From Living Space to Urban Quarter: Acceptance of ICT Monitoring Solutions in an Ageing Society

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Abstract. The question of designing safe, secure, and human-centered urban living environments is complex, as different and controversial needs from different sources have to be harmonized. The ongoing demographic change with more and more older and frail persons living in urban environments raise the question how modern technologies in the information and communication sector can be seamlessly integrated in specific urban spaces. Not only (medical) safety and data security issues need to be considered but also technology acceptance and the fragile trade-off between the ubiquity of technologies on the one and the perceived trust in and reliability of technologies on the other hand are of pivotal importance. To understand users' willingness to accept monitoring technologies in different locations (ranging from home to public spaces) we pursued an exploratory approach. 127 participants in a wide age range volunteered to take part in the questionnaire study. Results show that individuals independently of age and gender are quite reluctant to accept such technologies in general, even for medical reasons. It was ascertained that acceptance was impacted by the type of technology and the space (domestic vs. public) and the health status of the people.

Keywords: Technology Acceptance, ICT Health Monitoring, Living Spaces, Urban Quarter, User Diversity.

1   Introduction

As a matter of fact the demographic change in most (western) societies raises considerable challenges for urban environments with respect to providing humane and human-centered living conditions. Characteristically, the requirements for designing safe, secure, and human-centered urban living environments are highly complex. Different and sometimes controversial needs have to be taken into account. These requirements include the harmonization of mobility aspects, the integration of safety and security of (medical) technologies in the context of treatment and care up giving sensitive consideration to the perceived intimacy, privacy and data security issues as well as individuals' fears of losing control. In addition, as communities might differ regarding their economic wealth, also cost burden need to be respected. Politics and communities take up the challenge and put effort into expanding conventional and well-established solutions by investing in retirement homes and the education of

elderly care nurses [1]. For the next half of the decade all efforts cannot provide suitable solutions to the challenge of a numeral increase in older and care-needing persons in contrast to the continuous decrease in younger and potential caring people [2]. While some age-induced issues like dementia or wound treatment require personal assistance, a great number of older adults endangered by sudden breakdowns [3] are at risk because they live alone and might not be found in case of emergency [4]. In these cases different surveillance technologies could provide possible solutions, but acceptance of these technologies, if researched at all, is desperately low.

While there is only restricted knowledge about the acceptance of integrated information and communication technology (ICT) in domestic spaces [5],[6], it is well known that public surveillance (CCTV) is controversially discussed especially because of peoples' fear of data privacy violation and the loss of control over the protection of intimacy [7],[8]. Also, it was found that acceptance for technology differs depending on nationality [9] and culture [10].

So far, research does not sufficiently address the role of context factors that might have a considerable impact on the extent to which persons would be willing to use surveillance technologies in urban and private spaces.

2   Research Aims

The willingness of citizens to accept technologies in domestic and urban environments is a highly complex and also fragile phenomenon, which is impacted by a multitude of environmental, spatial, and individual factors, driven by personal needs and using motives. In order to gain a first insight into this complex interaction system, we pursued an exploratory approach in which we selected the monitoring technology type (camera, microphone and positioning system) within the context of medical monitoring. As technology acceptance for or against the medical monitoring is considerably influenced by the specifics of the location or space in which such technologies would be installed, we also varied different spaces, ranging from home (sleeping and living room, garden) to public spaces (park, station, shopping mall). Understanding the trade-off between the perceived usefulness of technologies in the different locations/spaces and the extent of wished control [11] and need of privacy [12], participants had to evaluate the extent of willingness to use the technical systems in the different locations.

3   Methodology

In this section we describe the procedure of the questionnaire study, the variables and the sample.

3.1   Questionnaire Study

To reach a broad user group, we applied the questionnaire technique, addressing users of different health states, ages and gender. The survey was broadcasted online via the

authors' private networks. The questionnaire was designed to obtain information about (1) demographic data (age, gender, health status) and (2) individual living conditions (rural vs. urban districts, alone vs. family, distance to medical care).

