Appropriation of SMART Glasses

A Qualitative Study on the Long-term Use of SMART Glasses in Healthcare

Niek Zuidhof, Oscar Peters, Peter-Paul Verbeek, Somaya Ben Allouch

Abstract

Smart glasses could revolutionize healthcare workplaces. Despite pilot studies, long-term use insights are limited. This study examines nurses using smart glasses (Vuzix M400) for wound care over several years. In the use case presented in this study, nurses visit patients at home, consult remote experts via smart glasses, and treat patients accordingly. However, since knowledge about the long-term use and appropriation of smart glasses is scarce, this study aims to understand long-term use experiences through interviews with home care nurses (n=7), remote wound care nurses (n=7), and hospital managers (n=3). Data were analysed using directed content analysis, revealing four main themes: personal experience, collaborative experiences, unanticipated consequences, and future needs. Respondents reported personal habits, emotional aspects, and experiences when working with smart glasses. In collaboration through smart glasses, respondents mentioned the increased quality of care and the change in interdependencies.

Furthermore, working together via smart glasses had an impact on care at home as well. The consequences of the long-term use of smart glasses led to more feedback between nurses and patients, and to shifts in tasks between stakeholders. Future needs for smart glasses lie in further coordination with various stakeholders: patients, colleagues, IT, management, and developers of smart glasses. In conclusion smart glasses enable hands-free, high-quality home care, where an expert advises with a first-person perspective, the nurse learns new skills and a vulnerable patient can remain in the comfort of their environment. Despite it is currently cost increasing, it also saves time and space in the hospital.

Keywords: smart glases, appropriation, healthcare, workplace innovation

Introduction

Increased use of smart technologies can play an important role in addressing the ageing population (Liu et al., 2016) but also in working during a pandemic like COVID-19 (Martínez-Galdámez et al., 2021). On the one hand, it offers the opportunity to provide care to vulnerable elderly people at home, on the other hand, expertise can be provided remotely and may contribute to dealing with staff shortages. Wearable technology such as smart glasses is promising for distinct market segments in professional settings such as engineering and technical fields but also in specialized settings for instance in firefighting or the medical field (Kress, 2014). There is a growing body of literature describing first experiences with smart glasses (Han et al., 2019; Mason, 2016; Mitrasinovic et al., 2015; Mühlematter & Donno, 2016; Sobieraj et al., 2023; Zuidhof et al., 2022), but very little is known about experiences in long-term use and even less is known for the specific target group of nursing.

In healthcare, there are several use cases for smart glasses that have been experimented with, for instance in surgery (Muensterer et al., 2014; Singh & Klein, 2014), emergencies (Schaer et al., 2015) or wound care (Ye et al., 2016). Google Glass (see Figure 1) is a type of smart glasses that is both famous and infamous. Although there are privacy issues with smart glasses in general (Basu, 2014; Hofmann et al., 2017; Hong, 2013), it was suggested to have less impact on the potential user, but possibly more on the outsider who is confronted with a user of smart glasses (Rauschnabel et al., 2018). Turning back to the healthcare context, this does not seem to play a role for the patient (Odenheimer et al., 2018). However, what has not yet emerged here is that also more stakeholders besides the nurse and the patient can be involved in the use of smart glasses. For instance, smart glasses are used in wound care, and in that use case, a nurse (user), a patient (Wüller et al., 2018), but also a remote expert are involved. The use of smart glasses might lead to situations of task shifting and task sharing between stakeholders.

Figure 1. Image illustrating as a general example how smart glasses can be used by a nurse in the home environment for wound care (published with permission)

Whether or not people want to use smart glasses is examined by technology adoption models (Goken et al., 2016; Özdemir-Güngör et al., 2020). Although acceptance models are

continuously adapted to the use case and context, a limitation is that research in this way remains a snapshot of technology diffusion, for instance, whether someone wants to use it or not. Beyond the scope of these models, it is also known that people and technology continuously shape each other (Bijker & Law, 1992) and by viewing smart glasses as a mediator between humans and the outside world (Verbeek, 2015), it is possible to gain insight into a broader perspective of not only smart glasses acceptance but also of sustained use concerning the interaction with the environment. Knowledge about appropriation may provide new information about how we experience adoption, use and how we interact with smart glasses and each other (Zuidhof et al., 2019) see Figure 2. This study aims to gain insight into influences on sustained use and future needs in the workplace by long-term users such as nurses and stakeholders of smart glasses in healthcare. The research question of this study was: *what influences does the long-term use of smart glasses have on peer collaboration in patient care?*

