Assistive Technology: From Research to Practice
P. Encarnação et al. (Eds.)
IOS Press, 2013

doi:10.3233/978-1-61499-304-9-1255

Technology Transfer within the Telecare Technology Innovation System

Remy D. van der Vlies[a] and Esther Felix[a]
[a] *TNO, Dutch Centre for Health Assets*

Abstract. Telecare technology is not common yet, although it is perceived as promising. Most studies on telecare technology transfer present a case involving the use of a single methodology and approach during some steps of technology transfer. Technology transfer models cannot be sensibly constructed if they don't consider the whole innovation process, therefore, the aim of this research is to introduce a model for the mapping of telecare technology transfer in an innovation system as a whole and assess its usability by mapping drivers and barriers as experienced in the transfer of a documented telecare technology introduction. We started from the basic System Innovation (SI) Framework as introduced and expanded by Klein Woolthuis and applied it to one of the cases published in Technology and Disability; 24(3): 'ACTION'. The SI-approach provided a structured overview of the complete innovation system and helped uncover the source of the success and the roots of the challenges.

Keywords. Technology Transfer, Innovation systems, older adults, ACTION

Introduction

About 90% of persons aged 55 and older would prefer to stay in their current residences as long as possible because older adults value their independence. However, aging in place is not only a way to meet personal needs it is also a societal necessity as pointed out by the European Health Telematics Association: without changing the way elder citizens are supported in 2020, almost 20% of all working people will have to work in health services [1]. This will lead to a scarcity of professional resources. Telecare technology is expected to enable fewer health professionals to fulfill the increasing need for care as healthcare is provided from a distance.

Although perceived as promising, telecare technology is not common yet [2] except for reactive emergency response systems, which are mainstream in some countries such as the UK and the Netherlands [3]. In general however, some commercial telecare systems are available but proof of cost effectiveness is still absent [4], this implies the technology transfer has reached the sixth of eight steps [5] but did not yet reach the last step 'the launch of a proven technology'.

Most studies on telecare technology transfer present a case involving the use of a single methodology and approach during some steps of technology transfer. Sometimes the method is developed during research and sometimes models are used which originate from domains other than telecare technology [5].

Perhaps the most influential theoretical model that describes the product adoption process is the Technology Acceptance Model (TAM). It was developed in the 1980s to predict the acceptance of computers [6] and has since been used frequently in the domain of health information technology [7]. It states that the intention to use a system is dependent on Perceived Usefulness (PU) and Perceived Ease-of-Use (PEoU) but TAM does not predict actual use. Recently, in order to be able to better predict the actual use of telecare by older adults, TAM has been adapted to TAUM: Telecare Acceptance and Use Model [8]. TAUM goes beyond the intention and includes the actual use. Both TAUM and TAM help evaluate the technology once it's there but these models lack clearly defined steps that help engineers to design acceptable technology.

'Human centered design' [9] and 'inclusive design' [10] provide guidelines for engineers who design assistive technology. Both are processes in which users are at the center of the design. Involving users in defining the requirements and evaluating the design will increase the likelihood that the technology will be usable and easy to use. The process of both 'human centered design and 'inclusive design' stops once a technological solution is available that is expected to be accepted and used. Even though the inclusive design process was recently altered and now includes 'building a business case' it does not nearly cover the whole 'transfer of new technology from the originator to many users benefitting'. It is expected that many users will benefit, but economical, societal, and political circumstances influence the technology transfer as well.

"*Technology transfer models cannot be sensibly constructed if they don't consider the whole innovation process and indeed that any individual project is occurring in a competitive space*." [5]

Aim of this research is to introduce a model for the mapping of telecare technology transfer in an innovation system as a whole and assess its usability by mapping drivers and barriers as experienced in the transfer of a documented telecare technology introduction.

Method

"... technology transfer occurs in a competitive space and does not occur in a vacuum nor is it pragmatically a simple sequence of steps." [5]

For the description of the system in which telecare technology is transferred we started from the basic System Innovation Framework as introduced and expanded by Klein Woolthuis et al [11]. The System Innovation (SI) approach emphasizes that innovation is both an individual and a collective act, resulting from technology transfer between multiple actors and organizations rather than from the independent actions of single users or organizations. The SI framework supports the identifying of drivers and barriers for technology transfer at various levels of the innovation system.

