Guidelines for Integrating Social and Ethical User Requirements in Lifelogging Technology Development

Julia Offermann-van Heek, Wiktoria Wilkowska, Philipp Brauner and Martina Ziefle
Human-Computer Interaction Center, RWTH Aachen University, Aachen, Germany

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Abstract: Lifelogging technologies have the potential to facilitate and enrich the everyday life of younger as well as older people. On the one hand, tracking and logging of data about activities and behavior support an active lifestyle. On the other hand, tracking medical data and movements support increasing safety by detecting, e.g., emergencies or falls. From a technical perspective, a variety of technologies enable lifelogging and are already available on the market. Instead, there is very little knowledge about the perception and acceptance of lifelogging technologies from users' socio-ethical perspective. Hence, this paper presents research results from four online survey studies (n = 1107) aiming at covering a broad range of lifelogging applications and reaching diverse target groups. Being based on insights gathered from the quantitative data collection, this paper derives guidelines for integrating ethical and social perspectives in lifelogging technology development and emphasizes gaps within the research landscape regarding its perception and acceptance.

1 INTRODUCTION

Demographic developments along with increasing proportions of older people in need of care pose tremendous social, political, and economic challenges for today's society and its care sectors (Pickard, 2015; Bloom and Canning, 2004; Walker and Maltby, 2012). For example, Germany is one of the countries representing strong demographic change developments resulting in 21% of the population aged above 65 years and 11% aged above 75 years in 2014 (Haustein et al., 2016). Decreasing proportions of people who are able to pay and care for the increasing proportions of older people aggravate this problematic development. Although, 64% of people beyond 90 years of age are in need of intensive care (Haustein et al., 2016), the majority of older people desires to stay at home as long as possible, staying active and living their life as independently and autonomously as possible (Wilkowska and Ziefle, 2011).

The usage of lifelogging technologies represents one approach to address and support the fulfillment of these wishes. Also, such technologies (e.g., smart watches, fitness trackers) have a preventive function in motivating and supporting a healthier and more active lifestyle for younger and older people likewise (Lidynia et al., 2018). These diverse functions already imply a very broad range of technologies that can be used for lifelogging, e.g., differing between wearable and non-wearable technologies, a single device and complex smart home systems, or camera-based vs. motion sensor-based systems (Rashidi and Mihailidis, 2013; Bouma et al., 2007).

Since such systems intervene deeply in the autonomy of their users, it is necessary to consider ethical, legal, and social aspects in addition to a solely technical perspective. Even if the implementation of a technology is aligned with engineers, lawyers and ethicists, its use can fail due to a mismatch between the system and the social expectations, and thus, a lack of social acceptance.

Consequently, this article presents users' social and ethical expectations of life-logging technologies for different stakeholders and different usage contexts. The findings from our four studies inform about which aspects are accepted and which are rejected. Taking this knowledge into account, this research can contribute to the development of accepted lifelogging systems.

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2 PERCEPTION OF LIFELOGGING TECHNOLOGY

In the following, the current state of the art is presented starting with a short technical overview of lifelogging, followed by research on users' perception of lifelogging technologies. Finally, the related research project of the current studies and the underlying research questions are detailed.

2.1 Lifelogging Applications

Commonly, the term lifelogging relates to different types of digital self-tracking and recording of everyday life. It is often interchangeably used with self-tracking or quantified self (QS) (Selke, 2016; Gurrin et al., 2014a). In general, lifelogging is understood as capturing human life in real time by recording physiological as well as behavioral data, whereas by storage of data, self-archiving, self-observation, and self-reflection are enabled. Thus, lifelogging represents a phenomenon whereby people can digitally record their own daily lives in varying amounts of detail, for a variety of purposes (Gurrin et al., 2014b).

As there is no tight boundary, lifelogging is connected to other research areas and can be seen as part of Ambient Assisted Living (AAL) aiming for activity monitoring, recognition of abnormal behavior, reminding, detection of emergencies, as well as supporting and facilitating everyday life (Rashidi and Mihailidis, 2013). Within the context of AAL, diverse technologies and sensors used for lifelogging reach from ambient-installed to wearable configurations and can be used in private environments, smart homes, as well as in professional care institutions for old and frail people (e.g., Jalal et al., 2014). In this way, collection, processing, and analyzing of person-related data can help to improve a longer independent living and provides assistance for diverse stakeholders (e.g., older and frail people, professional caregivers, relatives of people in need of care, etc.).

The spectrum of single lifelogging applications is extremely broad, reaching from assisting technology devices for older people to sportive devices mainly used by younger people during their leisure time. To mention some technology examples, health and monitoring tools aim for monitoring of single activities and movements (Nambu and Masayuki, 2005), recognizing social activity (Wang et al., 2009), identifying changes in movements or behaviors as indicators for dementia (Hayes et al., 2008), or enabling fall detection (Shi et al., 2009). Instead, sportive technology applications aim for tracking and improving of physical activity, nutrition, and gamification (e.g., Schoeppe et al., 2016). Besides technical opportunities, functions, and feasibility, the users' perception and acceptance of those technologies is essential.