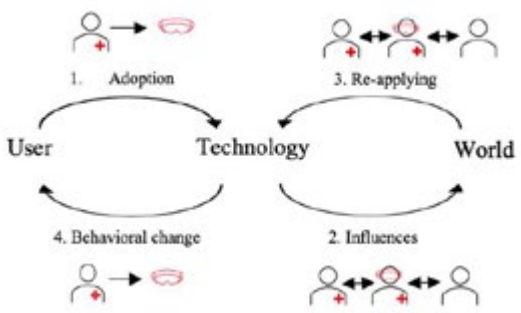

Figure 2. The theoretical framework to study the long-term use of smart glasses derived and adapted from Zuidhof et al. 2019

Methods

The current study included interviews with healthcare professionals involved in smart glasses use from three perspectives, the smart glasses user, the remote expert, and the manager. Interviews offer an effective way to obtain in-depth information. In addition, themes can be made transparent in analysis in this way. This study was reviewed and approved by the Ethics Committee of the Behavioural, Management, and Social Sciences of the University of Twente, The Netherlands (approval number: 200946). All participants provided written informed consent.

Participants

Interviews were carried out (n=17) with nurses as users of smart glasses (n=seven) from a Dutch healthcare organization, wound care nurses working as remote experts (n=seven), and managers (n=three) of a Dutch hospital. One wound care nurse was excluded because the

inclusion criterium of minimum experience of three months of smart glasses usage was not met. The average experience with smart glass usage was over three years (m=45.9 months, sd=29.3 months). The respondent group consisted mainly of women (88%) and the mean age was 47.17 years old (sd=11.46).
The participants were interviewed about the following use case for smart glasses. Before smart glasses were introduced, a patient with a complex wound had to return to the hospital regularly for a check-up by the wound care nurse. Due to physical limitations, a patient may be brought by a caregiver or taxi. In the situation of using smart glasses, a nurse visits the patient at home and after unpacking and cleaning the wound, she puts on the smart glasses (Vuzix M400) and connects with the wound care nurse in the hospital. Then they discuss the cure on the spot and the nurse at the patient's home receives treatment instructions from the remote expert.

Procedures

To identify relevant insights into the long-term use of smart glasses and workplace needs, the theoretical framework was used as a basis for semi-structured interviews (see Figure 2) and is based on the knowledge of technology adoption and technology mediation (Zuidhof et al., 2019).

Data collection

Data was collected with semi-structured interviews with the following topics: experience of use, social influences during use, behavioural changes, technology acceptance, and the future of healthcare.

Data analysis

The interviews were transcribed verbatim and anonymized, analysed with directed content analysis, and coded with an inductive approach since only broad topics regarding adoption, use, and consequences were known. Approximately 10% of the data were independently coded and discussed by two researchers with an intercoder agreement in two rounds (Cohen's Kappa .71).

Results

Themes derived from the analysis can be divided into four main groups: personal experiences in the use of smart glasses, the experiences in peer collaboration, consequences of sustained use, and needs for future use of smart glasses in the workplace.

Personal experiences in the use of smart glasses

"Very positive because I think it's a really good development. It is for older people, usually the group we work with, that it is often so difficult to come to the hospital. Then you have to arrange a taxi because the children live far away. It's all tricky. How nice is it that you can just do the check at home? (...) There is contact between the wound clinic and the patient. I think it's great. It is a bit more work for us, but in the end, it will inevitably save time and money. In the planning, but also the healthcare costs. If you work that out properly and start working with it much more, that is simply a very positive development." (Respondent nine)

Table 1. Demographic characteristics of the participants (n=17)

Category	Specification	Number of respondents
Gender	Male	2
	Female	15
	Prefer not to say	
Year of birth	<1950	
	1950-1959	2
	1960-1969	4
	1970-1979	7
	1980-1989	2
	1990-1999	2
Highest degree	High school or less	2
	Some college but no degree	2
	Associate degree	
	Bachelor's degree	14
	Master's degree	
	Professional or Doctoral degree	1
Years of work experience	3 months – 1 year	2
	1-3 years	6
	3-6 years	9
Relationship with smart glasses	User (nurse)	7
	Distant user (remote expert)	7
	Manager	3

The nurse uses smart glasses directly at the patient's home and the wound nurse is indirectly involved, remotely in the hospital. Both return that *habit* plays an important role in their experience. Over time, they have become more accustomed to using smart glasses, with the nurse at the patient's home becoming increasingly skilled in using them and the remote expert saying that it was mainly a matter of time to get used to them. this way of working. There were also *emotional aspects* to the personal experience, both are enthusiastic about their tasks, although the work can now be a bit more stressful for the user, and that sometimes creates some tension. This can be understood by how the experience of *working with smart glasses* is perceived. Important aspects were the stability of technology in the context and the number of steps that must be taken before a connection is established. For

example, the success of a dial-up moment via smart glasses is determined by whether the connection is stable. Mobile use of internet connections and visiting rural or more remote areas can sometimes lead to connection problems. If there is a weak connection, a consultation is not successful and has cost the patient, nurse, and remote nurse time and frustration. Furthermore, issues can arise in the wearing comfort for the user, for example in combination with wearing eyeglasses.

