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The Impact of Connected Health Technologies on The Quality of Service Delivered by Home Care Companies: Focus on Trust and Social Presence

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Abstract

The objective of this paper is to focus on the impact of connected health technologies on the quality of service delivered by home care companies for the seniors. The focus will be on 'trust' and 'social presence' dimensions. We used SERVQUAL for measuring the quality of service delivered by home care companies. We targeted elderly people using connected health technologies (assistive alarm, telecare, sensors, etc.) at home and receiving health care at home. We received 213 questionnaires back by post. As we had several latent variables, we used partial least squares (PLS). The results show that the level of trust in these technologies impacts significantly almost all dimensions of SERVQUAL. In parallel, the perception of the social presence with the use of these technologies impacts positively the *empathy* and *tangibles* dimensions of SERVQUAL.

Keywords: Connected health technologies; Smart homes; SERVQUAL; Trust; Social presence

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Introduction

Life expectancy is increasing worldwide. According to the World Health Organization (2011), this trend shows no sign of slowing in the coming years. Due to chronic health problems that arise with increased life expectancy, improving the quality of life of elderly people represents a major challenge for today's society. Faced with an exploding elderly population and longer life expectancies, seniors increasingly need care and new healthcare technologies that can be useful in improving their quality of life at home. Indeed, we have to rethink the way in which services are provided to the elderly.

Seniors expect and desire to stay at home as long as possible instead of going to nursing homes (Townsend *et al.*, 2011; Demiris *et al.*, 2004). Connected technologies cannot prevent transfer to a nursing home but may enable the elderly to stay in their houses for longer. Continuing home care is therefore becoming a pressing objective. In this context, connected technologies (e.g. assistive alarm, telecare, sensors, etc.) may play a key role. One such concept is the "smart home", which refers to a house equipped with technology that enhances the safety of elderly people at home and monitors their health (Demiris *et al.*, 2004). The system is able to track the senior and trigger an alarm if any abnormal vital signs are detected (Virone *et al*., 2002). It is also able, for example, to collect data such as respiratory or sleeping disorders in order to have a better understanding of the senior's problems (Nishida *et al*., 2000). Obviously, the choice of the connected technology depends on the pathology, the context, and the kind of care desired. As mentioned by Höpflinger *et al.* (2011), although healthcare needs are the first cause of a transfer to a nursing home, other factors such as age-related fragility (increased risk of falls) or social, mental and economic problems (social isolation, depression, alcoholism and

other addictions, poverty) also play a decisive role. Nevertheless, we have to ask ourselves several questions about these technologies that strengthen healthcare services, including: Do seniors have trust in these solutions? Can these technologies impact the perception of social presence? Do these solutions impact the overall quality of service delivered by firms at seniors' home? By answering the above mentioned research questions we expect to contribute to the enrichment of knowledge about the elderly's perception of smart home technologies.

The goal of this study is to focus on the feeling of social presence (the perception that there is personal human contact) with these connected technologies and the degree of trust of elderly people using these systems. We want to identify if these two aspects (social presence and trust) can have an impact or not on the quality of service delivered by home care service companies. To the best of our knowledge, this is something new for the academic world in this context.

Connected Health Technologies (CHTs)

New delivery modes for healthcare, such as smart homes, are required to ensure quality as well as cost effectiveness for the services provided to an aging population (Townsend *et al.*, 2011). Smart homes rely on data acquisition equipment and devices to assess the current status of residents and their environments (Alam *et al*., 2012). In addition, ambient-assisted living (AAL) consists of assisted living technologies based on ambient intelligence (Rashidi and Mihailidis, 2013). These monitoring devices can be put into three categories: sensors (identifying the user's location, body temperature, etc.), physiological devices (monitoring the user's heart rate, blood flow velocity, etc.), and multimedia devices (displaying information, speaker voice command, etc.). Although the term Health Smart Homes has been widely used to describe information technologies that support healthcare services facilitating 'aging in place', the scope of the definition seems to differ from one author to the next. Indeed, in their