'Lock-in' is a central concept in the SI approach. Lock-in means that a particular technology is dominant, not because its costs are lower or its performance is better, but because it benefits from the system, for example: users are accustomed to the 'old' technology (e.g. qwerty vs. the more ergonomic dvorak key-boards), the required infrastructure is lacking (e.g. hydrogen-fuel cell cars), etc. By doing so Klein Woolthuis builds on the research of Smith:

"*... technological alternatives must not only compete with components of an existing technology, but with the overall system in which it is embedded. Technological regimes or paradigms persist because they are a complex of scientific knowledge, engineering* *practices, process technologies, infrastructure, product characteristics, skills and procedures which make up the totality of a technology and which are exceptionally difficult to change in their entirety.*" [12]

The SI-framework has been used for analysis of various innovations such as a transport system for fresh fruits [11], market opportunities for sustainable products [13], and sustainable technologies in construction [14].

In the SI-framework the characteristics of the innovation system are positioned at the left-hand side whereas the actors that created the system, and thus can also remove barriers or create drivers are positioned at the top. The list of system characteristics are considered to be the same for all innovation systems [14]:

- Infrastructural failures (concerning the physical infrastructure, such as railroads, telecom);
- Institutional failures: hard (e.g. laws, regulation) and soft (e.g. norms, values, implicit rules of the game);
- Interaction failures (too strong or too weak networks);
- Capability failures (e.g. entrepreneurship, adequate labor qualifications and the like);
- Market demand: demand quantity and demand quality (the presence of buyers that demand a high quality stimulates innovations);
- Market structure: market power (free market - monopoly) and entry barriers (e.g. high initial costs);
- Externalities: split incentives (actor A invests, actor B profits) and transparency (the market price does not account for the external effects of an economic activity: e.g. pollution).

The actors in an innovation system depend on the type of technology and therefore the list of actors varies. When comparing the actors in the SI-frameworks of i) the transport system for fresh fruit, ii) sustainable products, and iii) sustainable construction technologies, we found them to have the following actors in common:

- User/buyer: the actor that pays, uses, owns, and profits from the innovation;
- Suppliers: the actor that invented, manufactures, and sells the innovation;
- Knowledge institutes: universities and technology institutes providing knowledge and possibilities for knowledge transfers.

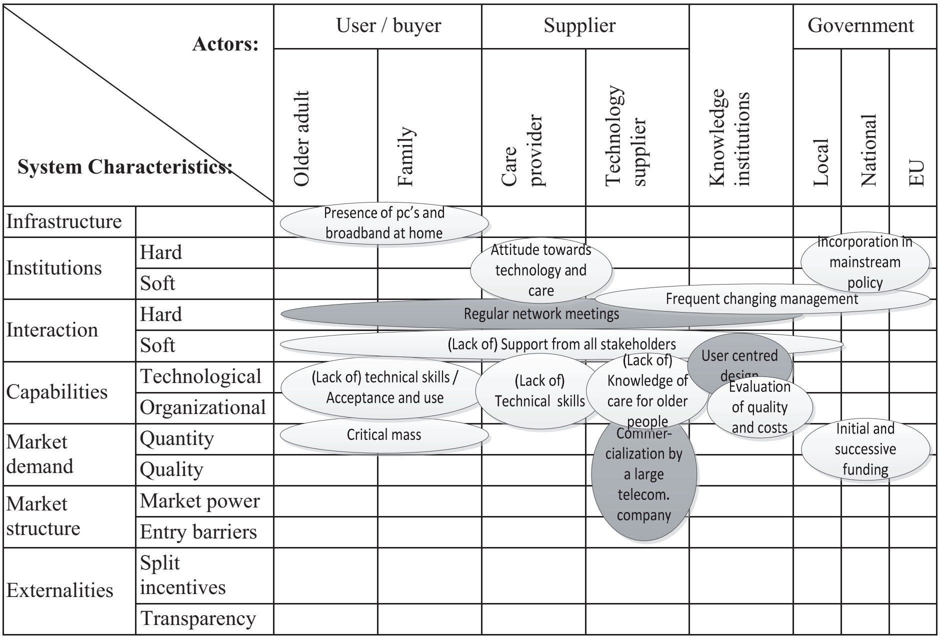
Other actors mentioned actors are: governments, consultants, banks, etc.

Results

As an example we applied the SI-framework to one of the cases published in Technology and Disability; 24(3). The case study of 'ACTION' [15] was chosen at random. The ACTION telecare technology includes the ACTION station (a personal computer) and a call center. This technology provides access to web-based educational programs, support from other ACTION families and dedicated care practitioners via the use of an integrated videophone system. The support service was designed together with frail older people and their family carers.