Table 1. Themes regarding personal experiences in the use of smart glasses from a user and remote expert perspective

Perspective	User of smart glasses (Nurse)	Remote expert in hospital (Wound care nurse)
Theme		
Habit	More skilful in the use	Takes time to get used to
Emotional aspects	Tension before use	
	Enthusiasm	Enthusiasm
Work with smart glasses	Multiple actions before use	One action to use
	Weight and fit issues	Connectivity issues

Experiences in peer collaboration using smart glasses

"People are now in the hospital for a shorter time, but they go home more complex. You do have to improve the quality of district nurses, of course, you must provide relatively much care in the home situation" (Respondent 11).

The experiences of working together with smart glasses are described from four perspectives, see Table 2. The interviewees were the nurse working with smart glasses working, the nurse working as a remote expert, and the manager. Patients were not interviewed because of COVID-19 lockdowns, but they were asked about their experiences as perceived by the nurses.

All four stakeholders showed that the *quality of care* has increased by working with smart glasses. This is primarily due to better and synchronous contact in the coordination between different healthcare providers that would otherwise not have been possible because it is normally asynchronous. The user and manager also indicate that in this way learning is also done while working, directly in patient contact. For example, the nurse at the patient's home can consult with the remote expert and receive guidance where necessary. Another aspect that contributes to better coordination is that the remote expert better understands the situation. Normally, the patient comes to the hospital neatly dressed for a check-up for example, but now there is an image of the home situation, in addition, there is also the patient who indicates that he is allowed to participate in the conversation and therefore feels seen and involved in the treatment. For instance, it may happen that a cat is lying on the

patient's lap near a complex wound, this situation provides an opportunity to discuss wound healing and hygiene and is something that might be less likely to be discussed in the hospital this way.

The use of smart glasses also entails *interdependencies between stakeholders*. A good relationship with the remote expert is important for the nurse to function properly with smart glasses. All parties are enthusiastic about working together via smart glasses, provided the technology works well. In line with this, another important condition for good cooperation is that there is mutual trust and that there is the possibility of low threshold contact for asking a short question or for peer consultation about a situation in which a nurse would like to share responsibility for patient care. The course of the consultation with smart glasses depends on the expertise of the remote expert on the complex wound on the one hand and on the user's ability to both work with smart glasses and translate the advice of the remote expert on the other hand to practice. This may mean that certain actions must be performed under the supervision of the remote expert or that certain advice in wound care must be discussed with the patient. There are also dependencies outside the care providers, namely those of informal carers. The pressure on informal care is reduced because the patient can stay at home and does not have to travel, which in some cases an informal caregiver would accompany.

Table 2. Themes regarding peer collaboration using smart glasses

Perspective Theme	User (Nurse)	Remote expert (Wound care nurse)	Patient at home	Manager (Hospital)
Raised quality of care	Better coordination			
	Learn from specialist	Better understanding		Bedside teaching
Interdependencies between stakeholders	Good relationship	Positive communication	Surprised Enthusiasm	Enthusiasm if it works out for everyone
	Low-threshold contact	Trust in relationship	Trust in both caregivers	More insight into process
	Added value depends on remote expert	Dependent on skills of district nurse	Less intensive for informal carers	Attention from others outside the organization
Care at home	More personal	Personal touch	Prefer home / Prefer hospital	
	Vulnerability (privacy), awareness of privacy	Faster policy Hospital is responsible Less inpatient care	No privacy issues reported Fewer travels	More space in the hospital for emergencies

"People are in their home environment, see other opportunities in the video call and say, for example: "Look, this is my dog I was talking about", or "You should see my front yard". This makes care more personal." (Respondent one)

Care that can be provided at home through smart glasses support is experienced in different ways, namely more personal, with additional vulnerabilities and consequences for hospital occupancy. For the nurse, working in this way is more personal because of the direct and synchronous contact with both the patient and the remote expert. This also applies to the