2.2 Users' Perceptions of Lifelogging

With regard to a social perspective, lifelogging technologies are overall seen as a possible solution for the challenges of demographic change, are mostly perceived and evaluated positively, and the necessity and usefulness of technical support are highly acknowledged (Beringer et al., 2011; Gövercin et al., 2016). Within the perception of benefits of using assisting technologies, the opportunity of staying longer at the own home and an independent life are strong motives to use (or imagine using) assisting lifelogging technologies especially with regard to older adults and aging in place. In particular, a reminding function is frequently confirmed as a reason for creating a lifelog by different stakeholders (i.e., older and younger adults as well as children likewise) (Morganti et al., 2013; Gall et al., 2016). Apart from these functions, when asking older people about potential benefits of lifelogging technologies, also safety-related benefits (e.g., alarms, fall detection) are of major importance (Schomakers et al., 2018; Biermann et al., 2018). Sharing and collecting information with people - in specific the family circle - (Caprani et al., 2013; Caprani et al., 2014) represents a further specific motivation to use lifelogging technologies. On the other hand, restraints and acceptance barriers such as feelings of isolation (e.g., Sun et al., 2010), feelings of surveillance, and invasion of privacy (e.g., Wilkowska et al., 2015) were frequently mentioned when asking people to think about using lifelogging technologies in their everyday life. In more detail, a perceived loss of control over sensitive data or unauthorized forwarding to third parties are great barriers for using life-logging applications (Lidynia et al., 2018).

Theories of technology acceptance have mainly focused on the two key components, perceived usefulness and perceived ease of use, so far. But studies have shown, that additional motives and barriers play a crucial role in the context of assistive technologies for older adults (e.g., Jaschinski and Allouch, 2015; Peek et al., 2014). Frequently, AAL technologies are designed to operate in our homes and be close to our bodies, are associated with negative aspects of aging, illness, and even with surveillance. Thus, barriers regarding stigmatization, privacy, and usability are predominant. Studies show that users acknowledge the potential of AAL technologies but are also concerned because of barriers. Thus, trade-offs between per-

ceived benefits and barriers are crucial for the acceptance of AAL technologies (van Heek et al., 2017a,b). Besides potential and perceived benefits and barriers, the type of technology (Himmel and Ziefle, 2016) and application context (van Heek et al., 2016) have been proven to impact acceptance patterns. Further, previous research has identified age and gender (Wilkowska and Ziefle, 2011), health status (Klack et al., 2011), and professional care experience (Peek et al., 2014) to be impacting user diversity factors for the acceptance of assisting and lifelogging technologies.

In contrast to social perspectives on lifelogging technology usage, there are only few studies focusing empirically on user-related ethical issues of using lifelogging technologies in diverse contexts. Within ethical considerations, a user-oriented structuring and preservation of personal privacy of the lifelogging technology users represents one of the most challenging tasks (Jacquemard et al., 2014). Some studies emphasize the importance of asking the legitimate and ethical questions related to sharing, ownership, and security of data (e.g., Wolf et al., 2014): In more detail, people want to know which data is tracked, when data is tracked, what happens to tracked data, and who has access to tracked or logged data. Other studies provide first ethical frameworks for specific types of technologies focusing on privacy, data handling, and provided information, e.g., wearable cameras (Kelly et al., 2013). Beyond privacy-related aspects, ethical considerations start even earlier asking for what are lifelogging technologies generally allowed to do or who has the right to make decisions referring to technology usage. So far, there has been hardly any research on a general ethical framework for a broad range of lifelogging technologies, diverse lifelogging contexts and target groups. In addition, it is questionable whether ethical requirements are influenced by user factors playing a crucial role for users' social perception of lifelogging.

2.3 Project PAAL and Research Aims

Parts of the European research project PAAL (Privacy Aware and Acceptable Lifelogging services for older and frail people) address exactly this gap by providing an empirically derived, user-related socio-ethical framework for lifelogging technology development. On this basis, privacy-aware lifelogging technologies will be developed and evaluated in the future project progression. To provide a framework for a broad spectrum of lifelogging technologies, fulfilling social and ethical perspectives, an empirical approach is necessary investigating diverse lifelogging contexts, diverse target groups of lifelogging users, and in particular their ethical and privacy-related concerns referring to lifelogging technology usage. Hence, the underlying research questions aim for an investigation whether the social perception of lifelogging technologies, their benefits and barriers depend on the lifelogging context and on user factors. Further, it will be analyzed in detail how diverse users perceive ethically relevant aspects of lifelogging technology usage and whether the ethical perception of data handling (e.g., data types, ways of handling, data access) depend on the lifelogging context. Answering these research questions will then provide the basis to derive guidelines for considering ethically and socially relevant issues in lifelogging technology development.

3 METHODOLOGY

This section presents the methodical approach of the study, starting with the empirical concept, followed by short descriptions of the conducted studies and their respective samples.

3.1 Research Approach

Beyond normative legal and ethical considerations, the current research approach aimed for an empirical exploration of socially and ethically relevant aspects for lifelogging from the user's perspective. In order to answer open research questions in regarding user-related socio-ethical requirements for a broad spectrum of lifelogging technology development, four different quantitative studies were conducted. Each of the studies had another thematic context and a specific target group: sportive, medical home, caregivers, and aging and health. The target groups reached from healthy young adults, middle-aged adults, middle-aged professional caregivers to a large sample of adults of all ages having experiences with chronic diseases and care.

All quantitative studies are based on preceding qualitative studies (interviews and focus groups). Overall, four online surveys were conducted reaching a total of $N = 1107$ participants in Germany.

3.2 Empirical Studies – Design

Each of the studies presented here is based on a specific qualitative preceding study enabling the concep-

tualization of the respective quantitative online survey study. A short overview of the single studies' concepts and sample is presented in the following.