By categorizing relevant actors at the top of the framework the complex buyer-supplier relationship becomes clear. In fact there are two suppliers: the actor that provides the technology and the actor that provides the care. Also the 'user/buyerfunction' is divided amongst two actors: the (older) patient and his or her family. Besides these four actors, knowledge institutions and governments were involved in the technology transfer as well, see table 1. Table 1 also shows the five success factors and seven challenges as distinguished by Magnusson and Hanson.

Table 1. Success factors (grey) and challenges (white) for the technology transfer of ACTION mapped in the SI-framework.



Magnusson and Hanson distinguish five critical success factors [15] for ACTION:

1. User centered, participatory approach; indicating the organizational capabilities of the designers, and sufficient interaction between the designers and potential users.
2. Innovative appeal and flexibility as technology based service; this success factor is interrelated with the first one, it shows that the outcome of the user centered design process successfully met user needs and requirements. Which resulted in acceptance and use.
3. Research based; this success factor too is interrelated with the first two. It refers to the capabilities, knowledge and knowhow of the designers involved.
4. Ongoing support by all key stakeholders; this success factor shows the importance of the regular network meetings. This created a network of interacting actors. Should there have been too little interaction this support would have been absent.
5. Commercialization of the service by a large telecommunication company; this indicates sufficient market demand and also the existence of entry barriers. Apparently, a sufficient economy of scale needs to be reached in order for the system to be profitable.

Besides the five success factors Magnusson and Hanson also distinguish eight challenges [15] for ACTION. It are these challenges that hinder further technology transfer:

1. Organizational complexity. It "is not just about installing and using the technology itself, rather it involves changing the way in which people work and think": this implies that in order to support older adults by empowering families rather than 'doing' for them involves a change of soft institutions. A second organizational threat is too little interaction between ACTION and existing care services.
2. Attitudes. This challenge is intertwined to the first issue pointed out under 'organizational complexity': specifically the norms and values (soft institutions) of care professionals are a barrier to technology transfer. "The last thing a sick older person … needs … is a technology based service".
3. Support from all stakeholder groups. The fourth strength proves to a challenge as well. Frequent changes at management level in the municipality disrupt the interaction which results in less support.
4. Evidence of cost effectiveness: actors involved lack the capabilities and the infrastructure to collect sufficient data and compare the outcome with a suitable comparator.
5. Mainstreaming/creating a critical mass: municipalities are wary of investing in more than 20 users. It is necessary to change hard institutions.
6. Solid business plan & model. Staff turnovers frequently disrupted the interaction. Writing a business plan required the capability (knowing how) to write a business plan, but also the capability to understand the technology and the way it supports care for older adults. The business case itself proved to depend on the absence or presence of a infrastructure of private payed personal computers and broadband.
7. Policy. This challenge is related to challenge number 5. There is a need to change policy (hard institutions) at all levels in order to enable this technology.
8. Financing: Government funding is necessary to overcome market imperfections, invest in the innovation and by doing so make the business case sound. Government can be convinced to do so by pointing out externalities. Also, should the market demand have been big enough, there would have been a commercial organization willing to invest themselves.

Discussion and Conclusions

The SI-approach provided a suitable framework for mapping drivers and barriers for the success of the technology transfer of ACTION and resulted in a structured overview of the complete innovation system. The framework helped uncover the source of the success and the roots of the challenges. It also showed some of the success factors to be intertwined and some of the challenges to have multiple facets and causes.

Based on the SI-analysis we may say that by including users in a human centered design process the engineers of ACTION were successful in designing a technology that is accepted and used. The two key success factors proved to be the user centered design and the sufficient interaction with stakeholders involved (e.g. regular network meetings). The technology transfer, however, is slowed down because of influences from the economical, societal, and political environment. Specifically changing the hard and soft institutions proved difficult.