The health condition of the participants was determined by four questions regarding chronic diseases, regularly check-ups, dependency on medical technologies and health care. People negating all questions were defined as healthy, whereas people agreeing to one or more of these questions were defined as ill. Then, participants had to evaluate the extent of acceptance. (3) Different integrated surveillance technologies (microphone, camera, positioning system) were to be evaluated in (4) various domestic private spaces (living room, bedroom, garden) as well as in public, urban spaces (local bar, city council, park, train station, museum, church, bus stop). In order to classify the different locations, living spaces were split in three dimensions: private vs. public, intimate vs. distant, and indoor vs. outdoor (see fig.1).
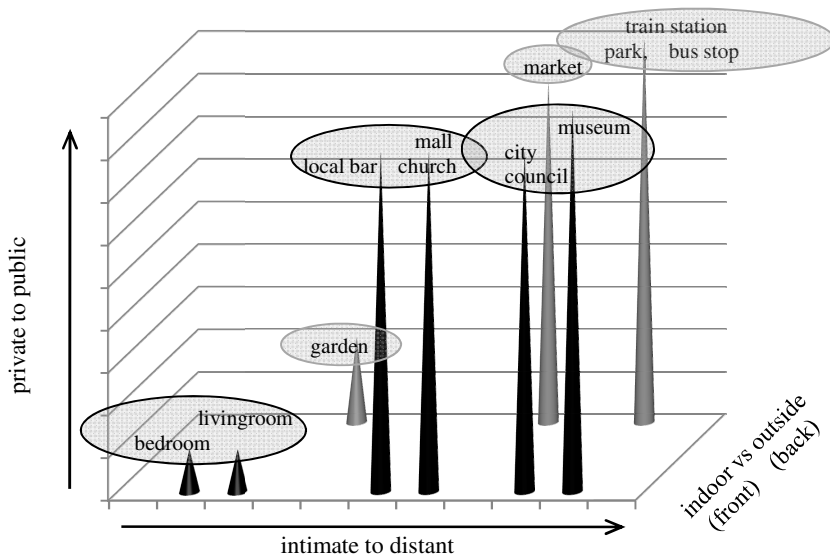

Fig. 1. Classifying regarded spaces in three dimensions

The participants had to judge their willingness to integrate each technology (three) in each space (twelve) on a six point Likert scale (never, no, rather no, rather yes, yes, always).

3.2   Participants

127 participants, aged 19 to 74 years, took part in this study (M=37.8, SD=17.9). 41% of the sample was female, 59% male. To investigate if technology acceptance differs depending on age and technology generation, the sample was split in age groups referring to three different technology generations: The young group was aged between 19 and 28 years, mainly university students (40%, M=22.8 SD=2.6, 49% female/ 51%

male), the middle-aged working generation between 29 and 59 years (30%, M=38.2, SD=9.4, 26% female/ 74% male), and the older adults between 60 and 74 years (30%, M=65.9, SD=4,3, 44% female/ 56% male).   The overall educational level (40% university entrance diploma, 47% university degree) lay high above average. 70% of the participants were classified as healthy (see 3.1).

4   Results

In a first exploratory research step we correlated the demographic variables with the acceptance items in order to identify the influence of the regarded user demographics on the acceptance. To get a deeper insight in the acceptance of monitoring for each living space and each technology we followed a two-way deductive approach. We first analyzed the general acceptance of our three chosen surveillance technologies (microphone, camera, positioning system) by summing up the acceptance ratings of this technology in all spaces and then checked for significant effects of user diversity (age, gender, health condition) (see 3.1). Then we analyzed the general acceptance of surveillance in all different living and urban spaces (see 3.2). Due to space limitations only the general acceptance of each technology in each space will be dealt with here. Finally, we focused on the most significant correlations by analyzing how the acceptance of camera surveillance in all spaces is affected by the health condition of the user (see 3.3). Q-Q plots and boxplots indicated that all our scales and items were normally distributed. Data were statistically analyzed by MANOVA procedures and ANOVAs. Significance level was set at 5%.