3.2.1 Study 1: Sportive Lifelogging

The first study aimed for an investigation of young adults' perceptions of lifelogging technologies in a sportive usage context.

Online Survey. Following a short introduction into the topic of lifelogging technologies for leisure applications (e.g., sports and health monitoring), the participants were asked for demographic information. Afterwards, attitudinal characteristics such as the participants' attitudes towards technology (5 items; α = .857) and their perceived needs for privacy (3 items; α = .778) were assessed. Among others, the participants were then asked to evaluate a) potential benefits (11 items; α = .873) and barriers (16 items; α = .899) of lifelogging technology usage, b) their acceptance of lifelogging technology usage (3 items; α = .929), and c) which information should be tracked by lifelogging technologies (17 items). Finally, the participants also assessed diverse options to realize lifelogging technology (17 items) and different applications contexts of lifelogging technology usage (17 items).

Sample. Overall, N = 169 participants completed the online questionnaire in summer 2018. The mean age of the participants was 35.3 years (SD = 14.1; min = 15; max = 69) with 56.8% (n = 96) females and 43.2% males (n = 73). The educational level of the participants was high with 48.8% holding a university degree and 35.5% a university entrance diploma. Further, 10.2% reported a completed apprenticeship as highest educational level, while 5.4% hold a secondary school certificate or had no degree (yet). 19.3% (n = 33) of the participants indicated to suffer from a chronic illness. Considering attitudinal characteristics, the participants indicated to have a rather positive attitude towards technology (M = 3.8; SD = 1.1; min = 1; max = 6) and they classified their needs for privacy as rather high (M = 4.1; SD = 1.1; min = 1; max = 6).

3.2.2 Study 2: Medical Lifelogging at Home

The second study aimed at an analysis of middle-aged persons' perception of medical lifelogging technology usage at home. Two focus groups provided the basis to conceptualize the quantitative study.

Online Survey. The participants indicated demographic information after a short introduction into the topic of using lifelogging technologies for monitoring (e.g., vital parameters) and reminding (e.g., intake of medicine) at home. Further, they reported if they suffer from a chronic illness or depend on care. Subsequently, the participants indicated previous experiences with care (e.g., family member in need of care). Referring to attitudinal characteristics, the participants evaluated their attitude towards technology (5 items; α = .873). As technology-related aspects, the participants assessed potential benefits (5 items; α = .873) and barriers (5 items; α = .873) of lifelogging technology usage as well as acceptance (5 items; α = .873). Further, the participants also evaluated specific functions lifelogging technologies should fulfil (5 items; α = .873). From an ethical perspective, the participants were asked to evaluate aspects lifelogging technologies were allowed (5 items; α = .873) and were NOT allowed to do (5 items; α = .873).

Sample. A total of N = 195 respondents participated in the online survey and supplied all required information in September 2018. The participants were on average 41.7 years old (SD = 14.7; min = 16; max = 71) with 65.1% females (34.9% males). The educational level was rather high with 41.5% of the participants holding a university degree and 19.0% a university entrance diploma. In addition, 28.2% indicated to complete an apprenticeship and 11.3% secondary school. Referring to health- and care-related issues, 32.3% (n = 63) of the participants indicated to suffer from a chronic illness, while only 2.1% (n = 4) reported to depend on care. Further, 24.1% (n = 47) reported to have professional care experience. Concerning private experience in care, 52.8% (n = 103) indicated to have a family member in need of care, while 41.0% (n = 80) have already been a caregiver for a family member in need of care.

3.2.3 Study 3: Caregivers and Lifelogging

A further study specifically focused on professional caregivers' perception of lifelogging technologies in care contexts and focused on data security and privacy issues (van Heek et al., 2018).

Online Survey. The online survey started with asking the participants for demographic information. Subsequently, the participants evaluated their needs for privacy (6 items; α = .883) as well as their attitude towards technology (4 items; α = .884). All participants had professional experience in working as caregivers in the areas geriatric care, medical care, and care of people with disabilities. Evaluating lifelogging technologies for monitoring and safety reasons in professional care contexts, the participants assessed potential benefits (14 items; α = .923), barriers (17 items; α = .944), and acceptance of lifelogging technologies

(6 items; α = .932). Focusing on data security and privacy aspects, the participants evaluated which types of information (14 items; α = .856) they allow to be gathered by lifelogging technologies as well as conditions of data storage (3 items; α = .760) and data access (3 items; α = .802).

Sample. Overall, N = 170 completed the online survey in summer 2017 and fulfilled the condition to have relevant experience in working as a professional caregiver. The participants were on average 36.3 years old (SD = 11.2; min = 19; max = 68) with 74.7% females (n = 127). The educational levels were medium with the majority of participants holding a completed apprenticeship as highest degree. Further, 23.0% hold a university degree or a university entrance diploma, whole 11.8% completed secondary school or had a comparable degree. With regard to attitudinal characteristics, the participants indicated a medium attitude towards technology (M = 3.4; SD = 0.7; min = 1; max = 6) and rather high needs for privacy (M = 4.2; SD = 0.9; min = 1; max = 6).

3.2.4 Study 4: Lifelogging and Aging

A last study focused on a larger sample of adults of all ages having different experience with chronic diseases and care. This study aimed for an investigation of ethically relevant aspects in the context of aging and usage of lifelogging technologies.