"*The idea was that the social model is one that assumes that the development of assistive technology is something that has to be driven by the goal of achieving an inclusive society – and so there are moral, financial, business and scientific issues to* *understand and manage.*" [5]

Concluding we may say that the SI-framework proved appropriate for analyzing telecare technology transfer. It covers those parts of the technology transfer which are out of reach of TAM and human centered design: moral, financial and business issues. As such, it covers the whole 'transfer of new technology from the originator to many users benefitting'. However, it cannot replace the models mentioned earlier since it does not provide the detailed insight needed when designing or evaluating telecare technology: the models are complementary. Also, some elements of the SI-framework proved complex in use. Specifically the constructs of 'hard and soft institutions' and 'hard and soft interaction' raised questions while using the matrix. These could be avoided by making two changes in the framework:

1. Rename 'hard institutions' into 'law and regulations' and rename 'soft institutions' into 'social norms and values'. The first change results in more understanding without any loss of quality. This is not true for the second change. Soft institutions include besides 'norms and values' also culture, the willingness to share resources with other actors, the entrepreneurial spirit within organizations, industries, regions or countries, tendencies to trust, risk averseness etc. However the increase in usability of the SI-framework outweighs this reduction in accuracy.
2. Stop distinguishing 'hard' and 'soft' interaction when using the framework to analyses technology transfer. Technically 'hard' and 'soft' interaction are different, like hard and soft institutions are different [16] but at a glance they seem to be two extreme values of the same variable. By treating hard and soft as two values of the same variable the accuracy of the framework is reduced but the framework gains in usability.

Currently, the authors are using the simplified SI-framework to identify the barriers and drivers for implementation of video communication telecare technology in the Netherlands by evaluating three projects and the surrounding innovation system.

References

[1] EHTEL, "Sustainable Telemedicine: paradigms for future-proof healthcare," EHTEL (European Health Telematics Association), Brussels, 2008.

[2] L. Kubitschke and K. Cullen, "ICT & Ageing; European Study on Users, Markets and Technologies," Empirica Gesellschaft für Kommunikations- und Technologieforschung, Bonn, 2010.

[3] M. Clark and N. Goodwin, *Sustaining innovation in telehealth and telecare*. London: WSD Action Network, 2010.

[4] H. Mistry, "Systematic review of studies of the cost-effectiveness of telemedicine and telecare. Changes in the economic evidence over twenty years," *J. Telemed. Telecare*, vol. 18, no. 1, pp. 1–6, 2012.

[5] P. A. Cudd, "Assistive Technology-Technology Transfer," *Technol. Disabil.*, vol. 24, no. 3, pp. 181–185, Jan. 2012.

[6] F. D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *Mis Q.*, vol. 13, no. 3, pp. 319–340, Sep. 1989.

[7] R. J. Holden and B.-T. Karsh, "The Technology Acceptance Model: Its past and its future in health care," *J. Biomed. Inform.*, vol. 43, no. 1, pp. 159–172, Feb. 2010.

[8] A. A. G. Sponselee, "Acceptance and effectiveness of telecare services from the end-user perspective," Technische Universiteit Eindhoven, Eindhoven, 2013.

[9] ISO 9241-210: 2010, "Ergonomics of human-system interaction -- Part 210: Human-centered design for interactive systems," 2010.

[10] P. Clarkson, R. Coleman, I. Hosking, and S. Waller, *Inclusive design toolkit*. Engineering Design Centre, University of Cambridge, UK, 2007.

[11] R. Klein Woolthuis, M. Lankhuizen, and V. Gilsing, "A system failure framework for innovation policy design," *Technovation*, vol. 25, no. 6, pp. 609–619, Jun. 2005.
[12] K. Smith, "Innovation as a systemic phenomenon: rethinking the role of policy," *Enterp. Innov. Manag. Stud.*, vol. 1, no. 1, pp. 73–102, 2000.
[13] B. Van Mierlo, C. Leeuwis, R. Smits, and R. K. Woolthuis, "Learning towards system innovation: Evaluating a systemic instrument," *Technol. Forecast. Soc. Change*, vol. 77, no. 2, pp. 318–334, 2010.
[14] R. J. A. Klein Woolthuis, "Sustainable Entrepreneurship in the Dutch Construction Industry," *Sustainability*, vol. 2, no. 2, pp. 505–523, 2010.
[15] L. Magnusson and E. Hanson, "Partnership working: The key to the AT-technology transfer process of the ACTION service (Assisting Carers using Telematics Interventions to meet Older people's Needs) in Sweden," *Technol. Disabil.*, vol. 24, no. 3, pp. 219–232, Jan. 2012.
[16] B. Carlsson and S. Jacobsson, "In search of useful public policies: key lessons and issues for policy makers," *Econ. Sci. Technol. Innov.*, vol. 10, pp. 299–315, 1997.