Table 3. Unanticipated consequences of sustained smart glasses usage

Perspective Theme	User (Nurse)	Remote expert (Wound care nurse)	Patient at home	Manager (Hospital)
Feedback	Receive more feedback	Give more feedback to nurse, patient	More involvement in the conversation	More interdisciplinary discussions
Preparation	Checks needed before use (batteries) More scheduling	Ask additional questions to clarify	Less hassle	Mediate between nurses and patients
Training	Aiming the camera at the wound takes practice	Taking turns takes practice		

remote expert because, due to the home environment, there is also a more personal touch to the contact with the patient, whether through contact with smart glasses. In addition, there are patients with a strong preference to receive care at home, on the other hand, there are also patients who see a visit to the hospital as an activity in the day and experience it as an 'outing'. The home situation in combination with technology also entails vulnerabilities, the nurse is very aware of this and discusses how the patient's privacy is guaranteed by, for example, not showing what is unnecessary, setting up a mobile connection, and discussing safety with the organizations involved. Until now, patients have never expressed any concerns regarding their privacy according to the respondents. It is also important for the remote expert they communicate clearly that they remain responsible for the treatment. This home care results in a faster policy for the remote expert and more space for the hospital at the location because this care has been relocated (see Table 2).

Unanticipated consequences of sustained smart glasses usage

“It is true that in the beginning, we said: gee, are you not wearing an apron or are you not wearing gloves or are you still wearing the jewellery? They are things that you can see

someone working on at home. Now you see that they no longer have sleeves underneath and they don't wear jewellery, even when we take pictures that they have gloves on. I think that something has changed in that sense if they have done something with the tips that we have given. Normally you have no control over someone who works in a home situation. (...) If you see that it also happens at home, you can point it out. Those things will change." (Respondent two)

Some aspects were not foreseen by the respondents, but looking back on their experiences, these have become an integral part of their work when they were not before. As mentioned earlier, there is therefore more synchronous contact between nurses, while at the same time, *feedback* is also given by the remote expert during the consultation and received by the nurse at the patient's home. Examples of this can be not having taken off a scarf or wearing and changing gloves. In addition, the patient is also involved in the conversation and the feedback sometimes also focuses on the patient about hygiene such as contact with pets. These interdisciplinary discussions have also been noticed by management and are perceived as positive for the quality of care and the patient's self-reliance. Another part is the necessary *preparations*. The nurse who works at the patient's home has been given extra tasks, such as checking whether the battery is sufficient, whether the device works properly and does not need to be updated, for example, but also the proper management of the agenda, after all, the contact moments must be coordinated with the patient and the hospital. Few additional tasks are required for the remote expert, other than carefully asking what is seen on the screen. For example, the colour of the wound must be checked and can be influenced by the quality of the camera or the incidence of light on the patient. For the patients, the preparations for a check-up are considerably reduced because they can stay at home. At an organizational level, coordination between institutions is often required for proper operation with smart glasses. Finally, a consequence is that *training* is needed for a smooth contact moment. Due to the position of the camera on the glasses, the nurse must practice aiming the camera in such a way that the remote expert can get a good picture. Another consequence for both the nurse and the remote expert is that because of the connection, it is sometimes difficult not to talk at the same time (see Table 3).

Future needs for smart glasses usage

"I'm thinking in the direction of privacy. We talked this morning about how scary it is right now. You now have the cookies that you find everywhere on the internet. That I am now discussing this subject with you, and I will come across this subject two hours later. That is apparently eavesdropped by an app. I find that frightening because (...) I tell something intimate. (...). In terms of privacy, I assume that all this is guaranteed, but I could be concerned about that."(Respondent three).

To continue working with smart glasses there are several *needs from the stakeholders*, the respondents consider it important that privacy and security are as optimal as possible. Although they are aware of this and comply with laws and regulations, this is also an area

that is difficult to trust. Good cooperation with other specialists in the field of IT and human resources is important to keep checking this. Another point is the loss of human contact, which remains of great importance to the nurse who works at the patient's home and is also a reason to do this work. They find it important that, despite working with smart glasses, attention is also paid to personal contact and see opportunities to tailor this to the wishes of the patient, because we have seen that one patient prefers to stay at home and the other just like that. love to visit a hospital. Optimal interaction is an important theme for the remote expert, how can you communicate well at a distance, deal with the possibilities and limitations of smart glasses and be and remain responsible for the treatment? For example, what tasks can you have a nurse perform under supervision and when do you call a patient back to the hospital? This requires further exploration. At the organizational level, scaling up is complicated. After a subsidy, the question arises who can and should bear the costs, and who benefits most from this intervention? At the moment it costs money because the hospital manages the glasses and buys software support from a supplier, at the same time there is a saving in the time that the remote expert spends on a check, which needs further investigation. Other *needs that come into play specifically for smart glasses* are possibilities that lie in integration with the electronic patient file, so that reports can be made at the same time, for example. For the remote expert, a detachable camera would be useful for a better view of a complex wound in a dark environment or a location that is difficult to capture, for example with a deep wound. Coordination with designers and developers is necessary to better integrate the smart glasses into the work and to appropriate them even better (see Table 4).

