Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses

Keijzer-Broers, Wally; de Reuver, Mark

DOI
10.1177/1420326X16670227

Publication date
2016

Document Version
Accepted author manuscript

Published in
Indoor and Built Environment

Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses

Post-print version: Keijzer-Broers, W. & De Reuver, M. (2016). Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses. Indoor and Built Environment (IF 0.943) DOI: 10.1177/1420326X16670227

Wally Keijzer-Broers, Mark de Reuver (2016)

Delft University of Technology, Faculty Technology Policy and Management

Jaffalaan 5

2628 BX Delft, The Netherlands

*Corresponding author: w.j.w.keijzer-broers@tudelft.nl; g.a.dereuver@tudelft.nl

+31 15 278 1920

Cooperation and knowledge challenges in realizing smart homes: The case of small installer businesses

***Abstract* — Despite technological advances, smart home concepts are not receiving widespread adoption. Small businesses that install and maintain heating, security and energy saving systems could play a major role in bringing advanced technologies to home owners. However, the role of such small installer businesses in the smart living industry is generally overlooked in practice as well as academic literature. This paper studies challenges small installer businesses face, when offering smart home and smart living services. A survey, as well as in-depth interviews, are conducted. A main pattern across the findings is that small installers, despite their potential role, are reluctant to be involved in the smart living industry. Lack of knowledge and entrepreneurial skills, limited sharing of knowledge and lack of cooperation hinder small installer businesses to offer smart living services.**

***Keywords*—small businesses, smart living, smart homes, high-tech, cooperation, knowledge transfer**

Introduction

Traditionally, smart homes utilize several computing devices and appliances in order to automate and support domestic tasks [1]. Thanks to increasing number of IP-enabled devices and technologies, like networked sensors, smart homes are changing from simple home automation systems towards more advanced ICT-enabled smart living services [2-6]. The concept of smart living is broader than just smart homes as it involves connecting our daily activities at home, along the way, or anywhere else, that can be supported by integrated ICT. Energy providers see opportunities for ICT-enabled smart energy management [7-9]. Telecom and Media companies are interested to turn the home into an experience centre with the help of remote controls [10, 11] and healthcare providers are looking for ways to utilize sensor networks and smart devices to enable elderly and disabled people to stay and live in independently as long as possible [12-16].

Although different industries acknowledge the potential of smart home concepts, applications have not reached the mass market yet [28-31]. Demand has been slack, and it has been argued that smart home solutions are technology focused rather than adjusted to the needs of customers [17, 18]. In other words, a bridge is needed between the technology-focused smart home solutions and the demand and daily life of end-users. Although numerous researchers study the smart living domain from the perspective of users [19, 20] or technology [21-24], no research, to the best of our knowledge, addresses the role of installers in this field. Probably because, for a long time, installers are being seen as subcontractors and are only sideways mentioned in related studies about smart homes, ambient assisted living and ageing in place [25-27].

To bridge the gap between the technology and the daily demand of end-users, installers could expand their intermediary role. Installers already have a relationship with end-users for installing and maintaining basic devices and providing convenience like heating systems, air conditioning, energy saving concepts and security systems. Although installers could benefit of their technical skills and their knowledge about the demand and daily living of the end-user, installers are not used to strengthen this advantage.

This paper studies what challenges small installers face to bring smart living services and products to the market. To achieve this, we conducted a survey and additional interviews.

Background: Small businesses in ecosystems

To the best of our knowledge, no work has been done on the specific case of small installer

businesses in the field of smart homes or smart living. Solaimani et al[18] find that in general most smart home research focuses on technological rather than organizational or business issues. Peine[28] observes that consequently, most smart home concepts are stuck in the development phase. Given the lack of prior research on the role of installers in smart homes and smart living, we develop a conceptual framing to understand the issues at hand, by drawing upon ecosystem literature.

The business ecosystem concept is first coined by Moore [37] and is used to describe a network of organizations that are cooperating and competing across different industries and co-evolve around a technology or a new innovation. Such an ecosystem goes through different stages of "birth, expansion, leadership, and self-renewal – or, if not self-renewal, death" [37]. According to Iansiti and Levien [38] a business ecosystem basically consists of a number of things: the central hub, a platform and niche players: elements that are all relevant for this research. The logic is that the central hub is the owner of the platform, and that niche players can use this platform to create value for themselves. As such, a network of organization and actors that emerge around an information platform that covers the smart living domain can be viewed as a business ecosystem.

The actors in a business ecosystem often fulfil different roles in the service delivery process. One of the severe challenges of any ecosystem is the "complex interplay between competitive and cooperative business strategies" [37] and ecosystems are typically dominated by large keystone players [39]. Collaboration is even more important in knowledge and information intensive ecosystems. The role of small businesses in general is often limited to a niche player position, as their assets, innovative capabilities and knowledge are limited or very specific. In the increasingly complex business ecosystems for ICT innovations, small businesses will face cooperation challenges as they have difficulties relating to other relevant actors [40-43]. As the smart living ecosystem is rapidly evolving, knowledge on technological solutions, user needs and business models are crucial to play a major role. 'Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information' [44]. 'It originates and is applied in the minds of 'knowers'. In organizations, knowledge often becomes embedded not only in documents but also in organizational routines, processes, practices and norms.' [45]. Improvements in knowledge management promote 'factors that lead to superior performance: organizational creativity, operational effectiveness and quality of products and services' [46]. The average knowledge base in small businesses, especially among micro firms, is low compared with

larger organizations [47]. The major skills gaps that impede small business are technical skills, managerial competency and poor marketing skills [48], as well as the absorptive capacity of firms, level of education, staff development, growth orientation and propensity to innovate [49]. Typically these skills and capabilities are knowledge related.