4.1   Acceptance of Surveillance Technologies: Overall Technology Acceptance

If summarizing the different locations and spaces under study, we find a low acceptance of all regarded technologies (camera, microphone, positioning) with no significant differences between them (see fig. 2).
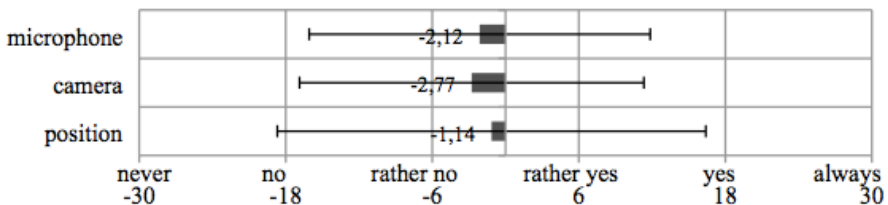

Fig. 2. Mean acceptance ratings and SD for different technology types

Obviously, participants were quite negative about the fact of being monitored at all and no technology was generally accepted, with the lowest levels of acceptance for the camera, followed by the microphone and the positioning system.

Age effects on Technology acceptance. When bringing the age groups into focus, one could see the tendencies of age influencing acceptance differing for each type of technology (see fig. 3). The acceptance of integrated microphones for health reasons marginally increased with age whereas cameras are least accepted by old people, also compared to all other technologies. Camera and positioning system are both most accepted by the middle-aged group. The smallest differences in acceptance were seen with the positioning system showing immunity against the influence of user demographics, which also was a key result in previous research [6]. Though, it should be noted that differences did not reach statistical significance corroborating that age is not driving acceptance: Rather the reluctance of people towards accepting monitoring systems in the medical context is high in all age groups.
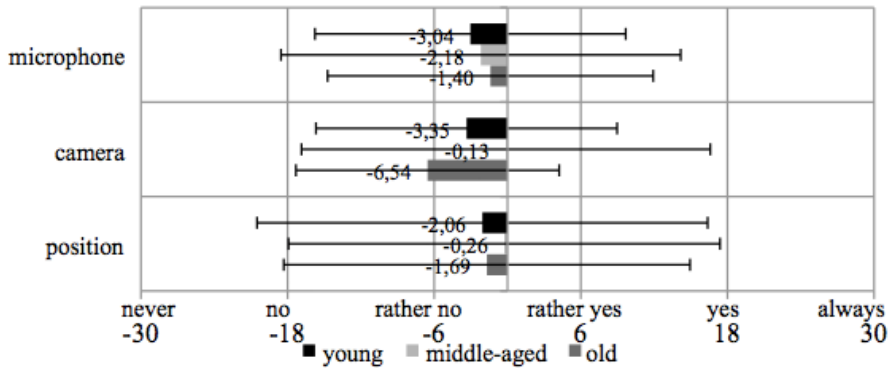

Fig. 3. Mean acceptance with SD by technologies, split by age

Gender effects on Technology acceptance. Different from other studies in which gender did impact the technical self-confidence [13] or interest in specific technologies [14], no significant gender effect could be detected for the acceptance of different technologies for health surveillance purposes (fig. 4).
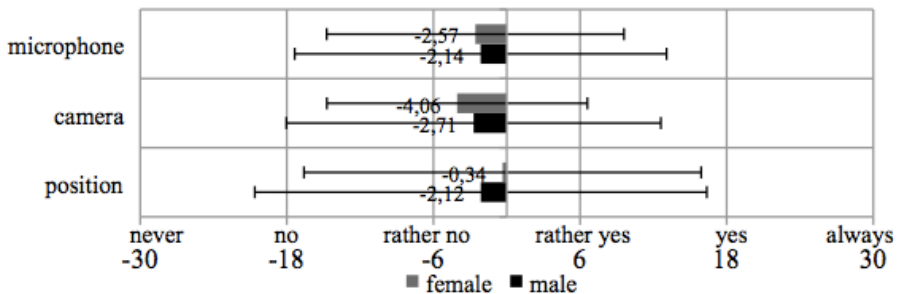