Online Survey. First, the participants indicated demographic information which provided the basis for a census representative selection of the sample regarding age and gender. Further, the participants evaluated their attitudes towards technology (4 items; α = .842). Subsequent to a short introduction into the topic of lifelogging technologies and their opportunities for aging in place, the participants assessed different benefits (14 items; α = .957) and barriers of technology usage (15 items; α = .953) as well as their acceptance of lifelogging technologies (3 items; α = .761) referring to different health scenarios. In addition, the study had an ethical focus asking for evaluations of life-end-decisions and who is allowed to decide in critical situations.

Sample. A total of N = 573 participants completed the online survey in spring 2018. The mean age of the participants was 48.3 years old (SD = 16.6; min = 20; max = 85). 13.6% (n = 78) of the participants were younger than 25 years, 29.5% (n = 169) were between 26 and 45 years, 30.7% (n = 176) between 46 and 60 years, and 26.2% (n = 150) were older than 60 years. Gender was almost equally spread (47.8% females, n = 274; 52.2% males, n = 299). The highest educational level was completely mixed: 36.0% completed an apprenticeship, 21.6% hold a university degree, 19.2% a university entrance diploma, and 23.2% diverse secondary school certificates. With regard to health- and care-related issues, 61.3% of the participants (n = 351) indicated to suffer from a chronic illness and 11.4% (n = 65) reported to depend on care in their everyday life. Among the indicated chronic illnesses, typical age-related illnesses (e.g., diabetes, high blood pressure, arthrosis, back pain due to slipped disc) were mentioned nearly as often as age-independent illnesses (e.g., multiple sclerosis, depressions, epilepsy). Referring to attitudinal characteristics, the participants' attitude towards technology was on average rather positive (M = 4.4; SD = 1.1; min = 1; max = 6).

4 RESULTS

The four studies aimed at answering the research questions introduced in section 2.3. In the following, the research questions are answered starting with relevant aspects belonging to the social perspective on lifelogging technologies. Afterwards, a focus on ethically relevant aspects provides detailed insights into data security and privacy-related evaluations of diverse user groups. Besides descriptive data analyses, correlation, regression, and inferential statistical analyses were applied. Whiskers within the diagrams of the results section indicate the standard deviations.

4.1 Social Insights

Regarding socially relevant aspects of lifelogging technologies, their perception and acceptance are focused on exploring perceived benefits and barriers of technology usage and impacting user factors.

4.1.1 Social Perception of Lifelogging

Taking all studies into account (N = 1107), step-wise linear regression analyses revealed that 49.4% (adj. r^2 = .494) variance of general acceptance of lifelogging technology usage was explained by perceived benefits (β = .547) and perceived barriers (β = -.312). According to that, the use is driven rather by perceived benefits than by barriers. To gain deeper insights into the importance of single benefits and barriers, step-wise linear regression analyses were conducted for each study.

Within the sportive usage context (n = 169), a final regression model showed that 55.6% (adj. r^2 = .556) variance of lifelogging technology acceptance was explained by five specific benefits and barriers:

increased life quality (β = .288), comfort (β = .199), increased mobility (β = .206), feeling to be not able to control the technology (β = -.270), and feeling of being controlled (β = -.178).

In contrast, in the professional care context study a lower percentage of variance of lifelogging technology acceptance was explained, being based on four different specific benefits and barriers (n = 170): here, 38.9% (adj. r^2 = .389) were explained by relief in professional everyday life (β = .298), increased autonomy (for patients) (β = .241), fear of replacing human care by technology (β = -.186), and fear of a complex technology handling (β = -.174).

Similar results were found within the regression analysis of older participants' perceptions of lifelogging technologies in the context of medical monitoring at home (n = 195). Here, a higher percentage of lifelogging technology acceptance' variance (46.7%, adj. r^2 = .467) could be explained by the benefits relief in everyday life (β = .171), increased autonomy (β = .234), increased feeling of safety (β = .181) and by the barriers invasion of privacy (β = -.244) and fear of replacing human care by technology (β = -.150).

Asking in particular older participants, who are experienced with illnesses and care (n = 573) revealed partly similar results: 42.0% of technology acceptance' variance were explained by the perceived benefits increased feeling of safety (β = .429), relief in everyday life (β = .121), increased autonomy (β = .117), and the perceived barrier invasion of privacy (β = -.161).

4.1.2 Realization of Lifelogging

The realization of lifelogging technologies and their specific functions represented a further element of some of the conducted studies.

Within the sportive usage context (n = 169), the participants evaluated (well-known) smart watches as best option of realizing lifelogging technologies. Health-related functions and applications were most desired – emergency detection, reminding functions (e.g., medicine, nutrition), control of health and activity –, while applications supporting social interaction or control of working progress were rather rejected.

With regard to professional care applications (n = 170), professional caregivers evaluated also already used and well-known technologies as most suitable: emergency buttons. Further, fall sensors, room sensors, or motion sensors were also accepted as options of lifelogging in professional environments. In contrast, audio- and video-based realizations of lifelogging technologies were clearly not desired.

4.1.3 Impact of User Diversity

As illustrated in Figure 1, all studies were analyzed for potential relationships between lifelogging technology perception and user factors (N = 1107).

First of all, the results revealed strong relationships between lifelogging technology acceptance and perceived benefits as well as perceived barriers. Further, the acceptance of lifelogging technologies correlated with all investigated user factors.

