

Diffusion of assistive technology among older people: A case of the House of the Present

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E. Zwierenberg, E. Finnema, A. Dijkstra, M. Hagedoorn, R. Sanderman. Diffusion of assistive technology among older people: A case of the House of the Present. Gerontechnology 2017;16(4):242-248; <https://doi.org/10.4017/gt.2017.16.4.006.00> In Smart Homes set up for demonstration purposes (hereafter: model Smart Homes), innovative Smart Homes and assistive technologies are presented that can enhance the quality of life of older people who continue to live in their own home until a high age. New assistive technologies spread through a network of people - if the innovation can be observed and experienced. In the Netherlands, the 'House of the Present' is such a model Smart Home. The aim of the present case study is to share experiences with the House of the Present and the views of visitors regarding the diffusion of Smart Home and assistive technologies: How do visitors assess their experience of a model Smart Home and the presented assistive technology solutions for the care of older people? Based on the Diffusion of Innovation theory, common sense and a systematic review of factors influencing the acceptance of technology among older people observed on site, a questionnaire was developed and presented to visitors to the House of the Present. A total of 131 visitors completed the questionnaire. Visitors recommend to others a visit to the House of the Present Smart Home (M=4.32) to observe on-site assistive technologies for care and wellbeing (M=4.21). Innovators (3.8% vs 2.5% of the overall population) and Early Adopters (38.9% vs 13.5% of the overall population) are over-represented. Visitors comment on the different types of exhibited products, and for 22 product groups, a list ranging from the most to the least valued groups of Smart-Home and assistive technologies was drawn up. This research shows that model Smart Homes demonstrating assistive technology are positively received by visitors. What we do not know yet is how effective model Smart Homes are in diffusing innovations in assistive technologies.

Keywords: older people, model Smart Homes, education, living lab

INTRODUCTION

The Diffusion of Innovation theory¹ states that innovations spread in a social system via communication, over time and in a given population. Model Smart Homes display and demonstrate assistive technology meant to support among others older people with a chronic illness. The models are meant to inform all kinds of stakeholders. Hence they help to diffuse technology and promote its use on a wider scale. Around 20 model Smart Homes exist in the Netherlands, showing assistive technologies that support 'living longer at home'. The Smart Homes and assistive technologies on display could reduce dif-

ficulties in care that arise from functional or mental disorders. It is expected that adopting these technologies will help to reduce the burden for care-givers, enhance the quality of care, soften its financial impact and raise the patients' quality of life². Most of the 20 model Smart Homes in the Netherlands are situated in apartments, shops, schools, hotels and other houses. In this article, we will introduce the 'House of the Present' and share some experiences and visitors' views.

House of the Present

One of the 20 model Smart Homes in the Netherlands is the House of the Present at the NHL

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University of Applied Sciences in the city of Leeuwarden. It is a 90 m² apartment with a kitchen, living room, bedroom, and bathroom. The name 'House of the Present' was chosen to reflect the fact that solutions are shown which are on sale in stores and web shops, not projected solutions for the future. In the House of the Present, the assistive technology, robotic and Smart Home solutions are presented. It is designed to introduce students, professionals, and older people to available new technology, and also to show them how the innovative solutions are used. A full-time employee gives guided tours, ensures that the technology is working well and maintains contacts with technology providers, so as to ensure that the best solutions are shown to the audience. Every year over 1500 people visit the House of the Present²: students, professionals (primarily nurses), and older people. When they enter the House, the employees show them the type of technology that is of interest to them. In total, there are about 100 solutions on display, of which a subset is shown in greater detail. During a visit, the assistive technology is introduced, demonstrated and discussed in terms of how it can help older people fulfil their desire to live at home as long as possible. Experiences of visitors and their helpful feedback have informed the recent update of the

House of the Present (Figure 1 and 2).