Fig. 4. Mean acceptance with SD by technologies, split by gender

Health condition effects on Technology acceptance. Significant health-effects were revealed for microphone (F(1,122)=4.24; p<0.05) and camera (F(1,122)=4.76; p<0.05) surveillance acceptance. Also, the positioning system showed similar but not significant tendencies. Ill people conveyed lower acceptance for health surveillance technologies (see fig. 5).
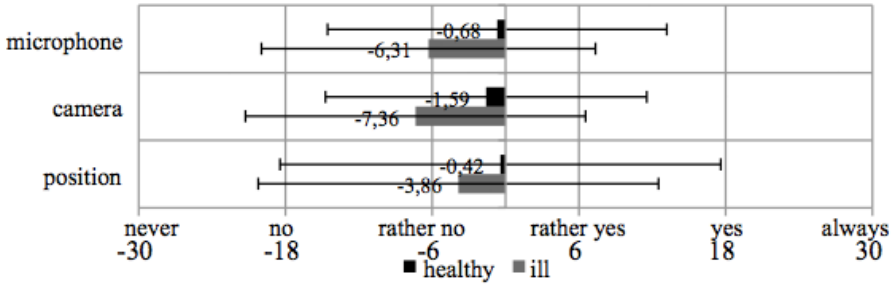

Fig. 5. Mean acceptance with SD by technologies, health-effect

4.2   Acceptance of All Surveillance Technologies in Different Spaces

Breaking down the summarized (general) acceptance of the three technologies into all twelve researched spaces indicated their reciprocal interaction. The consideration of different dimensions for the regarded spaces (see fig.1), seems to depend on the type of technology and needs further research. All data for the whole sample, not considering user diversity, did not show statistical significant effects. The following results are visualized (see fig.6) and discussed descriptively.

For *camera* surveillance the lowest acceptance was recognized when entering private space (living-, bedroom, garden), decreasing from intimate to more distant spaces. This decrease was not transferable to public spaces, where there were no significant differences for private and distant spaces. However, the descriptive data shows positive tendencies for accepting camera surveillance at the train station and bus stop. Regarding all public spaces, a decreasing acceptance of cameras could actually be recognized from indoor to outdoor spaces. The museum as the most accepted place for surveillance plays a particular role – a possible effect might be the acceptance of anti-theft devices. The acceptance of *auditory* surveillance increased from indoor to outdoor spaces, not differing between private vs. public using contexts nor showing different evaluations regarding intimate vs. distant spaces. Microphones' usefulness for surveillance in outdoor spaces could have been regarded as poor for health reasons.