review of smart home applications, Demiris and Hensel (2008), define Health Smart Homes as the set of technologies that enable the monitoring of health related parameters of residents. According to the authors, the term includes the two following categories of devices: “functional Monitoring/Emergency detection and response” and “safety monitoring and assistance”. The first includes devices that collect and analyze data pertaining to functional measurements such as motion, activity levels among others features and the second refers to collecting and analysis of data regarding the user’s location. However, for Scanaill *et al*. (2006) the term Health Smart Homes describes assistive solutions that involve the installation of ambient sensors aimed at gathering data on the user’s health and bodily functions. The authors (Scanaill *et al*., 2006) refer to the term ‘wearable systems’ to designate devices that measure biomechanical and physiological data regardless of subject location and that subjects can wear during the day. For the authors there is third category consisting of a combination of wearables/health smart home systems that can be used to measure mobility. Given the differences that exist in the literature regarding the scope of Health Smart Homes, we decided to use the term of “Connected Health Technologies” (CHTs) which is a more general way of interpreting all the technologies used for supporting the health status of elders in their own homes. Understanding what motivates the intention to use the CHTs is critical to broaden their usage and foster aging in place.

Theoretical Background and hypothesis

Social presence is described as the perception that there is personal, sociable, and sensitive human contact (Gefen and Straub, 2004; Etemad-Sajadi, 2016). Heerink *et al.* (2009) showed the impact of social presence on the acceptance of screen agents in eldercare. Their study showed that the feeling of social presence was indirectly impacting the intention to use the technology. Elders’ perception of social presence can also be predictive of perceived enjoyment when interacting with screen agents. Indeed, the presence or interaction with

connected technologies is believed to potentially alleviate elders' loneliness (Broadent *et al.*, 2009; Portet *et al.*, 2013). Bickmore *et al.* (2005), found that seniors can consider the feeling of social presence as positive if they believe the technology is beneficial to them. Moreover, several authors identified that the perception of social presence can affect user trust (Sung and Mayer, 2012; Gefen and Straub, 2004; Hassanein and Head, 2007; Etemad-Sajadi, 2016). According to these authors, the inclusion of social cues facilitates the building of trust. The feeling that, through the use of these technologies, there is a connection between the senior and the external world may reassure and increase the feeling of trust. It would be interesting in our context to identify if the criteria of social presence can impact the perception of the quality of service delivered by home care service companies. Therefore, we propose the following hypothesis:

H1. The more seniors judge positively the social presence through CHTs, the better they perceive the quality of service delivered by the home care service company.

Having trust in a technology is primordial for increasing its usage (Gefen and Straub, 2003; Kim, 2012). According to the literature, the facets of trust are reliability, ability, integrity, benevolence, and honesty (Kumar, 1996; Geffen and Straub, 2004). Since the system receives information of vital importance, the system has to make sure that the information reaches only the right people. Thus, CHTs must be respectful of privacy and should provide reassurance regarding who is going to access the collected private data (Portet *et al.*, 2013). In our context we want to identify if the degree of trust in these CHTs impact the perception of the quality of service delivered by home care service companies. Therefore, we propose the following hypothesis:

H2. The more seniors have trust in CHTs, the better they perceive the quality of service delivered by the home care service company.

Methodology

Measures

Responses to the items presented below were used to create this current study's measures and to assess its hypothesized structural model. Response options for each item ranged from 1 (*strongly disagree*) to 7 (*strongly agree*).

Social presence was assessed with items adapted from Gefen and Straub (2003). We selected the following items: i) The technology used makes me feel connected with the external world, ii) There is a sense of human contact through the use of this connected technology, and iii) The technology used makes me feel less dependent on people.

Trust was assessed with items adapted from Gefen and Straub (2003), Gefen and Straub (2004), and Cyr *et al.* (2005). We used the following items: i) I trust the reliability of information delivered by this system, ii) I trust this technology to keep personal information secure, and iii) The technology used looks trustworthy.