As far as knowledge sharing is concerned it involves the process of converting knowledge and creating new knowledge [50] as well as the process of sharing relevant information, ideas and expertise with others [51]. Knowledge sharing refers to the provision of task information and know-how to help others and to collaborate in order to solve problems, develop new ideas, or implement policies or procedures [52]. Knowledge sharing differs from knowledge transfer and knowledge exchange. Knowledge transfer involves both the sharing of knowledge by the knowledge source and the acquisition and application of knowledge by the recipient. Knowledge transfer typically has been used to describe the movement of knowledge between different units, divisions, or organizations rather than individuals [53]. Besides knowledge already attained by small businesses, knowledge transfer is important to learn about new technologies, user needs and business models. Knowledge transfer is related to the firm's absorptive capacity, or its lack thereof [54]. This absorptive capacity is defined as the 'ability to identify, assimilate and exploit knowledge' [55]. In a knowledge-driven economy the management of information and knowledge is one of the main challenges small businesses are facing [56]. Yet, often entrepreneurs are captured by day-to-day business operations and thus prevented from actually tackling this challenge [57, 58].

Methods

This study combines two methods to explore cooperation and knowledge related issues for small installer businesses: a survey and interviews. The survey was used to elicit which issues are most important regarding cooperation, knowledge related skills and knowledge transfer, among a large group of stakeholders, which were subsequently explored in depth in a series of interviews with a selected group of stakeholders. Typically this research is an example of mixed-method research in which survey results were used for a broad orientation and the in-depth interviews for a more in-depth understanding of the topic of research.

Survey

We carried out an online survey enabled by the Dutch branch organization of installer businesses.

Their membership is related to some kind of specialization in the engineering sector. A substantial part of these members are involved in smart living projects. In total, 1746 of the 5300 members were preselected according to their involvement in smart living projects. Most respondents belong to a chapter within the branch organization that focuses on intelligent home, building automation and ICT. Within this chapter both mechanical and electrical contractors are involved. 144 members participated, yielding response rate of 8%. Fifty-seven companies have ten or less employees (total 272 employees). Thirty-three companies have between 11 and 25 employees (total 1590 employees). Nineteen companies have between 26 and 50 employees (777 employees). Fourteen companies have between 51 and 100 employees (1028 employees). Finally nineteen companies fall into the category 100+ (4460 employees). So typically the majority qualifies as small businesses.

Respondents are active in the areas: smart grid, heat/cold storage, e-Health, independent living for elderly, home entertainment and information and communication systems, smart and secure remote management, time and place independent works, green IT, smart air-conditioning systems and intelligent water management. Notable are the high scores for involvement, in independent living, smart security and remote management, but also smart climate. While intelligent water management and smart grid get the least attention. For the majority of firms trying out new technologies and doing challenging projects is an important motivator to get involved in smart living concepts. The results from the survey are used as input for the second part of the research: a qualitative study by means of interviews.

Interviews

As a follow-up we selected the most challenging issues for small installer businesses from the survey to explore the outcomes in more detail, specifically knowledge and cooperation challenges, based on eleven in-depth interviews. Interviewees discussed the hurdles in case of the roll-out of smart living services from three different angles: installers, opinion leaders and manufacturers. Interviewees were pre-selected based on their role as strategic decision making within their company or within the industry, and are active in the domains of health, safety, energy and entertainment. See Table 1 for an overview. The semi-structured interviews were guided by questions focusing on the main challenging issues as found in the survey study.

Table 1: Interviewees

Category	Organization	Job description
Installers	Entron	Director
	BAM Techniek	Innovation manager
	Hogervorst Elektra	Director
	Domutron	Marketing director
Opinion leaders	TU Eindhoven	Professor
	TNO-ICT	Senior researcher
	TU Delft / KPN	Professor and strategist
	UNETO-VNI	Innovation manager (branch organization)
Manufacturers	ABB	Marketing manager
	Genexis	CEO
	Hager-Tehalit	Director Home & Building Solutions

All interviews were transcribed and then imported into Atlas-Ti, a qualitative analysis software tool. We used Atlas-Ti to discover relevant concepts and their properties and dimensions in the domain of smart living. We open coded the transcripts, having the core concepts of the survey in mind but also paying attention to other possible explanatory factors not mentioned in the propositions. Next, code networks were created to structure the codes hierarchically. The Atlas-Ti software was used to facilitate the coding done by the researcher, i.e. no automatic coding was done. Instead, the software was used as a tool to support the qualitative analysis by the researchers. The software was used to store codes, store network views and retrieve codes and quotes at a later stage, which is a commonly accepted approach in qualitative interview analysis, as suggested by Muhr[61] and Friese[62].

Results

Survey

The survey shows that 62% of the installers are involved in one or more forms of smart living projects, e.g. surveillance (37%), climate control (31%), independent living (26%), remote healthcare (24%), entertainment (21%), remote working facilities (17%), systems for storing heat (16%), smart grids (13%), green ICT (9%), and intelligent water systems (4%). Overall, respondents agree that collaboration with others leads to better smart living services (65%) and that there are ample reasons to collaborate for smart living services (74%).

Installers have limited knowledge and information about smart living. Most respondents acquire knowledge through suppliers (49%), trade publications (45%), websites (41%) and courses (28%). The

participating installers do not see acquiring knowledge and information to be very important. In general involvement in projects seems to be primarily motivated by market-related motivations.

From the sub-group that does work on smart living projects (N = 88), most are generally dissatisfied with financial return and return on investment. Main motivations to work on smart living projects are trying out new technologies and engaging in challenging projects.

In the sub-group that works on smart living projects (N = 88), 40% has active collaboration in consortia, which typically operate on an ad-hoc basis for specific projects. Installers mainly partner with electrical and construction firms.

The sub-sample who actively collaborates with others in smart living projects (N = 42) were asked follow-up questions. Their collaboration is mostly focused on short term addressing of common problems, and only 34% report they share long-term plans with partners. 70% reports that operational processes in collaboration with other firms leads to problems due to different ways of working in different industries. They also report to lack knowledge on other firms' ways of working.

Interviews

Codes were hierarchically structured using coding networks. In each network, nodes represent a code, and the numbers between the parentheses represent the number of times mentioned in the interviews (N) and the number of links to other codes (M), respectively. Relations between codes were derived from statements made by interviewees.