The *positioning system* seems to be independently accepted for all spaces – with exception of the museum, which breaks ranks shouting for further research. It is maybe affected by acceptance of anti-theft motion detecting, whose functionality basically is one kind of positioning system. This result also verifies former research.
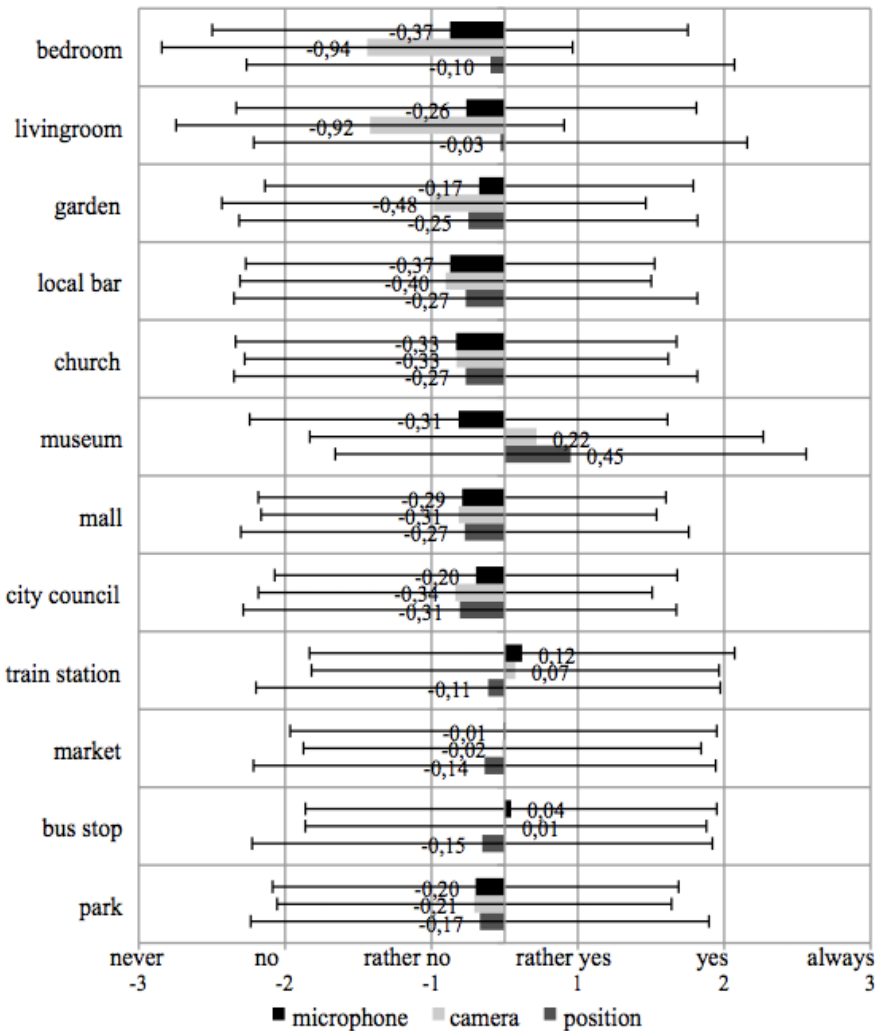
Fig. 6. Mean acceptance with SD by technologies and spaces

4.3   Acceptance of Camera Surveillance and Effects of Health Status

The explorative research approach using correlation analysis indicated the most significant effects on acceptance regarding the camera technology for each space (dependent variables) and the attribute of being healthy or ill (independent variable). Age and gender did not show any significant correlation effects on acceptance.

The acceptance patterns for healthy people can be orientated on the general acceptance results for camera (compare fig.6 with fig. 7)).
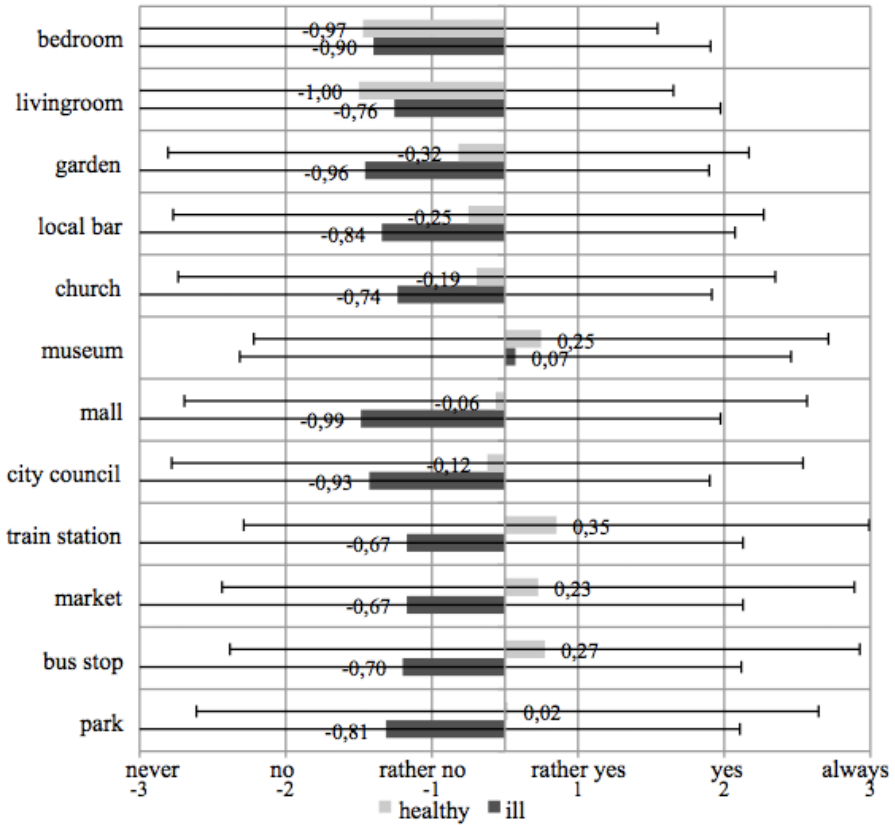
Fig. 7. Mean acceptance with SD of camera surveillance in different spaces, health effect