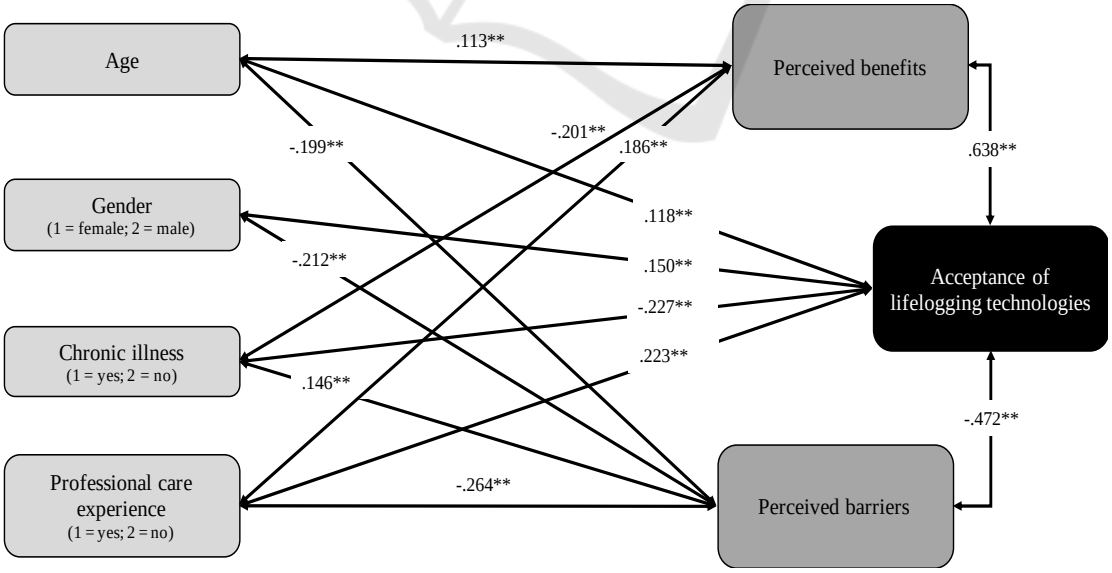

Figure 1: Correlations of demographic factors and social perception and acceptance of lifelogging technologies (n = 1107).

In particular, older participants tend to accept lifelogging technologies and acknowledge potential benefits more than younger people, while there was a negative correlation between age and the perception of barriers. Regarding gender, the results indicate that men were more inclined to accept lifelogging technologies than women, while women see higher barriers of lifelogging technologies. Considering experience with a chronic illness, people who suffer from a chronic illness tend to accept lifelogging technologies and their potential benefits more than healthy participants. Instead, healthy participants showed to higher evaluations of potential lifelogging technology barriers. Taking professional care experience into account, professional caregivers were characterized by a lower acceptance and lower evaluation of lifelogging technology benefits, while they showed a higher evaluation of potential barriers compared to participants without professional care experience. Summarizing, acceptance increases with demand through age or illness.

These relationships give rise to the necessity to analyze ethically relevant aspects (i.e., ethics- and barrier-related issues such as privacy and data security) in more depth and for diverse lifelogging contexts.

4.2 Ethical Insights

This section represents results referring to user-related ethical requirements for using lifelogging technology. Thereby, aspects like data access, data handling, and decision-making are focused.

4.2.1 Which Data May be Gathered?

In study 1 (N = 169), predominantly young participants were asked to indicate which information they want to track using lifelogging technology (Figure 2). The most frequently mentioned information referred to tracking of vital parameters, sleep, and nutrition. Daily steps and travels were also mentioned frequently. Besides further health-related information such as weight or burned calories, also other areas like tracking of finances, hobbies, or exposure of time were indicated. Compared to that, aspects like tracking of number of spoken words, places, creative ideas, or mood were mentioned occasionally.

Asking professional caregivers for their opinion which information is allowed to be gathered in their professional everyday life, clear statements were found (n = 170) (van Heek et al., 2018): Within professional care contexts, they clearly agree with tracking of emergency-related information, e.g., actuation

Figure 2: Mentioned information being allowed to be gathered using lifelogging technologies (n = 169).

of emergency buttons or recordings of cries for help. Further, the professional caregivers also accepted to track room data enabling smart home functions, such as automated doors and windows. Tracking of patients' position was merely tolerated, while tracking of the caregivers' position was strictly rejected – although the potential benefits of knowing the positions of colleagues for fast support were acknowledged. Finally, the use of microphones or video-based technologies to track care-related information, such as duration of care, times at which rooms are entered or left, or talks during care, were strongly rejected.

4.2.2 How Should Data be Handled?

The way of data handling was also evaluated in study 3 (Figure 3). Independent from the type of data, the participants were only willing to accept data to be evaluated for the moment. Storage on a daily basis or long-term storage was most likely accepted for room data, while it was clearly rejected for more privacy-intensive data such as position, audio, and video data.

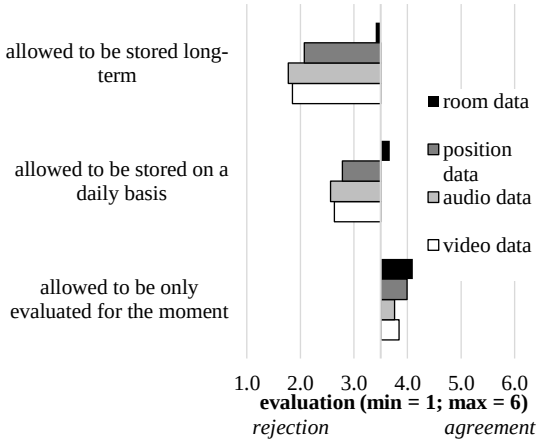

Figure 3: Evaluation of data handling (n = 170).