Regarding cooperation challenges, interview results indicate the main issue to be collaboration with organizations from other sectors (i.e., trans-sectoral collaboration). As Figure 2 shows, the challenge of collaboration across sectors was mentioned 23 times in the eleven interviews. Interviewees point to a lack of trans-sectoral collaboration (code O-2.1 in Figure 2) and the failure to collaborate in general (O-2.4). Three main issues cause the problems in trans-sectoral collaboration: lack of commitment (O-1), lack of trust (O-3) and perceived risks (O-4).

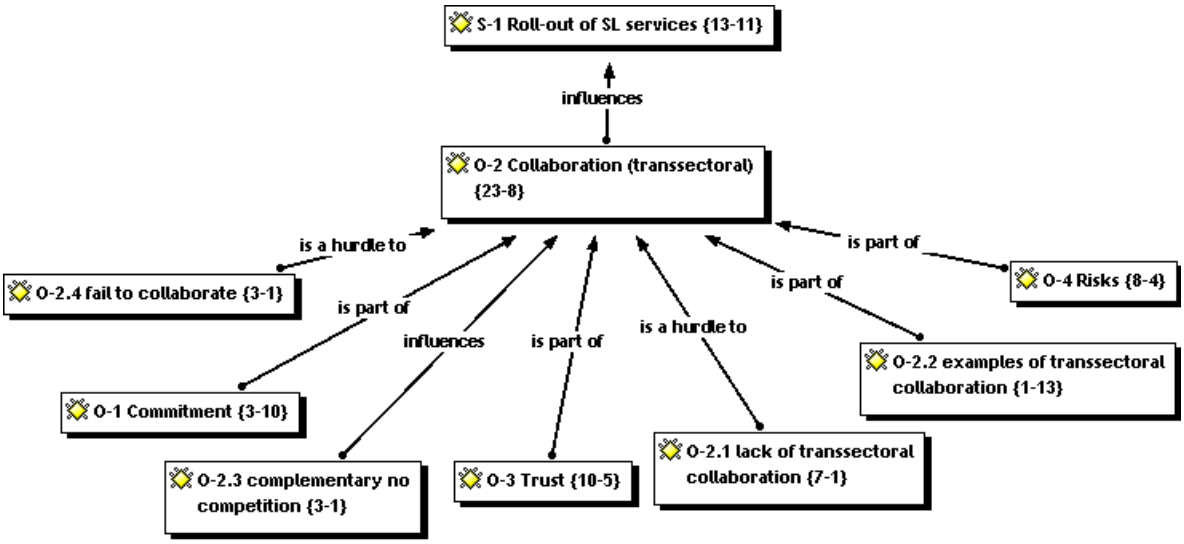

Figure 2. Cooperation challenges

Next, we explored cooperation challenges regarding commitment, trust and risks in more detail. At the commitment level (O-1) especially the interdependency of installers, housing cooperations and developers (O-1.2) and the conservative construction sector (O-1.6) are seen as bottlenecks (Figure 3).

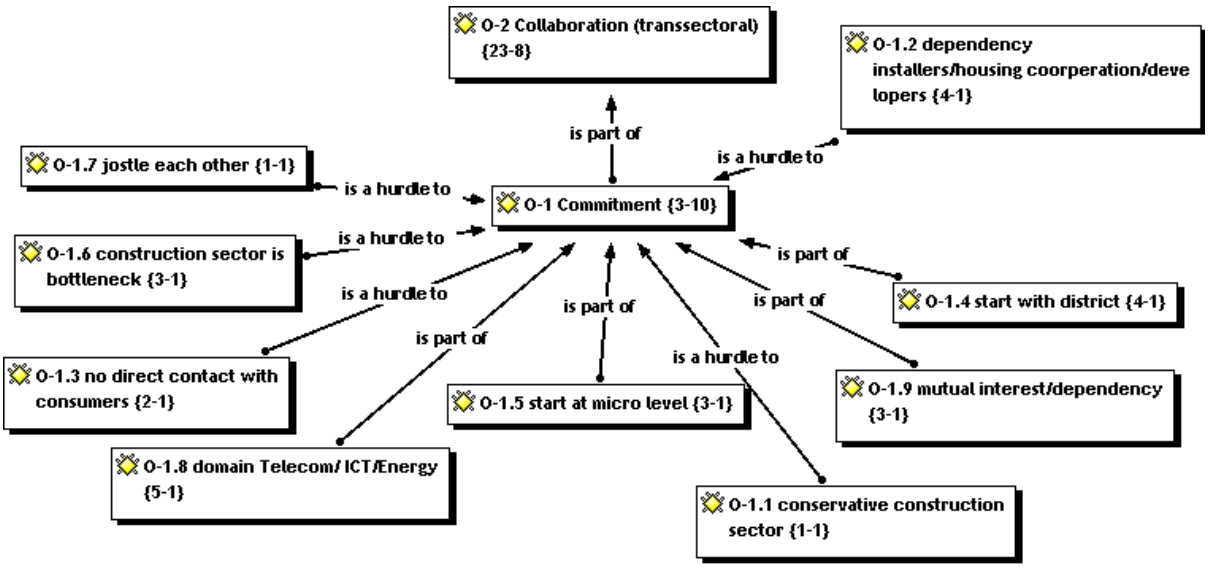

Figure 3. Commitment in the Organizational domain

According to the majority of the respondents cooperation will be more rewarding if companies start to collaborate on a micro-level (O-1.5) or at least start collaborating in their own region (O-1.4). Five

interviewees pointed out that there should be more mutual commitment in the Telecom, ICT and Energy sector (O-1.8) to foster trans-sectoral collaboration in the smart living domain.

At the trust level (O-3) people are scared to share information (O-3.1) and there is a lack of mutual trust (O-3.2) (Figure 4).