Assistive technology

NICTIZ, the Dutch Centre of Expertise for Standardization and eHealth³, classified the purposes of Smart Home and assistive technology as follows: (1) convenience services, (2) welfare services, (3) security and surveillance services, and (4) treatment and care. The Smart Home and assistive technologies displayed in the House of the Present can be grouped according to these four categories, which represent the most important needs of older people. Some research has been done into the personal, social and physical contexts that determine the level of technology that can enable older people to continue living at home and may lead them to adopt Smart Home and assistive technology. The expectation is that showing the technology to visitors to a model Smart Home and giving them the opportunity to experience the innovations will encourage them to adopt a more positive attitude towards the new technologies, to begin to use them and to recommend them to others. Furthermore, a systematic review by Peek and others⁴ identified a total of 27 factors that influence the acceptance and facilitate the use by older people of Smart-Home and assistive technology. These factors are often referred to in discussions during the guided tours so as to help visitors understand what influences the use of Smart Home and assistive technology.

Aim

The aim of the present case study is to share experiences gained at the House of the Present and the attitude of visitors regarding the diffusion of Smart Home and assistive technologies. Recently polled opinions of visitors were used. The focus was on how visitors perceive the use of Smart Home and assistive technology for the care of older people in general and what might lead them to recommend the technologies they see here to others. Furthermore, the study lists the technologies visitors observed in the House of the Present and identified what they thought would be useful in actual practice. This will set the stage for thoughts on the potential role of model Smart Homes in the diffusion of technology.

METHOD

Procedure

Groups of 5 to 15 visitors take guided tours lasting 45 to 75 minutes. At the end, they are invited to leave their email address so that they can be sent a newsletter and perhaps be approached for research purposes. In November 2016, a total of 991 questionnaires were sent by email to visitors to the House of the Present who had provided their email address after their visit to the facility. After the first email, two reminders were sent to those who had not responded. A total of 74

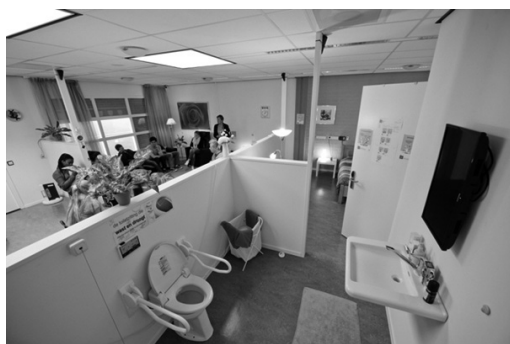


Figure 1. The House of the Present, Leeuwarden before the summer of 2017

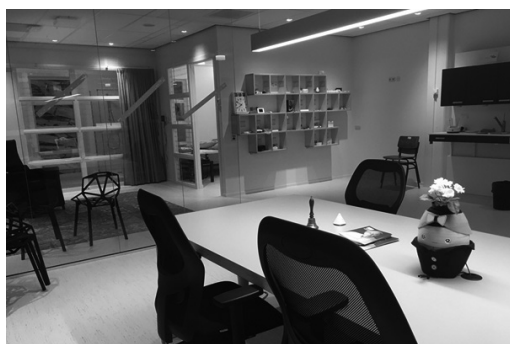


Figure 2. The House of the Present after renovation in the summer of 2017

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emails bounced, 242 surveys were started and 112 surveys were completed. In addition, the questionnaire was distributed via teachers to students who had visited the facility. This added 19 completed surveys and took the total to 131. To encourage participation, respondents were offered the chance to win a small prize.

Questionnaire

The questionnaire was developed and subsequently programmed in Qualtrics software, (© 2016 Qualtrics, Provo, UT) a web-based platform for building and distributing questionnaires. The initial version was written by 2 researchers, and additional 7 gave their feedback, which was used to finalize the questionnaire. Respondents needed less than 10 minutes to answer all the questions.