Table 4. Needs for future use in the workplace

Perspective	User (Nurse)	Remote expert (Wound care nurse)	Manager (Hospital)
Theme			
Needs from the stakeholders	Privacy and security must be optimal		
	Loss of human touch: keep face-to-face, tailor, to needs	Optimal interaction between nurse and expert	Scale up but the business case is difficult, dependency on fees
Needs towards smart glasses	Integration of electronic health record	Detachable camera for close-ups	Collaboration with designers/developers

Discussion

This study aimed to gain insight into the influences of long-term use and future needs regarding the use of smart glasses in healthcare. Although studies regarding long-term users with a clear use case are scarce, the present study investigated how different stakeholders reflect on their use, how the collaboration between user and remote expert is represented and which needs arise for continued use in the context of wound care.

As the most important conclusion in personal experiences of the nurse and the remote nurse in working with smart glasses, the increase of skills and enthusiasm in use is central. This finding contradicts earlier findings of potential users who presented many concerns when anticipating use (Due, 2015; Honan, 2013; Hong, 2013; Lawler, 2014; Zuidhof et al., 2022). The reason for this difference may be that the previous studies mainly focused on Google glass and the use of the current glasses (Vuzix M400) offers more possibilities to handle data safely in accordance with European laws and regulations. Due to the use of different type of smart glasses and also different use case, more positive evaluations were seen in this study compared to other studies (Yu et al., 2016). Furthermore, in working together via smart glasses, the nurse at the patient's home and the wound care nurse can coordinate better and learn from each other, which ultimately increases the quality of care. An important interdependence in cooperation is the relationship and the quality of the contact through trust and constructive feedback. A result of providing care at home is creating a more complete picture of the patient, which also potentially will save on hospital staffing and reduces travel movements.

Subsequently, unanticipated consequences that have changed the work lie in the collaboration and especially direct communication between the user, remote expert, and the patient. Other skills are also important, such as proper preparation and planning of daily work activities with smart glasses. Needs for continued use again lie in collaboration where privacy and safety must be paramount and coordination between all stakeholders can be improved, also considering the needs of patients. Patients do not appear to be concerned about privacy, which is in line with previous research (Odenheimer et al., 2018). This may be due to the trust of the patients in the healthcare provider. That the need for optimal privacy and security must be and remain present is in line with other studies on smart glasses and is confirmed by these studies (Adenuga et al., 2019; Hong, 2013; Kudina & Verbeek, 2018; Przegalinska, 2019). Furthermore, smart glasses can be improved in terms of software and hardware for every stakeholder, and involving the stakeholder in the development of smart glasses is essential. There is also a role here for an organizational role for instance in management and human resources to facilitate collaboration across institutions, collaboration with IT to tailor security and technology to users and train users for optimal alignment, communication skills, and efficient planning of work with smart glasses for the optimal use of technology.

An interesting outcome is that the theoretical framework (Figure 2) focused on behavioural changes and they were also partly found, but respondents also looked ahead and stated their needs for continued use. This result is in line with both the diffusion of innovations (Rogers, 1983) but also with the theoretical framework (Figure 2) in which it is assumed that appropriations fit into an infinite lemniscate in which humans and technology gradually shape each other (Bijker & Law, 1992; Pinch & Bijker, 1984). The theoretical framework used in this study (see Figure 2) was based on a combination of adoption and interaction with technologies from the perspective of appropriation (Zuidhof et al., 2019). Previous work on the adoption and appropriation of mobile technologies has been conducted in other

contexts such as with young people or in the household. The attractors and appropriation criteria that were found for young people (Carroll, Howard, Vetere, Peck, & Murphy, 2002) do not seem applicable to this professional setting in healthcare except for safety and security. The same applies to the domestication approach, which distinguishes four elements: appropriation, objectification, incorporation, and conversion (Silverstone & Hirsch, 2003). In this professional context, there is no personal purchase or ownership (appropriation in the domestication approach), or it takes up a place in the household (objectification in the domestication approach), but there is incorporation and conversion that can best be compared with the theme found in this study on the influences in the collaboration with others, namely how smart glasses are used over time and what unanticipated consequences the use of smart glasses has.