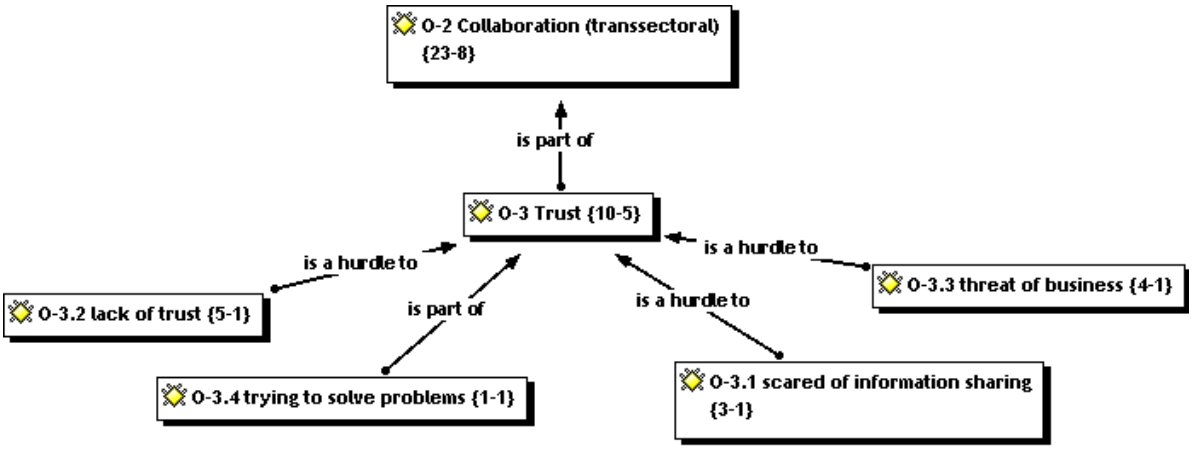

Figure 4. Trust in the Organizational domain

Four interviewees mentioned that a lot of parties refer to collaboration as a threat of the business (O-3.1) and that they are afraid of losing their competitive advantage if they collaborate, but as interviewees state: “firms that are afraid of sharing knowledge, slow down the innovations in the smart living business” and “cross-overs will increase your competitive advantage on the market.”

At the risk level (O-4) competition (O-4.1) and the failure to collaborate with reliable third parties in the first place (O-2.4) are the most mentioned topics (Figure 5).

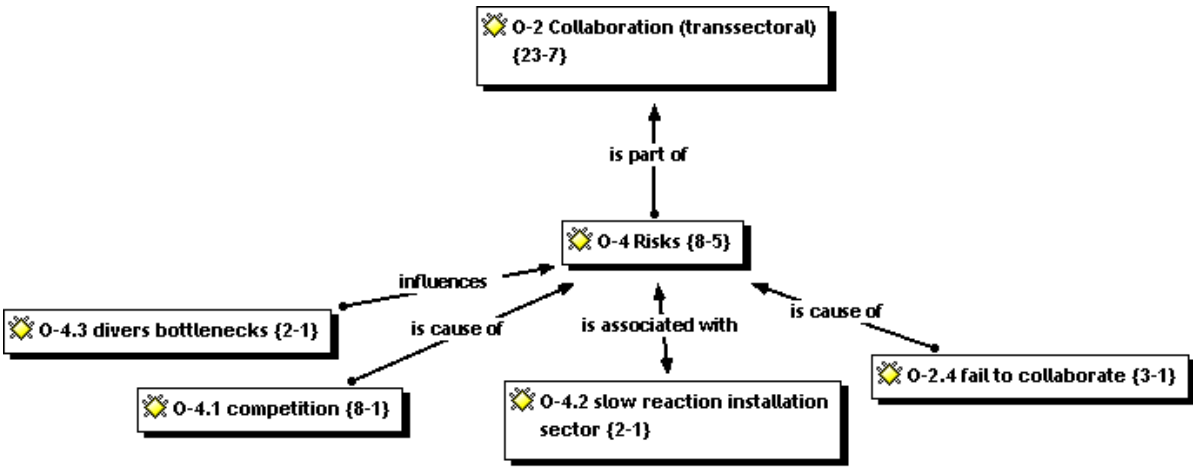

Figure 5. Risks in the Organizational domain

With regard to cooperation challenges, the interviewees consistently mentioned the need to collaborate across different sectors. Lack of collaboration is the main reason that smart living services did not make it into the mass market, yet. Interviewees argue that installers should consider long-term strategic cooperation and commitment to reliable partners within and beyond their own industry. One interviewee states: "Collaboration costs money first, after a number of projects you reach the breakeven point and then you can start to earn money" and "Collaboration is not a secondary priority." Another respondent noted that installers offering complementary services should not consider each other as competitors: "Everything is based on mutual trust. As long as companies do not see smart living as a common interest, trans-sectoral collaboration is a utopia." The pivotal role of installers in reaching the end-user is stressed by several interviewees. As one manufacturer argues: "It is a paradox: we supply components and hope that someone else can provide a system or a concept" and “a leading position is available for installers and innovative parties that do not necessarily operate on a national scale.”

Interviewees suggested various forms of existing cooperation strategies. For instance, a regional party that serves as a service broker could intermediate between installers and end-users. Alternatively, government agencies and policy makers could stimulate cooperation in the ecosystem.

Overall, we find that small installer businesses face cooperation challenges, resulting from a lack of trust, lack of commitment and perceived risks of collaboration. Therefore, we suggest the following proposition.

Proposition 1. Small installer businesses face challenges with cooperation in the smart living ecosystem

Regarding knowledge related challenges, findings suggest that small installer businesses generally lack skills to bring smart living concepts to the market. Figure 6 shows that the lack of sales skills (K-1.6), the conservative environment (K-1.4), and a lack of pro-active installers (K-1.3) were pointed out as the biggest hurdles to implement smart living services. Respondents indicate that installers focus too much on technologies, while commercial and marketing skills are lacking. The installation and

engineering sector is seen as a conservative sector (K-1.4), which persists in traditional system concepts. Installers are generally not proactive in developing new knowledge and business opportunities (K-1.3). Interviewees put this as follows: "Technology is still leading and installers are not pro-active in exploiting their sales skills" and "technology is not core, it is the effect of the technology that you sell to your customer."