Finally, SERVQUAL was readapted and used for measuring the quality of service. We used and adapted several items developed based on Parasuraman *et al.* (1988). SERVQUAL is composed of five dimensions which are:

(1) Reliability (ability to perform the promised service dependably and precisely);

(2) Assurance (knowledge and courtesy of employees and their ability to inspire confidence);

(3) Responsiveness (willingness to help customers and provide prompt service);

(4) Tangibles (physical facilities, equipment, personnel); and

(5) Empathy (individualized attention given to customers).

For *reliability*, one of our items among others was: '*When the home care service*

company promises to do something, it does so'. As far as the *assurance* dimension is concerned, one items among the others was: '*I feel safe in my interaction with employees of the home care service company'*. For *responsiveness*, one of our items among others was: '*The home care service company gives prompt services*'. For *tangibles*, we used items such as the following: '*The home care service company gives up-to-date equipment*'. Finally for *empathy*, one of our items among others was: '*The home care service company gives individual attention'*.

We added a new dimension called '*communication'* to the five traditional dimensions of SERVQUAL. The reason is the fact that according to several interviews done before launching this study, we identified that in the context of service delivery for elderly, communication is a real issue. We are not only talking about the communication between the company and the senior himself/herself. The communication between the company and the senior's family or even the communication between the company and other solutions providers is very important. The following items have been used: i) '*Employees take time to communicate with me in order to better understand my needs*', ii) '*The communication between the company and me is good*', iii) '*The communication between the company and my family is good*', and finally, iv) '*The communication between the company and other solutions providers is good*'.

Sampling and data collection procedures

For the distribution of the questionnaire, we had the opportunity to reach the clients of the Croix-Rouge (Neuchâtel), Secutel, and Domosafety. We sent the questionnaire by post (with a return stamped envelope) to 605 seniors. We targeted elderly people using CHTs (assistive alarm, telecare, sensors, etc.) at home and receiving healthcare at home. As far as the technologies are concerned, our respondents use the traditional assistive alarm and/or sensors installed in the senior's house. We did not focus on more intrusive techniques such as cameras. Overall, we received 213 questionnaires back (34.9%). Considering the profile of the

respondents, we were very positively surprised by the high number of respondents. As far as gender is concerned, it was divided with 27.8% male and 72.2% female. The average age of the respondents was 82.10. Finally, 64.9% were living alone, 22.8% with their husband or wife, and 12.3% did not answer if they live alone or not.

Data analysis method

Structural equation modeling (SEM) was adopted to test the hypotheses due to the fact that the model contains several latent variables. SmartPLS 2.0 was used for the analysis. We employed a bootstrapping method (200 sub-samples) to test the significant level of regression path coefficients (Hair *et al.*, 2011). We used the blindfolding approach (cross-validated communality and redundancy). The cross-validated communality index measures the quality of the measurement model of each block. The quality of each structural equation is measured by the cv-redundancy index (i.e. Stone-Geisser Q^2). The Stone-Geisser Q^2 for reliability, responsiveness, empathy, assurance, tangibles, and communications is respectively 0.18, 0.12, 0.10, 0.17, 0.11, and 0.08. Q^2 measures the extent to which observed values are reconstructed by the model and its parameter estimates (Chin, 1998). The technique represents a synthesis of function fitting and cross-validation (Henseler *et al.*, 2009). If it is negative, the model has no predictive relevance; values around 0.15 indicate a medium predictive relevance (Henseler *et al.*, 2009; Hair *et al.*, 2012). In this model, the independent variables have a moderate predictive relevance.

Results

Reliability and validity of measures

Table 1 shows that all latent variables have a composite reliability higher than 0.8, confirming that the scale reliabilities have adequate and stable measurement properties.