Regarding the different scope and therefore absence of the workplace in influential theory on appropriation (Silverstone & Hirsch, 2003), appropriation in mandatory settings provide valuable insights for organizational support and to better understand the findings in this, such as found in the use of IT in mandatory settings. In Engelbert's proposed model of appropriation, cognitive, social, and technical aspects shape the attitude towards appropriation and the resulting appropriation itself (Engelbert & Graeml, 2013). This study confirms the perceived differences in time and experience with smart glasses. However, objective appropriation as the ultimate endpoint of this process does not seem to have been achieved. Rather, as stated above, it can be perceived to be a mutual and ongoing process that continues to evolve over time, as suggested in the framework of long-term adoption (Figure 2). In the present study, the identified needs for future use indicate that further development may be necessary, particularly concerning technical aspects (e.g., detachable camera), social aspects (e.g., optimizing the feedback culture among professionals through smart glasses), and an element not explicitly covered in Engelbert's model: the revised business case informed by previous experiences.

Furthermore, workplace innovation offers recent research on augmented telework (Watanabe, 2023) and a useful framework within which to situate the experiences of professionals and managers reported in this study, especially regarding the impact on skill development, social and functional support, autonomy in nursing, and task variety. The concept of hospitality for telework appears to be relevant, as the unanticipated consequences in giving and receiving of feedback was a surprising finding in this study. Little evidence was found in the experiences described of increased work pressure or physical strain, which seems to be largely attributable to the specific use case in this study (short-term use of smart glasses) and the healthcare context in which this study was conducted, where the inherent variety of tasks is already substantial. The context-dependence and the continuous evolution of workplace dynamics highlight the need for ongoing implementation and appropriation research into such innovations, especially considering the inherent limitations of each individual study.

Limitations and future directions

This study was limited by the absence of input from a key stakeholder, namely the patient. The focus of this study was aimed at nurses and managers, but the patient is an indispensable stakeholder. However, this study was conducted during the COVID-19 pandemic and lockdowns, it was therefore impossible and irresponsible to ask vulnerable patients to participate in this study. The primary reason why patients could not be included in this study was that, during the COVID-19 pandemic, many nurses were deployed to intensive care units, and appointments for other types of care were postponed wherever possible. Despite this we recognize that, from the perspective of workplace innovation, the lack of patient voices limits our ability to fully evaluate the socio-technical dynamics involved. Another limitation is that the interviews were conducted digitally via video calls due to COVID-19 lockdowns. Despite a good connection and satisfaction with the researcher, an interview might have gone differently if it had been conducted face-to-face.

In terms of methodology, this study has demonstrated how different stakeholders experience innovation and what is needed for further development. Given that patients are central to this context, they should now be included as restrictions related to COVID-19 have eased. Additionally, HR emerges as an important stakeholder to consider, alongside insurers (or other actors responsible for funding), to enable a more comprehensive integration at the managerial, strategic, and systemic levels. From both a theoretical and practice-oriented perspective, the themes and job characteristics of SMART work design could provide an interesting lens for organizational conditions and psychological processes (Parker & Knight, 2024), complementing the framework for long-term adoption (Figure 2). Together, they offer valuable insights into how workplace innovation and technological innovation can be optimally aligned with the needs and experiences of each stakeholder.

In summary, by looking at the appropriation of smart glasses, we found that initial concerns about use, such as privacy, are much less prominent than previously thought in anticipated adoption. Possibly the benefits after long-term use outweigh the initial barriers. Furthermore, long-term use of smart glasses facilitates hands-free, high-quality home care, where an expert advises in a first-person perspective, the nurse learns new skills and a vulnerable patient can remain in the comfort of their environment.

References

Adenuga, K. I., Adenuga, R. O., Ziraba, A., & Mbuh, P. E. (2019). Healthcare augmentation: Social adoption of augmented reality glasses in medicine. ACM International Conference Proceeding Series, 71–74. https://doi.org/10.1145/3328833.3328840

Basu, S. (2014). Privacy in Public: "Google Glass" and "Creepshots." January. https://doi.org/10.13140/2.1.3893.1526

Bijker, W. E., & Law, J. (1992). Shaping technology / Building society. The MIT Press.

Due, B. L. (2015). The social construction of a Glasshole: Google Glass and multiactivity in social interaction. PsychNology Journal, 13(2–3), 149–178.