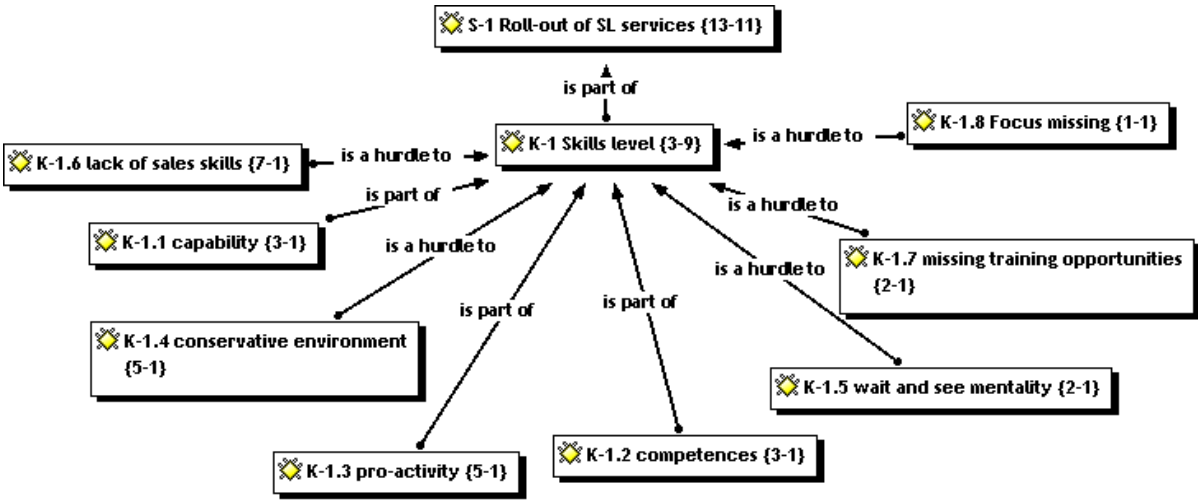

Figure 6. Overall skills as part of the knowledge domain

The analysis shows several reasons why small installer businesses lack knowledge on smart living concepts. Besides a lack of commercial skills and overly focus on technologies, the conservative environment and lack of proactive nature are main reasons why installers do not get access to knowledge and information. Therefore, we suggest the following proposition.

Proposition 2. Small installer businesses face challenges with knowledge related skills in the smart living ecosystem

Knowledge sharing challenges appear relevant on two levels: among installers themselves and between installers and other stakeholders. As one interviewee stated: "knowledge sharing is required on different levels to raise awareness about reliable smart living products". Regarding knowledge sharing among installers, interviewees point out a lack of information transfer (K-3.1) and knowledge transfer (K-3.3). Sharing of knowledge between installers hardly takes place (K-3.4), see Figure 7.

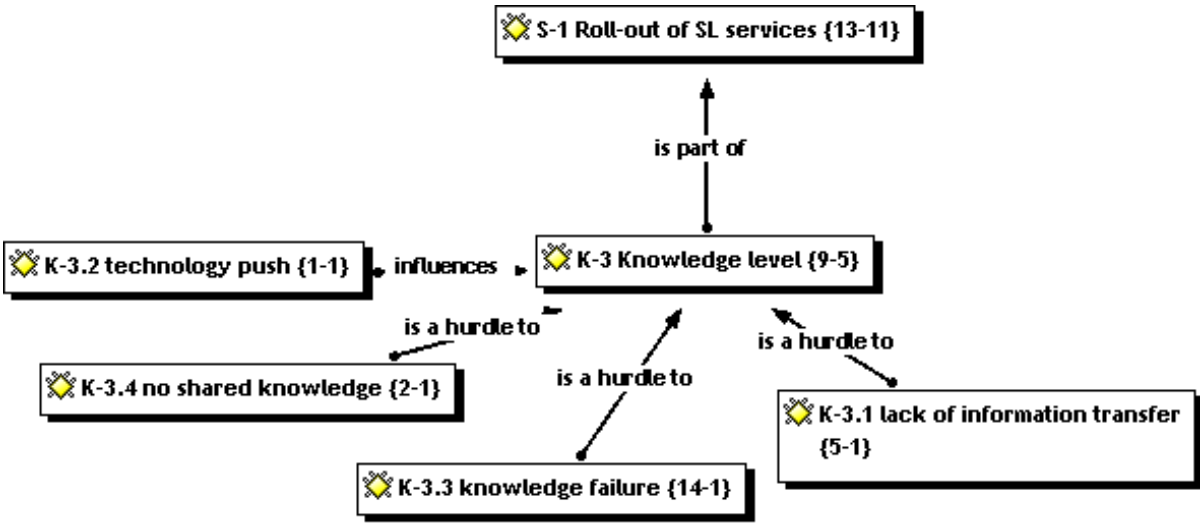

Figure 7. Knowledge level as part of the knowledge domain

Regarding knowledge sharing between installers and other stakeholders, interviewees especially refer to the lack of awareness about smart living for end-users (K-2.9) and the need to elicit end-user requirements (K-2.10). They argued to use different types of media and platforms to disseminate smart living knowledge (K-2.2), which could be used by government or branch organizations (K-2.4). Sharing of knowledge across industries in the smart living domain could be facilitated by a platform for information and knowledge transfer (K-4) or an online databank (K-2.5), see Figure 8. As interviewees state: “an information platform where products and services in the smart living domain are discussed between peers would be a helpful tool to gather knowledge”, “we need an information platform to exchange ideas, combined with a databank for reliable smart living products” and “there is an urgent need for a one-stop-shop within the smart living domain.”