In interviews with some of the participants of this study it became clear that the willingness of data storage increased with a deeper understanding of the advantages of data storage compared to data processing (e.g., enabling detailed health analysis, movement analyses). Hence, more detailed information about data storage and its related characteristics led to acceptance of – at least – short-term storage of health-related data. Correlation analyses revealed that those evaluations were not related with user factors, such as age, gender, or duration of care expertise.

4.2.3 Who is in Control? Who Owns Data?

In diverse studies, the participants were asked for their opinions on who is allowed to access personal data, when using lifelogging technologies. In professional care contexts (study 3, n = 170), personal data was neither allowed to be accessible for colleagues (M = 2.9; SD = 1.2), nor direct supervisors (M = 2.9; SD = 1.3), and in particular not for all supervisors (M = 2.5; SD = 1.2). Correlation results revealed that demographic characteristics of the professional caregivers did not affect these results. In contrast, a tendency was observable that position and room data were more likely to be accessible for colleagues and supervisors than audio and video data.

In the fourth study, participants were asked, who is allowed to make decisions in severe health situations (Figure 4). The majority of the participants (59.8%) indicated to want to decide totally themselves. Smaller proportions want that the doctor (27.6%) or their immediate family (23.6%) decide. In contrast, the participants did clearly not want that other relatives had decision-making power (5.1%). Further, the selections show that doctors are accepted to decide largely by 38.0% of the participants.

The evaluation pattern of "not at all allowed to decide" confirms that other relatives are not accepted to make health decisions (35.0%), followed by the immediate family (12.6%). To decide "not at all" for themselves (1.7%) and decisions by doctors (2.8%) received the lowest selections. Here, correlation analyses revealed influences of age referring to the selection of "myself" ($r = .222$; $p < .01$) and my "relatives" ($r = -.129$; $p < .01$) are allowed to decide: the results indicate that older adults were more inclined to decide "themselves" and expressed more strongly not to want their "relatives" to decide compared to younger participants.

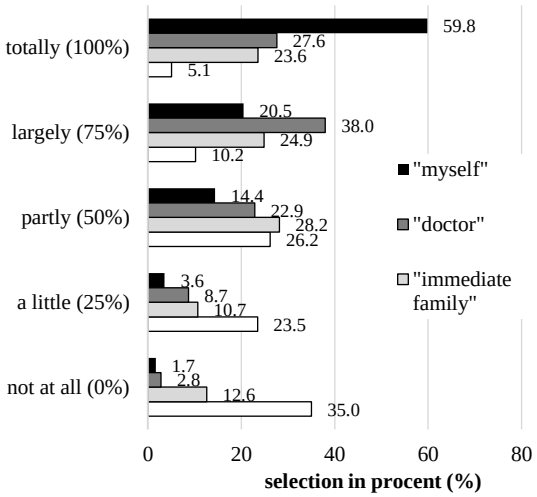

Figure 4: Participants' selections (n = 573) who is allowed to decide (and to what extent) in severe health situations.

4.2.4 Do's and Don't's of Lifelogging?

Figures 5 and 6 show the results of the participants' evaluation of allowed and not allowed functions of lifelogging technologies (study 2).

As shown in Figure 5, lifelogging and monitoring technologies are highly desired to be used for functions of reminding (M = 5.3; SD = 0.8) or supporting in everyday life (M = 5.0; SD = 0.9). Functions like recognition of languages and gestures (M = 4.8; SD = 1.1), fingerprints (M = 4.7; SD = 1.3), medical monitoring (M = 4.6; SD = 1.2), and storage of data (M = 4.4; SD = 1.3) were also allowed. In contrast, there

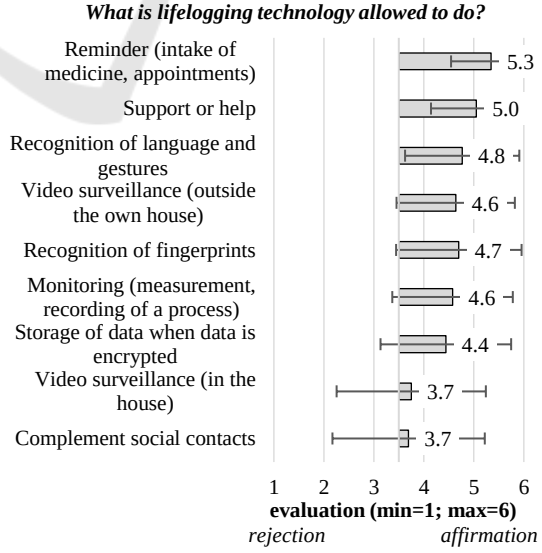

Figure 5: Evaluation of allowed functions of lifelogging technologies.

was no clear agreement to use technology to complement social contact (neutral evaluations: M = 3.7; SD = 1.5). Referring to the usage of video cameras, a clear distinction between outdoor and indoor usage was striking: while it was accepted outdoor (M = 4.6; SD = 1.2), video cameras were clearly not wanted to be used inside the own house (M = 3.7; SD = 1.5).

Referring to the functions the participants want lifelogging technologies *not* to do, also a diverse evaluation pattern was striking (Figure 6). High agreements of the participants show that they clearly do not want to be dependent on a technology (M = 5.0; SD = 1.2). Further, they do not want lifelogging technologies to make decisions independently (M = 4.9; SD = 1.4). The evaluations show that – not surprisingly - the technology should not fail (M = 4.8; SD = 1.5), should not restrict the freedom of choice (M = 4.6; SD = 1.7), nor taking over too much tasks (M = 4.3; SD = 1.5) or substitute social contacts (M = 4.4; SD = 1.7). Recording audio and video material (M = 3.7; SD = 1.5) was slightly confirmed to be not allowed by the technology.

