that support this should be much more widespread than is currently the case. This is particularly important because of the social changes taking place such as the widely discussed and well documented aging population and the change in the composition of the family unit. These are worldwide problems.

The technology is capable and builders efficient but a lack of standards, commitment by Government and money for research and development is restricting development. In this modern age, people should be able to age in their own homes, supported by assistive technologies if this is their wish; the means are available but the will appears to be lacking.

References

1. Houben P. Changing housing for elderly people and co-ordination issues in Europe Housing Studies. 2001; 16(5): 651-73.

2. Hagberg J-E, Old people, new and old artifacts: Technology for later life, in Changing worlds and the ageing subject. Öberg B-M, Editor. Ashgate: Aldershot; 2004.

3. Barlow J, Venables T. Will technological innovation create the true lifetime home? Housing Studies. 2004; 19(5): 795-810.

4. Dewsbury G, Rouncefield M, Clarke K, Sommerville I. Depending on digital design: Extending inclusively. Housing Studies. 2004; 19(5): 811-25.

5. Barlow J. From craft production to mass customisation. Innovation requirements for the UK house building industry. Housing Studies. 1999; 14(1): 23-42.

6. Imrie R. Editorial housing quality, disability and domesticity. Housing Studies. 2004; 19(5): 685-90.

7. Essén A. Kvarboende och äldrevård i hemmet. Vad hämmar utvecklingen av nya tjänster? Institute for Future Studies, Report series (5)2003.

8. Hrdlicka A, Tegstam A. Teknik för hem och vardag. Svenska möjligheter i Japan. En återträff med framtidens hem: Människor, myter och manicker. Panel report, December. 2003. Available from: http://www.nita.uu.se

9. Junestrand S. It och bostaden, ett arkitektoniskt perspektiv. 1998. Available from: http://www.arch.kth.se/~junestrand/licrapport/tekniklicrapport.pdf.

10. Peterson F. Smarta hem och smarta ting. Hur datorerna tar plats i världen och förändrar vårt vardagliga liv. CID report. 2000.

11. Tidd J. Development of novel products through intraorganizational and interorganizational networks. Journal of Product Innovation Management. 1995; 12: 307-22.

12. Staudenmayer N, Tripsas M, Tucci C. Interfirm modularity and its implications for product development. Journal of Product Innovation Management. 2005; 22: 303-21.

13. Booz, Allen & Hamilton. New products management for the 1980s. Booz, Allen & Hamilton. New York. 1982.

14. Kelly D, Storey C. New service development: Initiation strategies. International Journal of Service Industry Management. 2000; 11(1): 45-62.

15. Brown S, Eisenhardt M. Product development: Past research, present findings, and future directions. Academy of Management Review. 1995; 20(2): 343-78.

16. Scheuing E, Johnson E. A proposed model for new service development. Journal of Services Marketing. 1989; 3(2): 25-34.

17. Johne A, Storey C. New service development: A review of the literature and annotated bibliography. European Journal of Marketing. 1998; 32(3/4): 184-251.

18. Smith A, Fischbacher M. New service development: A stakeholder perspective. European Journal of Marketing. 2005; 39(9/10): 1025-48.

19. Syson F, Perks H. New service development: A network perspective. Journal of Services Marketing. 2004; 18(4): 255-66.

20. de Jong J, Vermeulen P. Organizing successful new service development: A literature review. Management Decision. 2003; 41(9): 844-58.

21. Stevens E, Dimitriadis S. Managing the new service development process: Towards a systemic model. European Journal of Marketing. 2005; 39: 175-98.

22. Edvardsson B, Haglund L, Mattson J. Analyzing, planning, improvisation and control in the development process of new services. International Journal of Service Industry Management. 1995; 6 (2): 24-35.

23. Von Hippel E. Economic of product development by users: The impact of sticky local information. Management Science. 1998; 44(5): 629-44.

24. Edgett S. The traits of successful new service development. Journal of Services Marketing. 1994; 8(3): 40-9.

25. Dolfsma W. The process of new service development – issues of formalization and appropriability. International Journal of Innovation Management. 2004; 8(3): 319-37.

26. Bliss J, Monk M, Ogborn J, eds. Qualitative data analysis for educational research. Croom Helm: London; 1983.

27. Strauss A, Corbin J. Basic qualitative research: Grounded theory, procedures and techniques. Beverly Hills: Sage Publications; 1990.

28. Lincoln Y, Guba E. Naturalistic inquiry. Thousand Oaks: Sage Publications; 1985.

29. Thomke S, von Hippel E. Customers as innovators: A new way to create value. Harvard Business Review. 2002; 80(4): 74-81.

30. Thomas P. The experience of disabled people as customers in the owner occupation market. Housing Studies. 2004; 19(5): 781-94.

31. Edvardsson B, Olsson J. Key concepts in new service development. Service Industries Journal. 1996; 16(2): 140-64.

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