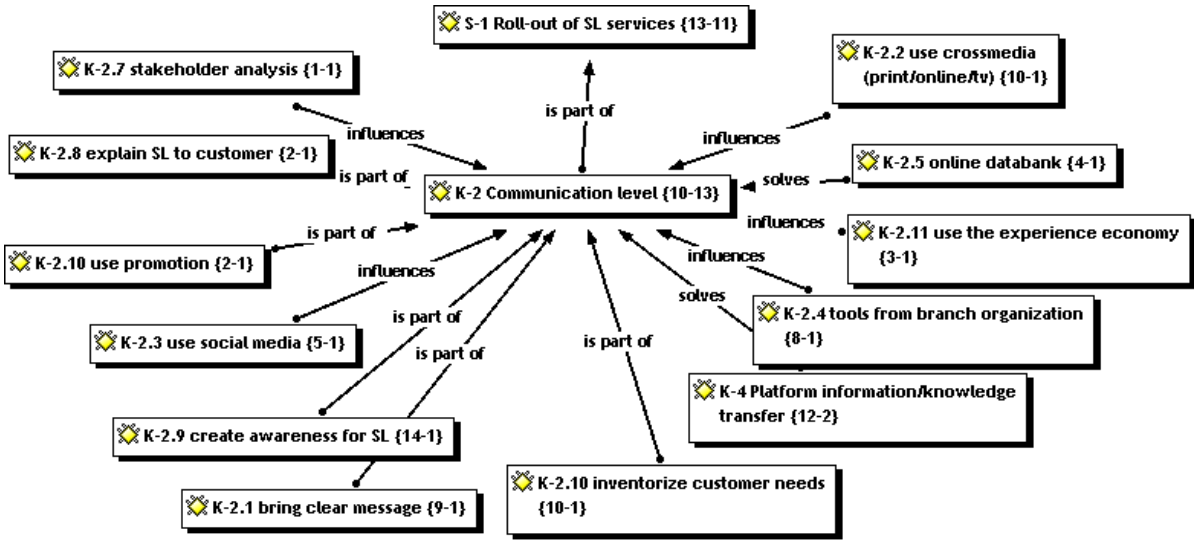

Figure 8. Communication skills as part of the knowledge domain

Overall, we find knowledge sharing challenges in many aspects. Among installer businesses, knowledge and information on smart living is hardly being shared.

When looking beyond the installation sector, awareness of end-users and other stakeholders of smart living is limited. Shared knowledge platforms or online databanks are lacking. Therefore, we suggest the following proposition.

Proposition 3. Small installer businesses face challenges with knowledge sharing related skills in the smart living ecosystem

Discussion

A main pattern across the findings is that small installers are not involved in smart living services. With exception of few innovative companies, most small businesses lack both technical and commercial skills to implement smart living services. Most installers are conservative and persist to offer traditional systems. Moreover, installers keep focusing on technologies rather than user experience, which prevents them from offering innovative concepts such as managed IT and service bundles.

The lack of knowledge small installer businesses have about the smart living domain and the degree of information transfer are currently seen as the biggest hurdles for the roll-out of smart living services and this hinders the end-user acceptance of technological innovations in and around the home. The

lack of knowledge transfer and fragmented availability of information about smart living services hinders creating 'awareness' among end-users. Interviewed installers and manufacturers opt for a knowledge platform to ensure that the transfer of information throughout the supply chain would be unambiguous and consumers are guided in selecting the right products for the right purpose. Bottom-up sharing of knowledge and cooperation between small businesses may help them to establish a firm position, jointly, towards players in other industry sectors. On the other hand, such knowledge transfer platforms may be more suitable for specialized system integrators or service brokers that can design innovative concepts with knowledge-intensive products and systems and customize solutions based on the demand of the end-user.

Despite these challenges, the position of installer businesses could potentially be highly strategic. Smart living concepts have not reached the mass market yet largely because of a lack of demand in the market [28-31]. To bridge the gap between the technology and the daily demand of end-users, installers could exploit their intermediary role more strategically. When challenges of cooperation and knowledge are overcome, installers could exploit their relationship with end-users.

The findings contribute to the domain of smart homes and smart living. The study shows the challenges small installers face as their low-tech stable industry is transforming to a high-tech dynamic ecosystem of multiple industries. On the one hand, small low-tech businesses can play an intermediary role between the end-user and high-tech provider of services and products. On the other hand, the indoor and built environment sector is transforming in such rapid pace that small traditional businesses have trouble catching up.

Although our study focused on the role of installers in the smart living ecosystem, their position is not unique. Many small businesses in the built environment industries struggle with similar issues when faced with high-tech innovations. Access to knowledge and knowledge sharing are issues, but at the same time the inherent attitude and existing skillset of small low-tech installer businesses may prevent them from looking for new opportunities, as shown in the case. When combined with cooperation problems stemming from low trust, perceived risks and low commitments of other stakeholders, these hurdles lead to inertia.

Conclusion

This paper has illustrated the cooperation and knowledge-related challenges for small installer businesses that intend to offer smart home and smart living services. The identified challenges explain why only few installer businesses are involved in smart living concepts.

This study suggests several promising areas for future research in the smart homes domain. First is to study how installers can participate in the roll-out of smart living into the market. Specifically, we suggest studying how installers can gain access to knowledge and partners in order to do so. Online platforms that disseminate business model ideas and allow matchmaking between partners could facilitate involvement of small installer businesses, but how to design such platforms to appeal to the interests of small installers is an open research issue. Second is to explore in which way installers can contribute to increase the acceptance of technological innovations in the house, so the house will have a central function in finding smart solutions for societal questions. Sourcing appropriate partners while balancing bridging and bonding relationships is a key research issue in this regard. The third area for future research is to explore how a knowledge and information exchange platform can support the installer sector in the smart living domain. Specifically, the antecedents why installers would be willing to share knowledge and information with competitors is an important research issue, as it evidences the typical collective action problem in smart homes literature[60].

A limitation of the present study is that we collected our material in a specific institutional and cultural setting, i.e. the smart living industry in the Netherlands. In addition, hurdles related to smart homes and smart living business models [18] and end-user acceptance [59] were left out of scope for this study.