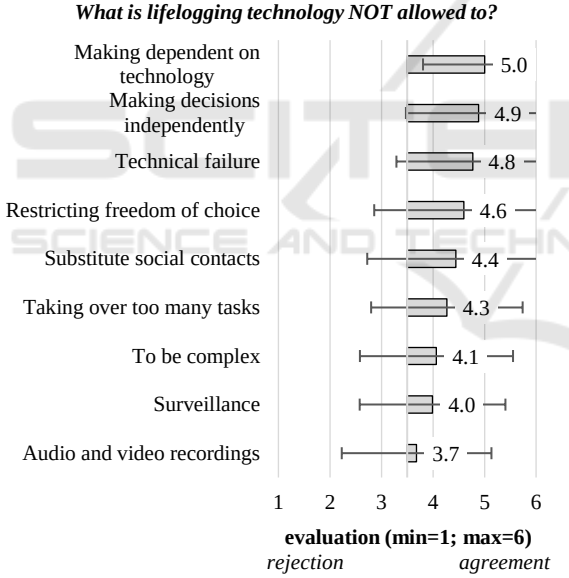

Figure 6: Evaluation of NOT allowed functions of lifelogging technologies.

Both ethical assessments of allowed and not allowed technological functions were analyzed for influences of user diversity using correlation analyses. Neither age, gender, suffering from a chronic illness, nor care experience were related with the overall evaluation of allowed and not allowed functions.

4.2.5 What about Life-end-decisions?

The probably most critical aspects within an ethical perspective on technology use in health contexts meet life-end-decisions. As optional questions, participants were asked for their evaluation of technology use in severe heath situations. In study 4, the question "Is technology allowed to prolong life?" was confirmed by 75.5% of the participants, while 24.5% of the participants denied this question. Instead, the complementing optional question "Is technology allowed to delay death?" was affirmed by only 42.7% of the participants, while 57.3% denied this question.

The second study confirmed these results by evaluations of two similar and one additional statement (Figure 7). Here, the participants showed a slight agreement referring the item "technology is allowed to prolong life" (M = 4.1; SD = 1.3; min = 1; max = 6) and a slight rejection of "technology is allowed to delay death"(M = 3.0; SD = 1.5; min = 1; max = 6). In addition, the item "technology is allowed to decide between life and death" (M = 1.8; SD = 1.1; min = 1; max = 6) was clearly rejected by the participants.

Both studies were analyzed for influences of user diversity on the evaluations. Yet, neither gender, suffering from a chronic illness, nor care experience influenced these results. In contrast, correlations with age were observable for both studies. In study 2 (r = -.220, p < .01) and study 4 (r = -.140; p < .01), older participants tend to reject that technology is allowed to prolong life stronger than younger participants. In line with this, older participants also denied more strongly than younger participants that technology is allowed to delay death (study 2: r = -.222; p < .01 ; study 4: r = -.219; p < .01). Consequently, younger people have less concerns about technology influencing the end of life than older people.

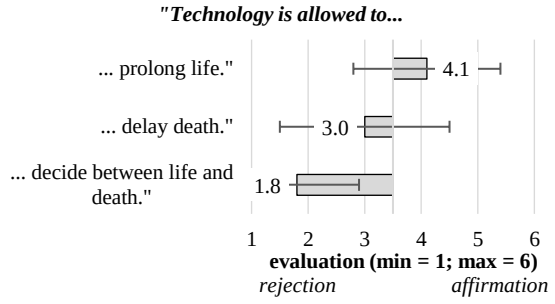

Figure 7: Evaluation of life-end-decisions and technology usage (n = 195).

5 DISCUSSION & GUIDELINES

This article provides empirical insights into socially and ethically relevant user requirements for development and usage of lifelogging technologies. In addition to conventional, normative (technical, legal, and ethical) considerations for lifelogging technology development, distinct agreements and rejections of ethically relevant user requirements within our study confirm the importance of empirical ethical and social considerations. Otherwise, technically, legally, and normatively harmonized lifelogging solutions will lack social acceptance and will not have viable societal impact. In the following, the research results are first discussed within the research field of lifelogging technology perception. Afterwards, guidelines are derived from the research findings (Table 1) and gaps for future research are highlighted.

5.1 Socio-ethical Insights

In particular, the results referring to socially relevant aspects revealed insights comparable to previous research in the field. In line with the results of the current study, perceived benefits and barriers have already been proven as relevant factors for lifelogging technology acceptance (Jaschinski and Allouch, 2015; Peek et al., 2014). In more detail, the current study confirmed that acceptance depends on the application contexts (van Heek et al., 2016) and also on the respective target group (van Heek et al., 2017a). In line with previous research (Himmel and Ziefle, 2016), the study also showed that acceptance depends on the type of technology: e.g., video cameras are not desired to be used compared to other technologies. Here, it has to be investigated if this pattern changes for different privacy-aware camera systems.