Background variables

Respondents were asked to indicate their age, sex and level of education, whether they were volunteer care-givers and whether they were semi-professionally engaged in the diffusion of information about assistive technology (Table 1). The survey then classified the visitors to the House of the Present according to diffusion theory⁵, which

says that novelties are first adopted by Innovators, then by Early Adopters, followed by the Early Majority, and finally the Laggards. This was done by asking: 'Do you buy the newest smartphone as soon as it comes out?' Furthermore, respondents were asked to what extent (on a 5-point Likert scale) they perceived the House of the Present as (a) a house of the future, (b) a living room, (c) a shop, (d) a laboratory, or (e) a museum.

Assistive technology

Opinion on assisted technology: A general question was asked to obtain an overall impression of how visitors viewed the assistive technology for the care and wellbeing of older people. Furthermore, based on the systematic review by Peek⁴, the survey asked on what grounds the respondents would advise using the assistive technology. The options offered were that it (a) is generally useful for care and wellbeing, (b) facilitates living longer at home independently, (c) adapts the current dwelling to the user's needs, (d) enhances the user's physical condition, (e) reduces vulnerability, (f) enhances social contacts, (g) reduces the fear of losing control of the housekeeping, (h) is financially attractive, (i) alleviates the fear of loss

of personal data, and (j) enhances social influence. A 4-point Likert scale was used, with a higher score indicating stronger agreement with the option concerned (Table 2).

Expectations of assistive technology: Respondents were asked to indicate on a 5-point Likert scale how much they expect assistive technology to improve life in the following four categories defined by NICTIZ: (a) (S)ecurity and surveillance, (b) (C)onvenience services, (c) (T)reatment/care, and (d) (W)elfare. A higher score indicates that respondents strongly agree with the item (Table 2).

Assistive technology reviewed: The assistive technology in the House of the Present nicely showcases what is on the market today. As some of the presented products serve

Table 1. Characteristics of visitors to the House of the Present (n=131)

	Description	Frequency	Percent
Age	<60	92	70.2
	>=60	34	26.0
	Missing	5	3.8
Sex	Female	38	29.5
	Male	91	70.5
	Missing	2	1.5
Volunteer care-giver	Yes	38	29.0
	No	93	71.0
Educational level	≤ Intermediate vocational	34	26.0
	University of Applied Sciences	55	42.0
	University	39	29.8
	Other	2	1.5
	Missing	1	0.7
Semi-professional in spreading	Yes	77	58.8
Knowledge assistive technology	No	54	41.2
Type of innovator according to Rogers	Innovators (2.5%)	5	3.8
	Early adopters (13.5%)	51	38.9
	Early Majority (34%)	31	23.7
	Late Majority (34%)	31	23.7
	Laggards (16%)	13	9.9
How would you describe the facility?		Mean (SD)	
	House of the future	3.89 (0.891)	
	Living room	3.76 (0.858)	
	Shop	2.56 (1.096)	
	Laboratory	2.50 (1.077)	
	Museum	1.98 (0.863)	

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Table 2. Opinions on assistive technologies for the care of older people (n=131)

Item	Mean (SD)
I would advise using assistive technology if:	
a) It will be useful for the user's care and welfare	4.21 (0.794)
b) It will increase the user's chances of living longer at home independently	3.44 (0.529)
c) It will adapt the user's current dwelling to their needs	3.35 (0.513)
d) It will enhance the user's physical condition	3.34 (0.569)
e) It will reduce vulnerability	3.32 (0.578)
f) It will strengthen the user's social contacts	3.19 (0.691)
g) It will reduce the user's fear of losing control of their housekeeping	3.13 (0.686)
h) It is financially attractive	3.09 (0.710)
i) There is no need to fear a loss of personal data	3.02 (0.775)
j) People around the user recommend it	2.99 (0.791)
Expectation value of assistive technology in support of four areas of life:	
Security and surveillance	4.63 (0.052)
Comfort	4.35 (0.063)
Treatment and care	4.17 (0.068)
Welfare services	4.06 (0.067)

the same purpose, the survey distinguishes 22 product groups (Table 3). They are described in such a way that the visitors can classify the products they saw and relate the product groups to the four categories of NICTIZ. For each of the 22 product groups visitors were asked (a) whether they have tried them and told others about them, and (b) to give their opinions on how useful these products are in enabling older people to continue living at home as long as possible.