This paper can be seen as a starting point addressing the promising but still not explored smart living market on behalf of the building installer sector. To scale up smart home solutions to the mass market, we thus recommend that policy makers should foster cooperation and knowledge sharing. For instance, by facilitating education and information exchange to strengthen the absorptive capacity of small installer businesses. Not only to support them how to gain a competitive advantage but also to teach them how to systematically identify, capture and share new knowledge about smart living services, to assimilate innovations.

Acknowledgement

We thank Harry Bouwman for comments on earlier version of the paper. We are also grateful to all interviewees. This research received no specific grant from any funding agency in the public,

commercial, or not-for-profit sectors.

Declaration

Authors declare that there is no conflict of interest. The first author initiated and executed the study, analysed results, and drafted a first version of the manuscript. The second author supervised parts of the study and edited the manuscript.

References

1. Goumopoulos C and Kameas A. Ambient ecologies in smart homes. *The Computer Journal*. 2009; *52*(8), 922-937

2. Lorente S. Key issues regarding domotic applications. *Proceedings of the International Conference on Information and Communication Technologies: From Theory to Applications*. IEEE, 2004, p. 121-2.

3. Aldrich FK. Smart Homes: Past, Present and Future. In: Harper R, (ed.). *Inside the Smart Home*. First edition ed. London: Springer, 2003.

4. Barlow J and Venables T. Smart home, dumb suppliers? The future of smart homes markets. *Inside the Smart Home*. London: Springer 2003, p. 247-62.

5. Marsh L. Taking control of energy. *Home Energy Magazine* 1998; 15: 23-28.

6. Lee H, Park SJ, Lim HW and Kim JT. Scenario-Based Smart Services for Single-Person Households. *Indoor and Built Environment* 2013; 22: 309-18.

7. Darby S. The effectiveness of feedback on energy consumption. *A Review for DEFRA of the Literature on Metering, Billing and direct Displays*. Environmental Change Institute - University of Oxford, Oxford, 2006.

8. Wood G and Newborough M. Influencing user behaviour with energy information display systems for intelligent homes. *International Journal of Energy Research* 2007; 31: 56-78.

9. Wood G and Newborough M. Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. *Energy and Buildings* 2003; 35: 821-41.

10. Brown M. Video-On-Demand: A Complete Guide to All the TV and Movie Downloading Services. 2011. http://www.maximumtech.com/videodemand-complete-guide-all-tv-and-movie-downloading-services.

11. Lo SC, Yu TH and Tseng CC. A remote control and media-sharing system using smart devices. *Journal of Systems Architecture* 2014; *60*(8), 671-683.

12. Rialle V, Duchene F, Noury N, Bajolle L and Demongeot J. Health Smart Home: Information

Technology for patients at home. *Telemedicine Journal and e-Health* 2002; 8: 395-409.

13. Oh H, Rizo C, Enkin M and Jadad A. What is eHealth (3): a systematic review of published definitions. *Journal of medical Internet research* 2005; 7: e1.

14. Mustafa B, Matthew P and Naveed F. A Smart Monitoring System for Assisted Living Support Using Adaptive Lifestyle Pattern Analysis. In: Chen L, Kapoor S and Bhatia R (ed).: *Intelligent Systems for Science and Information, Studies in Computational Intelligency 542*; London: Springer International Publishing, 2014, pp1-24.

15. Cho ME and Kim MJ. Characterizing the interaction design in healthy smart home devices for the elderly. *Indoor and Built Environment* 2014; 23: 141-9.

16. Lee H, Park SJ, Kim MJ, Jung JY, Lim HW and Kim JT. The service pattern-oriented smart bedroom based on elderly spatial behaviour patterns. *Indoor and Built Environment* 2013; 22: 299-308.

17. Chan M, Estève D, Escriba C and Campo E. A review of smart homes - Present state and future challenges. *Computer Methods and Programs in Biomedicine* 2008; 91: 55-81.

18. Solaimani S, Keijzer-Broers W and Bouwman H. What we do - and don't - know about the Smart Home - An analysis of the Smart Home literature (IBE-13-0120) *Indoor and Built Environment* 2015; 24(3): 370-383.

19. Augusto JC and Nugent CD. Smart homes can be smarter. *In Designing Smart Homes*. Heidelberg: Springer Berlin, 2006, p. 1-15.

20. Sixsmith A and Sixsmith J. Smart care technologies: meeting whose needs? *Journal of telemedicine and telecare* 2000; 6: 190 - 2.

21. Ding D, Cooper RA, Pasquina PF and Fici-Pasquina L. Sensor technology for smart homes. *Maturitas* 2011; 69: 131-6.

22. Umberger M, Humar I, Kos A, Guna J, Žemva A and Bešter J. The integration of home-automation and IPTV system and services. *Computer Standards & Interfaces* 2009; 31: 675-84.

23. Stefanov DH, Bien Z and Bang W-C. The smart house for older persons and persons with physical disabilities: structure, technology arrangements, and perspectives. *Neural Systems and Rehabilitation Engineering, IEEE Transactions on*. 2004; 12: 228-50.

24. De Silva LC, Morikawa C and Petra IM. State of the art of smart homes. *Engineering Applications of Artificial Intelligence* 2012; 25: 1313-21.

25. Van Hoof J, Kort H, Hensen J, Duijnstee M and Rutten P. Thermal comfort and the integrated design of homes for older people with dementia. *Building and Environment* 2010; 45: 358-70.

26. Van Hoof J, Kort H, Rutten P and Duijnstee M. Ageing-in-place with the use of ambient intelligence technology: Perspectives of older users. *International journal of medical informatics* 2011; 80: 310-31.

27. Bierhoff I, Müller S, Schoenrade-Sproll S, Delaney S, Byrne P, Dolničar V, Magoutas B, Verginadis Y, Avatangelou E, Huijnen C. Ambient Assisted Living Systems in Real-Life Situations: Experiences from the SOPRANO Project. *Technologies for Active Aging*. Vol 9 of the series International Perspectives on Aging; London: Springer, 2013, p. 123-53.