Convergent and discriminant validity are components of a larger measurement concept known as construct validity (Straub *et al.*, 2004). Convergent validity is shown when each measurement item is strongly correlated with its construct. It is usually satisfied by retaining variables whose loadings are high, indicating that they share sufficient variance with their related construct. Discriminant validity is satisfied when each measurement item is weakly correlated with all other constructs except with the one with which it is theoretically associated (Gefen and Straub, 2005). With PLS, convergent and discriminant validities are confirmed if each construct AVE is larger than its correlation with other constructs. Moreover, each item should load more highly on its assigned construct than on the other constructs (Gefen *et al*., 2000; Straub *et al*., 2004). Table 1 shows the intercorrelation of the research constructs. The diagonal of this matrix represents the square root of the average variance extracted. For adequate discriminant validity, the diagonal elements should be significantly larger than the correlation of the specific construct with any of the other constructs and should be at least 0.5 (Fornell and Larcker, 1981). In our case, one can claim that discriminant validity is mostly confirmed and sufficient to support the model.

Table 1: Reliability and discriminant validity

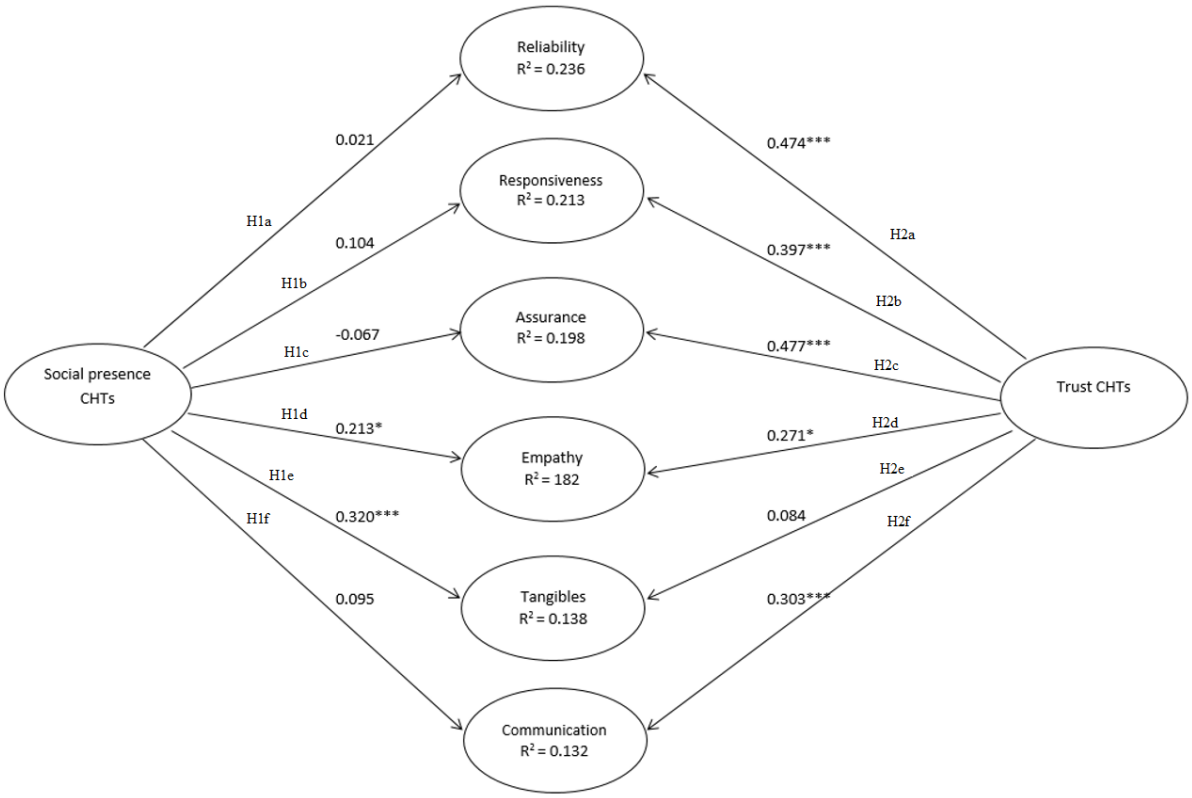
Constructs	Composite reliability	1	2	3	4	5	6	7	8
1. Social presence CHTs	.83	.78 [a]							
2. Trust CHTs	.90	.53**	.87						
3. Reliability	.93	.27**	.48**	.88					
4. Responsiveness	.82	.31**	.45**	.82**	.78				
5. Assurance	.94	.19*	.44**	.78**	.78**	.92			
6. Empathy	.86	.35**	.38**	.80**	.77**	.71**	.78		
7. Tangibles	.90	.36**	.25**	.50**	.57**	.49**	.48**	.91	
8. Communication	.88	.25**	.35**	.63**	.72**	.77**	.63**	.60**	.80