Engelbert, R., & Graeml, A. R. (2013). Use of Information Technology in Mandatory Settings: A Proposal for an Objective View of Appropriation. . Americas Conference on Information Systems.

Goken, M., Basoglu, A. N., & Dabic, M. (2016). Exploring adoption of smart glasses: Applications in medical industry. 2016 Portland International Conference on Management of Engineering and Technology (PICMET), 6, 3175–3184. https://doi.org/10.1109/PICMET.2016.7806835

Han, D.-I. D., Tom Dieck, M. C., & Jung, T. (2019). Augmented Reality Smart Glasses (ARSG) visitor adoption in cultural tourism. Leisure Studies, 38(5), 618–633. https://doi.org/10.1080/02614367.2019.1604790

Hofmann, B., Haustein, D., & Landeweerd, L. (2017). Smart-Glasses: Exposing and Elucidating the Ethical Issues. Science and Engineering Ethics, 23(3), 701–721. https://doi.org/10.1007/s11948-016-9792-z

Honan, M. (2013). I, glasshole: my year with google glass. http://www.wired.com/2013/12/glasshole/

Hong, J. (2013). Considering privacy issues in the context of Google glass. Communications of the ACM, 56(11), 10–11. https://doi.org/10.1145/2524713.2524717

Kress, B. (2014). See Through Optical Architectures for Wearable Displays. Imaging and Applied Optics 2014, JTu1A.1. https://doi.org/10.1364/AIO.2014.JTu1A.1

Kudina, O., & Verbeek, P. (2018). Ethics from Within : Google Glass , the Collingridge Dilemma , and the Mediated Value of Privacy. Science, Technology & Human Values, 1–24. https://doi.org/10.1177/0162243918793711

Lawler, R. (2014). Get ready for even more Google Glasshole sightings. https://techcrunch.com/2013/01/28/glassholes/

Liu, L., Stroulia, E., Nikolaidis, I., Miguel-Cruz, A., & Rios Rincon, A. (2016). Smart homes and home health monitoring technologies for older adults: A systematic review. In International Journal of Medical Informatics (Vol. 91, pp. 44–59). Elsevier Ireland Ltd. https://doi.org/10.1016/j.ijmedinf.2016.04.007

Martínez-Galdámez, M., Fernández, J. G., Arteaga, M. S., Pérez-Sánchez, L., Arenillas, J. F., Rodríguez-Arias, C., Čulo, B., Rotim, A., Rotim, K., & Kalousek, V. (2021). "Smart glasses evaluation during the COVID-19 pandemic: first-use on Neurointerventional procedures." Clinical Neurology and Neurosurgery, 106655. https://doi.org/10.1016/j.clineuro.2021.106655

Mason, M. (2016). The MIT Museum Glassware prototype: Visitor experience exploration for designing smart glasses. Journal on Computing and Cultural Heritage, 9(3). https://doi.org/10.1145/2872278

Mitrasinovic, S., Camacho, E., Trivedi, N., Logan, J., Campbell, C., Zilinyi, R., Lieber, B., Bruce, E., Taylor, B., Martineau, D., Dumont, E. L. P., Appelboom, G., & Connolly, E. S. (2015). Clinical and surgical applications of smart glasses. In Technology and Health Care (Vol. 23, Issue 4, pp. 381–401). IOS Press. https://doi.org/10.3233/THC-150910

Muensterer, O. J., Lacher, M., Zoeller, C., Bronstein, M., & Kübler, J. (2014). Google Glass in pediatric surgery: An exploratory study. International Journal of Surgery, 12(4), 281–289. https://doi.org/10.1016/j.ijsu.2014.02.003

Mühlematter, T., & Donno, F. (2016). Why smart bankers wear glasses: Performance and user acceptance of smartglasses by bank employees. ACM International Conference Proceeding Series, 21-23-Sept, 16–23. https://doi.org/10.1145/2967175.2967179

Odenheimer, S., Goyal, D., Jones, V. G., Rosenblum, R., Ho, L., & Chan, A. S. (2018). Patient Acceptance of Remote Scribing Powered by Google Glass in Outpatient Dermatology: Cross-Sectional Study. Journal of Medical Internet Research, 20(6), e10762. https://doi.org/10.2196/10762

Özdemir-Güngör, D., Göken, M., Basoglu, N., Shaygan, A., Dabić, M., & Daim, T. U. (2020). An Acceptance Model for the Adoption of Smart Glasses Technology by Healthcare Professionals. https://doi.org/10.1007/978-3-030-27285-2_6

Parker, S. K., & Knight, C. (2024). The SMART model of work design: A higher order structure to help see the wood from the trees. Human Resource Management, 63(2), 265–291. https://doi.org/10.1002/hrm.22200

Pinch, T. J., & Bijker, W. E. (1984). The Social Construction of Facts and Artefacts: or How the Sociology of Science and the Sociology of Technology might Benefit Each Other. Social Studies of Science, 14(3), 399–441. https://doi.org/10.1177/030631284014003004

Przegalinska, A. (2019). Wearable Technologies in Organizations: Privacy, Effciency and Autonomy in Work.