Ill and frail persons show a significantly lower acceptance for camera surveillance except in private indoor spaces (living- and bedroom, in which both groups do not accept cameras) and the exceptional museum (where both groups would accept cameras, if at all). The camera in garden $(F(1,121)=5.08;\ p<0.05)$, local bar $(F(1,121)=8.8;\ p<0.05)$ and church (just failed $p<0.05$ significance level) are congruently assessed: No one accepts cameras which is more distinct within ill people. This different acceptance rating grows with changing dimensions (see fig. 1.) from private to public spaces. The distinction in acceptance regarding mall $F(1,120)=21.24;\ p<0.00)$ and city council $(F(1,120)=9.72;\ p<0.00)$ still increases wherever both are still not accepted. Moving on from indoor to outdoor respective from intimate to more distant spaces, the acceptance not only keeps drifting, observing park $F(1,120)=10.26;\ p<0.00)$, market $F(1,121)=20.22;\ p<0.00)$, train station $F=(1,121)=15.11;\ p<0.00)$ and bus stop $F=1,121)=23.7;\ p<0.00)$ – the tendencies even show a turning point for healthy people, who barely could accept these technologies. We therefore can say for the camera as one health monitoring solution and healthy people as regarded user attribute the debated dimensions have a significant influence on acceptance.

5   Discussion and Outlook

In this study we undertook a first exploratory approach regarding the question if and if so persons would accept medical monitoring technologies within urban living environments. The need of understanding individual barriers and perceived benefits of technologies integrated within urban environments is high, especially as increasingly more and older people are living in urban communities, which might be bothered by age-related frailness and which need medical monitoring to maintain mobility and independency at older age.

Summarizing the findings of this exploratory study we see a lot of reluctance to accept medical monitoring in urban environments. Especially the camera is least accepted, followed microphone and positioning systems. Though, acceptance strongly differs depending on the specific location (especially for the camera and the microphone, to a lesser extent for the positioning system). The differentiation between private and public spaces has a strong impact on acceptance, especially for camera surveillance, while the difference between indoor and outdoor spaces plays a minor role.

Referring to well established technology acceptance theories we could replicate the strong effect of technology adaption: surveillance systems for public places (train station, museum), which were first installed ages ago for crime prevention [15], received the highest acceptance. Also, user diversity is a modulating factor of technology acceptance of ubiquitous surveillance technologies. When widening the focus from private living space to public urban quarter, a higher technology acceptance for healthy people was revealed. This might be contra-intuitive on a first sight as healthy persons could see less advantages in health surveillance (technologies) in comparison to ill people, which - according to common preconceptions – are naturally accepting medical technologies, simply because they do not have alternatives [16]. However, the sensitive understanding of illness and age require deeper insights into individual attitudes, wishes, needs, and values. Possibly, ill people could be more sensitive to health monitoring technologies, especially those depending on medical devices, as they might fear stigmatizing and violations of intimacy requirements and data privacy [12]. Future studies will have to find out the reasons of older persons to accept or decline medical surveillance technologies. Still more important we will have to explore possible conditions under which persons would conditionally accept medical technologies implemented within the urban living environment.

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