Notes:
* Correlation is significant at the 0.05 level.
** Correlation is significant at the 0.01 level.
a Diagonal: (Average Variance Extracted)$^{1/2}$ = $(\Sigma\lambda_i^2/n)^{1/2}$

Results and discussion

Figure 1 presents the results of the PLS analysis and the values of different path coefficients. One can observe that the social presence through CHTs impacts significantly empathy (γ = 0.213) and tangibles (γ = 0.320). Hence *H1d* and *H1e* are accepted. Trust in CHTs impacts significantly almost all the dimensions of our extended SERVQUAL. Indeed, it impacts reliability (γ = 0.474), responsiveness (γ = 0.397), assurance (γ = 0.477), empathy (γ = 0.271), and communication (γ = 0.303). Hence, *H2a, H2b, H2c, H2d, and H2f* are all accepted. We see that CHTs can impact the quality of service delivered in this context. Moreover, we observe that there is a complementarity of the social presence and trust in these technologies. The impact of trust is higher than the impact of social presence.

Figure 1: Results of the PLS analysis



Notes:

*	Significant at 0.05 level
**	Significant at 0.01 level
***	Significant at 0.001 level

Conclusion

The aim of the study was to get a better understanding of how our seniors perceive CHTs focusing on the feeling of social presence (the perception that there is personal human contact) with these connected technologies and the degree of trust of elderly people using these systems. The positive influences of the feeling of social presence and trust on the quality of service perceived, show us that the use of CHTs can impact positively the overall perception of the service quality. We also found that people who are living alone are more willing to accept the use of CHTs compared to people who are living with their husband or wife. Moreover, we observed that the more advanced in age seniors are, the more they judge that these connected technologies positively impact their connection with the outside world. These results are particularly relevant to companies in their quest to improve their products/services and communication strategies. Indeed, a better understanding of the relation that the elderly have with CHTs is an essential prerequisite to supporting the development of new solutions capable of satisfying the specific needs of our seniors.

Our study has several limitations. First, our sample covers a population benefiting from similar CHTs. It was difficult to distinguish and interpret the added value of each technology separately. It would be interesting to identify which sets of connected technologies contribute the most to a positive feeling of social presence or trust. Our study is also limited to a population with a similar culture. Further research is needed to understand if the perception of CHTs differs according to cultural and psychological characteristics of seniors.

References

Alam, M. R., Reaz, M. B. I., & Ali, M. A. M. (2012). A review of smart homes - Past, present, and future. *Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on*, 42(6), 1190-1203.

Bickmore, T. W., Caruso, L., Clough-Gorr, K., & Heeren, T. (2005). 'It's just like you talk to a friend'relational agents for older adults. *Interacting with Computers*, 17(6), 711-735.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, 295(2), 295-336.

Cyr, D., Bonanni, C., Bowes, J., & Ilsever, J. (2005). Beyond trust: Web site design preferences across cultures. *Journal of Global Information Management*, 13(4), 24-52.

Demiris, G., & Hensel, B. K. (2008). Technologies for an aging society: a systematic review of "smart home" applications. *Yearb Med Inform*, *3*, 33-40.