28. Peine A. Understanding the dynamics of technological configurations: A conceptual framework and the case of Smart Homes. *Technological Forecasting and Social Change* 2009; 76: 396-409.

29. Solaimani S, Bouwman H and De Reuver M. Smart home: Aligning business models and providers processes; A case survey. In: 21st Australasian Conference on Information Systems, Brisbane, 1-3 December 2010; *ACIS 2010 Proceedings, Paper 91*. Australia 2010.

30. Balta-Ozkan N, Davidson R, Bicket M and Whitmarsh L. Social barriers to the adoption of smart homes. *Energy Policy* 2013; 63: 363-74.

31. Wichert R, Furfari F, Kung A and Tazari M. How to overcome the market entrance barrier and achieve the market breakthrough in AAL. In *Ambient Assisted Living*. Springer Berlin Heidelberg. 2012, p. 349-58.

32. Levy M, Loebbecke C and Powell P. SMEs, co-opetition and knowledge sharing: the role of information systems. *European Journal of Information Systems* 2003; 12: 3-17.

33. Alegre J, Sengupta K and Lapiedra R. Knowledge management and innovation performance in a high-tech SMEs industry. *International Small Business Journal* 2013; 31: 454-70.

34. Evangelista P, Esposito E, Lauro V and Raffa M. The adoption of knowledge management systems in small firms. *Electronic Journal of Knowledge Management* 2010; 8: 33-42.

35. Bommer M and Jalajas DS. Innovation sources of large and small technology-based firms. *Engineering Management. IEEE Transactions on* 2004; 51: 13-8.

36. Lehtimaki A. Management of the innovation process in small companies in Finland. *Engineering Management. IEEE Transactions on* 1991; 38: 120-6.

37. Moore J. Predators and prey: a new ecology of competition. *Harvard Business Review* 1993;

71: 75-83.

38. Iansiti M and Levien R. *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Harvard Business School Press, Boston, 2004.

39. Basole RC. Visualization of interfirm relations in a converging mobile ecosystem. *Journal of Information Technology* 2009; 24: 144-59.

40. Schubert P, Fisher J and Leimstoll U. ICT and Innovation in Small Companies. *ECIS 2007 Proceedings*. European Conference on Information Systems (ECIS), available from AIS electronic library (AISeL), 2007, pp1226-1239.

41. Corallo A, Passiante G and Prencipe A. *The digital business ecosystem*. Edward Elgar Publishing, Cheltenham, 2007.

42. Zeng SX, Xie XM and Tam CM. Relationship between cooperation networks and innovation performance of SMEs. *Technovation* 2010; 30: 181-94.

43. Bengtsson M and Johansson M. Managing coopetition to create opportunities for small firms. *International Small Business Journal* 2014; 32: 401-27.

44. Baskerville R and Dulipovici A. The theoretical foundations of knowledge management. *Knowledge Management Research & Practice* 2006; 4: 83-105.

45. Davenport T and Prusak L. *Working Knowledge: How Organizations Manage What They Know*. Boston, MA: Harvard Business School Press, 1998.

46. Wiig KM. *Knowledge management foundations: thinking about thinking: how people and organizations create, represent, and use knowledge (Vol. 1)*. Arlington, TX: Schema Press, 1993.

47. Hutchinson V and Quintas P. Do SMEs do knowledge management? Or simply manage what they know? *International Small Business Journal* 2008; 26: 131-54.

48. Freel MS. Where are the skills gaps in innovative small firms? *International Journal of Entrepreneurial Behaviour & Research* 1999; 5: 144-54.

49. Gray C. Absorptive capacity, knowledge management and innovation in entrepreneurial small firms. *International Journal of Entrepreneurial Behaviour & Research* 2006; 12: 345-60.

50. Van den Hooff B and De Ridder JA. Knowledge sharing in context: the influence of organizational commitment, communication climate and CMC use on knowledge sharing. *Journal of knowledge management* 2004; 8: 117-30.

51. Bartol KM and Srivastava A. Encouraging knowledge sharing: the role of organizational reward systems. *Journal of Leadership & Organizational Studies* 2002; 9: 64-76.

52. Cummings JN. Work groups, structural diversity, and knowledge sharing in a global organization. *Management Science* 2004; 50: 352-64.

53. Szulanski G, Cappetta R and Jensen RJ. When and how trustworthiness matters: Knowledge transfer and the moderating effect of causal ambiguity. *Organization Science* 2004; 15: 600-13.

54. Alavi M and Leidner D. Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly* 2001; 25: 107-36.

55. Venkatraman N and Tanriverdi H. Reflecting "knowledge" in strategy research: Conceptual issues and methodological challenges. *Research Methodology in Strategy and Management* 2004; 1: 33-65.

56. De Clercq D, Dimov D and Thongpapanl N. Structural and relational interdependence and entrepreneurial orientation in small and medium-sized enterprises: The mediating role of internal knowledge-sharing. *International Small Business Journal* 2015;33(5):514-536.

57. Chen S, Duan Y, Edwards JS and Lehaney B. Toward understanding inter-organizational knowledge transfer needs in SMEs: insight from a UK investigation. *Journal of knowledge management* 2006; 10: 6-23.

58. Durst S and Edvardsson IR. Knowledge management in SMEs: a literature review. *Journal of Knowledge Management* 2012; 16: 879-903.

59. Kim MJ, Oh MW, Cho ME, Lee H and Kim JT. A critical review of user studies on healthy Smart Homes. *Indoor and Built Environment* 2013; 22: 260-70

60. Nikayin F, De Reuver M and Itala T. Collective action for a common service platform for independent living services. *International Journal of Medial Informatics* 2013; 82: 922-39

61. Muhr T. Atlas/ti—a prototype for the support of text interpretation. Qualitative sociology 1991; 14: 349-71

62. Friese S. Qualitative data analysis with ATLAS. London: Sage, 2014..