Ethical considerations

Visitors to the House of the Present were asked to leave their email address if they wanted to receive a newsletter or possibly a questionnaire with research questions. In the questionnaire, they were asked whether they agreed to participate and were told that their input would not be used on an individual level. This is how the privacy of the participants was safeguarded.

RESULTS AND DISCUSSION

This section presents the data in this convenience sample of visitors to the House of the Present and comments on the findings. It will end with some concluding remarks on how model Smart Homes might be used in the diffusion of technology. These remarks address the question of what kind of research is needed to find efficient and effective ways of diffusing assistive technology that will enable older people to go on living independently for longer than would otherwise be possible.

Characteristics of visitors and their opinions on the House of the Present

The characteristics of the respondents (N=131) are given in Table 1. These visitors were mostly nurses, semi-professionals, older people, and to the lesser extent students. Furthermore, the overall education level was quite high. If we look at their propensity to spread new technologies, using Rogers' classification⁶, and compare this with the population of the Netherlands, we can conclude that there were more Innovators (3.8% vs 2.5%) and Early Adopters (38.9% vs 13.5%) in this group of respondents than in the overall population as a whole. Consequently, there were fewer respondents in the categories Early Majority (23.7% vs 34%), Late Majority (23.7% vs 34%), and Laggards (9.9% vs 13%). Obviously, we need to take this into account when interpreting the opinions of respondents concerning the assistive technology.

Most perceive the House of the Present as a 'House of the Future' (mean 3.89), probably because they saw many Smart Home and assistive technology solutions that were new to them, or not available where they live. In the first 6 months of 2017, an estimated 1000 people visited the House of the Present. The expectation is that in 2017 the number of visitors will grow for the fifth year in a row. It would seem that the communication about the House of the Present and its displays is successfully attracting more and more visitors. If asked what gave them the idea to come, visitors often mentioned a newspaper article they had read about the House of the Present. Many also said they had heard from other visitors that it was interesting. This is in line with the answer to the question whether respondents would recommend a visit to the House of the Present (mean 4.32). A third reason for the steady growth in the number of visitors is that over the years more and more teachers from various schools include a visit in their curriculum and take their students to the model house (Table 1).

Opinions on assistive technology

Table 2 shows the answers to the questions based on Peek² and the questions based on the NICTIZ model. Most respondents responded positively to the question whether they see opportunities