Compared to the socially gained insights, the studies revealed new and specific results referring to ethically relevant requirements. As an example, Wolf et al. (2014) have emphasized data security and privacy as most relevant ethical issues. However, specific insights in users' perception of ethically relevant data security and privacy parameters as well as concrete knowledge about ethically accepted or rejected technologies, functions, and recorded information have not yet appeared. The current study showed which information have been seen critically by participants, how processing of data should be handled, and who is allowed to have access to data. Existing ethical frameworks (e.g., Kelly et al., 2013) are mainly based on normative investigations for a single technology – here wearable cameras – and include politically and legally relevant aspects, e.g., data storage should be "according to national data protection regulations" (p. 318). In contrast, our findings give detailed insights into future users' wishes, needs, and requirements regarding lifelogging technology use in different situations. These insights are used to derive guidelines to integrate socially and ethically relevant user requirements into the development of a broad spectrum of lifelogging technology and for diverse stakeholders.

5.2 Lifelogging Technology Guidelines

Guidelines were derived from the studies' findings and are detailed in Table 1. Overall, guidelines were developed for three areas: design of lifelogging technology, data requirements, and information and communication of lifelogging technology.

A participatory technology "design" is required, integrating users from initial development phases instead of users' evaluations of final products. Thereby, it should focus on decision-making power, specific technology characteristics, interaction with the technology, and transparency of the design.

As data security and privacy represent the most crucial barriers of technology adoption, in the area of "data requirements" well-defined and transparent regulations of data handling are essential. In particular, accepted and rejected data types as well as ways of data processing should be considered.

Finally, it is of utmost importance to provide users with open, transparent, and comprehensible "information and communication". Thereby, technology development should consider which information future users need, how accessible information can be provided, and how technology should be communicated to respective stakeholders.

5.3 Gaps for Future Research

Research on lifelogging perception has mainly focused on isolated evaluations of benefits and barriers of using specific technologies. Hence, there is currently hardly any knowledge about relationships and trade-offs between beneficial and impeding factors answering which aspect is more important in decisions on using lifelogging technologies.

A further aspect refers to the majority of existing studies focusing on country-specific evaluations of lifelogging technologies. As previous research did hardly investigate lifelogging perception internationally and cross-culturally, future studies should focus on direct comparisons of lifelogging perceptions and relevant ethical issues depending on different countries, their cultures, and backgrounds.

In addition, future investigations should focus on

Table 1: Guidelines for lifelogging technology development.

	Guidelines:
Design	**participatory design** integrating users iteratively from initial phases
Decision making power	– users want to decide themselves: keep the user in control – technology should not patronize and decide for users – self-determined data sharing policy: sharing of data should be under control of users
Technology characteristics	– optimum: technology profiles with different integrated levels of privacy preservation: should be predefined but individually adaptable (ideal for diverse applications contexts and stakeholders) – possibility of system deactivation: users should be in control of system's operation (e.g., emergency switch)
Interaction	– keep technologies easy to handle, as easy to learn as possible, as complex as necessary – prevent feelings of heteronomy by well-defined and transparent data handling regulations – design technologies that can be integrated in or combined with (well-known) existing systems (e.g., in care institutions, smart home systems)
Transparency	– enable a transparent overview of functions and performable actions – ask beforehand if a specific action should be performed (depending on context, if possible) – give feedback when a specific action is performed (e.g., transfer of data, activation of alarms or cameras)
Data Requirements	**well-defined and transparent regulations of data handling are needed**
Type of data	– first, focus on safety-relevant functions: emergency detection and calls, monitoring of health parameters – use highly aggregated data (e.g., binary room presence data instead of full sensor data) – prevent a permanent recording of video- or audio-based data; if necessary, enable situational, authorized, and temporally limited recordings
Data processing	– prevent permanent storage, only temporally limited use (as shortly as useful possible; as long as necessary) – enabling authorized and authenticated access to data which can be managed by the user
Information & Communication	providing **open, transparent, and comprehensible information**
What?	– users have to be informed about: **which** data are logged? **where** are data logged? **who** has access to data? **how long** is data stored? **why** is data stored?
How?	– providing **accessible information** (not too much, essential information first; detailed information on request; "speak the user's language") – give the possibility to "turn off" the personal information gathering **at any time**
Communication Strategies	– **promote benefits** of technologies and **explain handling of potential barriers** (e.g., data security) – **short and comprehensible explanation** of technology usage and system functioning – **promote self-determined decisions** of technology handling (e.g., data access) – **clearly explain relationships between perceived barriers** and **benefits** (e.g., longer data storage enables deeper analyses of health development, changes in movements or behaviors) – **context-** and **stakeholder-tailored communication** as technologies and their benefits and barriers are perceived differently depending on diverse contexts and user groups: – **sports:** communicate data handling policy to prevent feeling of being controlled – **medical home:** consultation and recommendations by doctors can facilitate technology adoption (as doctors are perceived as accepted and trustworthy) – **medical home and professional care:** promote that technology usage aims for relief, support in everyday life, and autonomy enhancement; make clear that technology is *no substitute* for human attention and care personnel – **age of users:** for younger users explaining handling of data- and privacy-related issues should be focused; for older users potential benefits should be focused in communication – **health status:** potential benefits of increased safety should be focused for people with chronic illnesses; clarifying the benefits of the technology for non-affected people by enabling them to empathize with living with chronic illnesses

further user diversity factors impacting lifelogging perception and ethically relevant parameters (e.g., attitudes towards aging and care, privacy needs). As there is also hardly any cross-cultural knowledge about attitudinal characteristics (e.g., attitudes towards aging) and their relationships with (ethical) lifelogging perceptions, future studies should also aim for cross-national comparisons in this regard.

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