Demiris, G., Rantz, M. J., Aud, M. A., Marek, K. D., Tyrer, H. W., Skubic, M., & Hussam, A. A. (2004). Older adults' attitudes towards and perceptions of smart home's technologies: a pilot study. *Informatics for Health and Social Care*, 29(2), 87-94.

Etemad-Sajadi, R. (2016). The impact of online real-time interactivity on patronage intention: The use of avatars. *Computers in Human Behavior*, 61, 227-232.

Fornell, C.R. and Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error, *Journal of Marketing Research*, 18 (1), 39-50.

Gefen, D., & Straub, D. (2005). A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example. *Communications of the Association for Information Systems*, 16(1), 91-109.

Gefen D. and Straub D. (2004). Consumer trust in B2C e-commerce and the importance of social presence: experiments in e-products and e-services, *Omega*, 32 (6), 407-425.

Gefen, D., Karahanna, E., & Straub, D.W. (2003).Trust and TAM in online shopping: an integrated model, MIS Quarterly, 27(1), 51-90.

Gefen, D., Straub, D., & Boudreau, M. C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the association for information systems*, 4(1), 1-77.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, 40(3), 414-433.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *The Journal of Marketing Theory and Practice*, 19(2), 139-152.

Hassanein, K. and Head, M. (2007). Manipulating perceived social presence through the web interface and its impact on attitude towards online shopping, *International Journal of Human-Computer Studies*, 65(8), 689-708.

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2009). Influence of social presence on acceptance of an assistive social robot and screen agent by elderly users. *Advanced Robotics*, 23(14), 1909-1923.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing*, 20, 277-319.

Höpflinger, F., Bayer-Oglesby, L., & Zumbrunn, A. (2011). *La dépendance des personne âgées et les soins de longue durée: scénarios actualisés pour la Suisse*. H. Huber.

Kim, J. B. (2012). An empirical study on consumer first purchase intention in online shopping: integrating initial trust and TAM. *Electronic Commerce Research*, 12(2), 125-150.

Kumar, N. (1996). The power of trust in manufacturer-retailer relationships. *Harvard business review*, 74(6), 92-106.

Nishida, Y., Hori, T., Suehiro, T., & Hirai, S. (2000). Sensorized environment for self-communication based on observation of daily human behavior. In *Intelligent Robots and Systems, 2000.(IROS 2000). Proceedings. 2000 IEEE/RSJ International Conference on* (2, 1364-1372). IEEE.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988). SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, 64(1), 12-40.

Portet, F., Vacher, M., Golanski, C., Roux, C., & Meillon, B. (2013). Design and evaluation of a smart home voice interface for the elderly: acceptability and objection aspects. *Personal and Ubiquitous Computing*, 17(1), 127-144.

Rashidi, P., & Mihailidis, A. (2013). A survey on ambient-assisted living tools for older adults. *IEEE Journal of Biomedical and Health Informatics*, 17(3), 579-590.

Scanaill, C. N., Carew, S., Barralon, P., Noury, N., Lyons, D., & Lyons, G. M. (2006). A review of approaches to mobility telemonitoring of the elderly in their living environment. *Annals of biomedical engineering*, 34(4), 547-563.

Straub, D., Boudreau, M.C. and Gefen, D. (2004). Validation guidelines for IS positivist research. *Communications of the Association for Information Systems*, 14, 380-426.

Sung, E., & Mayer, R. E. (2012). Five facets of social presence in online distance education. *Computers in Human Behavior*, 28(5), 1738-1747.

Townsend, D., Knoefel, F., & Goubran, R. (2011, August). Privacy versus autonomy: a tradeoff model for smart home monitoring technologies. *Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE* (pp. 4749-4752). IEEE.

Virone, G., Noury, N., & Demongeot, J. (2002). A system for automatic measurement of circadian activity deviations in telemedicine. *IEEE Transactions on Biomedical Engineering*, Vol. 49 No. 12, pp. 1463-1469.

World Health Organization. (2011). Joint FA.