Table 3. Technology in the House of the Present n=131

Item	Experienced in the House		Opinion on value for care of older people				
	Tried N (%)	Advised N (%)	Disagree N (%)	Undecided N (%)	Agree N (%)	Mean (SD)	
(S) Water, fall and smoke detection sensors	5 (3.8)	16 (12.2)	1 (0.8)	5 (3.8)	125 (95.4)	4.39 (0.602)	
(S) Fixed connection to care centre	19 (14.5)	25 (19.1)	0 (0.0)	11 (8.4)	120 (91.6)	4.37 (0.635)	
(S) Doorbell with camera	36 (27.5)	26 (19.8)	1 (0.8)	4 (3.1)	126 (96.2)	4.35 (0.619)	
(S) Mobile personal alarms with GPS	14 (10.7)	24 (18.3)	0 (0.0)	10 (7.6)	121 (92.3)	4.35 (0.619)	
(T) Smart alarm for medication intake	13 (9.9)	28 (21.4)	1 (0.8)	7 (5.3)	123 (93.9)	4.32 (0.611)	
(S) Telephone/doorbell with light, vibration or audio signals	18 (13.7)	14 (10.7)	0 (0.0)	9 (6.9)	122 (93.2)	4.29 (0.588)	
(C) Extra toilet with cleaning function (bidet)	13 (9.9)	23 (17.6)	3 (2.3)	9 (6.9)	119 (90.9)	4.27 (0.689)	
(C) Control of lighting with remote sensor or time controlled	24 (18.3)	18 (13.7)	0 (0.0)	15 (11.5)	116 (88.6)	4.24 (0.646)	
(C) Electronic door lock	22 (16.8)	19 (14.5)	1 (1.6)	10 (7.6)	119 (90.9)	4.23 (0.686)	
(C) Video communication with family members/care-givers	13 (9.9)	20 (15.3)	1 (0.8)	16 (12.2)	114 (87)	4.21 (0.679)	
(C) Height-adjustable kitchen	24 (18.3)	9 (6.9)	2 (1.5)	20 (15.3)	109 (83.2)	4.07 (0.682)	
(C) Electric curtains	27 (10.6)	15 (11.5)	4 (3.1)	23 (17.6)	104 (79.4)	4.02 (0.749)	
(C) Simplified microwave oven	8 (6.1)	8 (6.1)	1 (0.8)	31 (23.7)	99 (75.5)	3.99 (0.718)	
(T) Lifestyle monitoring for people with mild dementia	11 (8.4)	18 (13.7)	4 (3.1)	26 (19.8)	101 (77.1)	3.96(0.738)	
(T) Online healthcare data sharing with health organization	10 (7.6)	9 (6.9)	4 (3.1)	36 (27.5)	91 (69.5)	3.88 (0.775)	
(S) Camera surveillance at home	11 (8.4)	17 (13.0)	7 (5.4)	32 (24.4)	92 (70.2)	3.86 (0.839)	
(C) Robot vacuum cleaner	4 (3.1)	8 (6.1)	12 (9.2)	43 (32.8)	76 (58)	3.63 (0.870)	
(W) Local TV or radio	7 (5.3)	6 (4.6)	6 (4.6)	51 (38.9)	74 (56.5)	3.63 (0.737)	
(T) Therapeutic robot (Paro)	32 (24.4)	15 (11.5)	7 (5.4)	58 (44.3)	66 (50.4)	3.57 (0.860)	
(W) Local events calendar	2 (1.5)	2 (1.5)	9 (6.9)	51 (38.9)	71 (54.2)	3.57 (0.765)	
(W) Church video or telephony	3 (2.3)	8 (6.1)	7 (5.4)	56 (42.7)	68 (51.9)	3.52 (0.778)	
(W) Older people tablet computer (Jaapie)	3 (2.3)	7 (5.3)	7 (5.4)	77 (58.8)	47 (35.9)	3.41 (0.783)	

Note on Column 1: (S) Security and surveillance, (C) Comfort, (T) Treatment and care, (W) Welfare services

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to apply assistive technology for care and well-being. This is consistent with the high percentage of innovators among them but would need to be confirmed using a more representative sample. When the respondents were asked to score reasons for advising others to use assistive technologies, they collectively gave the highest score to 'Increases the possibility to live longer at home independently' (mean 3.44). This is in line with the purpose of the House of the Present. It is interesting that the answer 'People around me recommend it' has the lowest score (mean 2.99). According to the literature on adopting innovations, the influence of other people is important for the spread of innovations⁶. In the responses to the question about the expected value of assistive technology according to the classification of NICTIZ, the highest scoring option was 'Security and surveillance solutions' (mean 4.63). However, all the options scored highly on the 5-point Likert scale (they are all above 4 with a very small standard deviation). In other words, it seems that respondents value assistive technology highly for various purposes (*Table 2*).

Review of assistive technology

The opinions of visitors regarding the use of the assistive technology solutions presented in the House of the Present are shown in *Table 3*. Visitors were asked which technology they had seen, experienced, and recommended to others. The table ranks the technologies according to their perceived value for the care of older people in the eyes of the respondents.