Rauschnabel, P. A., He, J., & Ro, Y. K. (2018). Antecedents to the adoption of augmented reality smart glasses: A closer look at privacy risks. Journal of Business Research, 92(August), 374–384. https://doi.org/10.1016/j.jbusres.2018.08.008

Rogers, E. M. (1983). Diffusion of Innovations (3rd ed.). Free Press of Glencoe.

Schaer, R., Salamin, F., Alfonso, O., Del Toro, J., Atzori, M., Muller, H., & Widmer, A. (2015). Live ECG readings using Google Glass in emergency situations. Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS, 2015-November. https://doi.org/10.1109/EMBC.2015.7318363

Silverstone, R., & Hirsch, E. (2003). Consuming Technologies (E. Hirsch & R. Silverstone, Eds.). Routledge. https://doi.org/10.4324/9780203401491

Singh, K., & Klein, G. O. (2014). Google Glass Has Potential for Rheumatology , Orthopedic Surgery. The Rheumatologist.

Sobieraj, S., Eimler, S., & Rinkenauer, G. (2023). Can Smart Glasses Change How People Evaluate Healthcare Professionals? A Mixed-Method Approach to Using Smart Glasses in Hospitals. International Journal of Human-Computer Studies, 103081. https://doi.org/10.1016/j.ijhcs.2023.103081

Verbeek, P. P. (2015). Beyond interaction: a short introduction to mediation theory. Interactions, 22(3), 26–31. https://doi.org/10.1145/2751314

Watanabe, K. (2023). Augmented telework with avatar technology: impact on workplace and required actions. In A Research Agenda for Workplace Innovation (pp. 51–66). Edward Elgar Publishing.

Wüller, H., Behrens, J., Klinker, K., Wiesche, M., Krcmar, H., & Remmers, H. (2018). Smart Glasses in Nursing – Situation Change and Further Usages Exemplified on a Wound Care Application. Studies in Health Technology and Informatics, 253, 191–195. https://doi.org/10.3233/978-1-61499-896-9-191

Ye, J., Zuo, Y., Xie, T., Wu, M., Ni, P., Kang, Y., Yu, X., Sun, X., Huang, Y., & Lu, S. (2016). A telemedicine wound care model using 4G with smart phones or smart glasses: A pilot study. Medicine (United States), 95(31). https://doi.org/10.1097/MD.0000000000004198

Yu, J., Ferniany, W., Guthrie, B., Ponce, B., & Parekh, S. (2016). Lessons Learned from Google Glass: Telemedical Spark or Unfulfilled Promise? J, 23(2). https://doi.org/10.1177/1553350615597085

Zuidhof, N., Ben Allouch, S., Peters, O., & Verbeek, P. P. (2019). A theoretical framework to study long-term use of smart eyewear. UbiComp/ISWC 2019- - Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers, 667–670. https://doi.org/10.1145/3341162.3348382

Zuidhof, N., Ben Allouch, S., Peters, O., & Verbeek, P.-P. (2022). Perspectives on the Acceptance and Social Implications of Smart Glasses: A Qualitative Focus Group Study in Healthcare. International Journal of Human–Computer Interaction, 1–11. https://doi.org/10.1080/10447318.2022.2111046

About the Authors

Niek Zuidhof is an associate professor of applied sciences at the research groups Employability Transition and Technology, Health & Care at Saxion University of Applied Sciences. His research concentrates on technology uptake, implementation, and appropriation in the workplace.

Oscar Peters is a researcher and lecturer at Saxion University of Applied Sciences. His research focuses on media use and effects, with particular attention to the use and adoption of new media and ICT from the user's perspective.

Peter-Paul Verbeek is Rector Magnificus of the University of Amsterdam and Professor of Philosophy and Ethics of Science and Technology in a Changing World. His research focuses on philosophy of human-technology relations.

Somaya Ben Allouch is professor Human-System Interaction for Health & Wellbeing at the University of Amsterdam and Amsterdam University of Applied Sciences. Her research focuses on het digital interaction between humans and non-humans.