The visitors had a favourable opinion of all product groups (*Table 3*). They were least positive about the 'older people tablet computer' (mean 3.41) and most positive about 'water, fall, and smoke detection sensors' (mean 4.39). The results presented in this table are in line with the presumed importance of the four areas of life (NICTIZ model). In this classification, the assistive technologies are ranked according to their expected value for (from most to least important) Security and surveillance, Comfort, Treatment and Care/Welfare. By presenting the number of people in the table who disagreed, were undecided or agreed, the table shows clearly that the first ten innovations were considered very useful. As for the other twelve innovations, only a few respondents denied their usefulness, but many were undecided. As we do not know the visitors' opinions of these innovations before they visited the House of the Present, we cannot say whether, and if so how, a visit to a model Smart Home changed what people know and think of assistive technologies. The solution that respondents were most inclined to recommend to others was the 'smart alarm for medication intake' (21.4%), and the one they would least recommend was the 'local events

calendar' (1.5%). This finding suggests that information on smart medication alarms will spread more rapidly to potential users than information on the other presented innovations (*Table 3*).

Conclusions and future perspectives

The concept of a Smart Home is broader than that of model Smart Homes like the ones discussed here. The idea of a Smart Home is closely related to technology development in consumer electronics, sustainable buildings, alternative heating solutions, harvesting of energy by solar panels, and so on. In this study, the focus was on a model Smart Home designed to demonstrate assistive technologies that help older people to go on living in their own homes as long as possible.

We can conclude that the visitors were positive about their visit to the House of the Present and perceived it as a living room or a house of the future. They regarded the 22 product groups as useful solutions for 'living longer at home'. In discussions during their visit, they often said that they already knew some of the solutions on display, but nearly all said they learned about some new technologies too, and this made the visit interesting for them. Often, they most enjoyed those displays that showed technology at work. A good example is a video connection to a nurse at another location, telling the visitors to the House of the Present in real time how the technology is used at her care centre.

Finding effective ways to diffuse new assistive technologies as demonstrated in the House of the Present is important if we consider the ageing population and the benefit that older people can potentially derive from assistive technologies. What are successful strategies for diffusion? There are various options, such as taking showcases to the homes, offices or schools of stakeholders, or offering eLearning programmes online, which can easily reach various target groups. In addition, new technologies like Virtual Reality might enable people to realistically experience the potential added value of innovations.

Staying closer to our topic, one could study what visitors take away from a visit to a model Smart Home, and whether a model Smart Home can be a platform to inspire a wide variety of visitors. Is a single exhibition like the House of the Present appropriate for all stakeholders (students, users, care-givers and other professionals)? Or is there a need for various kinds of model Smart Homes designed for specific target groups? When working to implement new assistive technologies, one needs to carefully consider and substantiate their effectiveness for certain kinds of users in a certain kind of setting with respect to certain outcomes. It is easy, but dangerous, to be dazzled

by a technological breakthrough and lose sight of the all-important question of who is actually going to buy, use, and benefit from the device. That needs to be researched continuously.

As far as diffusion is concerned, it might be interesting to see how a visit to a model Smart Homes affects visitors by comparing their knowledge and attitudes before and after the visit. We also need to understand better how such knowledge is acquired and how it influences behaviour, including the uptake of the technology. Hence, it would be good to link the existing model Smart Homes to a wide variety of activities and implementation tools, and map what each of these tools seems to add to diffusion. This might lead us to reconsider the way in which we promote the spread of assistive technologies to potential older users.

With the current case study, we aimed to show that a model Smart Home can engage a lot of people. In our experience, it is a useful way to inform all kinds of stakeholders. More importantly, a facility like this also serves to promote

the actual adoption of these useful technologies.

The experiences of the last 5 years with the House of the Present and the information gathered in the current research have been used to update this model Smart Home. Two rooms with an area of 20 m² have been added. It is now possible to accommodate groups of 20 people or more, and the routing of the guided tour is more logical. QR codes are used to start short videos on the displays. Across the whole facility, technology is used and integrated into ways that are better geared to showing the usefulness of Smart Home and assistive technology. Once a sufficient number of visitors have visited the updated facility, their opinions on the new House of the Present can be polled and compared with our findings regarding the current House of the Present. The new study could tell us about the added value of the updated facility in the diffusion of innovation of assistive technology.

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