Information Privacy in Smart Office Environments: A Cross-Cultural Study Analyzing the Willingness of Users to Share Context Information

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Abstract. This paper presents a cross-cultural study analyzing the willingness of users to share context information in work environments. The focus of the study is on three aspects: the general willingness to provide different types of context information, the acceptance of manual and automated data capturing mechanisms and the identification of personal and cultural differences among users. The results of the study show that potential users are rather reluctant to provide context information, especially if the data is automatically captured by the system, and that the willingness to provide context information differs significantly between user groups with different cultural backgrounds and different degrees of computer knowledge.

Keywords: Context-Awareness, Privacy, Ubiquitous Computing, Pervasive Computing, Ambient Intelligence, Evaluation, Technology Acceptance.

1 Introduction

Over the last few years, companies started to show an increased interest in deploying Ambient Intelligence technologies to realize the benefits, offered by location- and context-aware systems (see, e.g., [32], [33] or [33]). In general, such systems enable office workers to communicate, collaborate and work in new and more efficient ways. The theoretical advantages range from increased work productivity through time-saving operations to higher work satisfaction through attentive and reactive environments. Especially the advances in the area of interface technology are expected to lead to considerable benefits. Today, office workers usually work with single user devices, which require manual user input via standardized interfaces. With the emergence of context-aware systems those explicit and static interaction paradigms will be enhanced through new input and output concepts. Sensor-enhanced environments will enable implicit interaction mechanisms, which are unknown in existing work environments with traditional computational devices. By automating routine task and thereby releasing office workers from vacuous work activities, context-aware office environments also bear the potential to increase overall job satisfaction. But in order for these benefits to occur, it is necessary, that the technology is used and also incorporated into the daily routines of employees [28]. Empirical evidence shows, that one of the main reasons for low returns of investment of new technologies is the poor

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usage of the installed applications (see, e.g., [8], [9] or [15]). In the majority of cases, the potential of the implemented applications is not fully realized, due to the reservations of users to fully incorporate the systems into their daily working routines [6].

2 Research Goal

For their operation, context-aware systems rely on appropriate and sufficient information from users. This information may include their location, identity, and usage patterns of systems or services, and it might be collected by explicit and implicit means. Besides general design and usability problems, most problems encountered in existing applications are associated with a new quality of data collection, that goes far beyond the capabilities of existing computational systems. The two most important differences in this context are the always-on nature of the devices and the invisibility of the technology. With traditional computers, the duration of data collection and potential surveillance is clearly limited to the time, a person uses the system. But in context-aware environments this clear distinction between 'online' and 'offline' might not longer be possible. At the same time the integration of computers into everyday objects is likely to lead to the disappearance of sensory borders, and thereby could make common principles of privacy protection useless [23].

In order to be able to design trusted systems, it is important to be aware of the concerns and perceived threats of potential end users regarding the collection of context information. Therefore, the goal of this paper is to identify the willingness of users to provide different types of context information as well as the preferred level of control over the employed capturing mechanisms, which are necessary to provide context-adapted services. In addition, the paper aims to explore the existence of inter-personal and inter-cultural differences among different groups of users. Technology diffusion studies conducted in the past suggest that there are significant inter-personal differences in the adoption process of new technologies (see, e.g., [2] for a comprehensive study on how individual differences affect usage). Especially when designing context-aware work spaces, it is essential to support a very heterogeneous group of users, as the developed devices will be available throughout a shared environment and are used by multiple users. While there are various individual difference that are likely to play a role in the adoption process, in particular cultural differences are becoming increasingly important, as more and more people are working in multi-national corporations or are collaborating in distributed teams with colleagues all over the world. Therefore, this paper will have a special focus on the identification of cultural differences, which influence the willingness of users to provide context information as well as the preferred level of control over the associated data capturing mechanisms.

3 Conceptual Approach

As explained above, it is expected that the users' willingness to provide context information depends on (at least) three aspects: the type of information that is being collected, the way the data capturing mechanisms are implemented, and the personal and cultural background of the user. Prior to the evaluation, all three factors were carefully examined. The insights gained in this process are briefly illustrated in the next sections.

3.1 Identification of Relevant Information Types

In a first step, existing application scenarios and prototype applications were analyzed in order to identify representative functionalities of state-of-the-art systems (see [31] for more details on the survey). This information was then used to distil the overall information requirements of context-aware office applications based on generic information types. The analysis revealed, that several types of information are necessary in order to provide state-of-the-art functionalities. These types include data about the identity of users, their location and activity, availability information, biometric information, personal preferences as well as information about planned activities in the future (see Tab. 1).

Table 1. Overview over typical information required by the majority of context-aware office applications

Type	Description
Identity Information	The identification of a specific user represents the initial step for all personalized services. From a technical point of view it is not necessary that users reveal their 'real' identity. Instead, pseudonyms can be used for the identification process and personal information can be stored in anonymous profiles.
Location Information	Of all context information, which is available in real-world environments, the users' location is still the information type most often used in context-aware applications. The majority of systems uses RFID technology as a low-cost solution to simultaneously capture location and identity information.
Activity Information	Activity information can be either data about past and current tasks or long-term activities, usually referring to specific projects or responsibilities within the company. Some applications also include up-to-date information about the current work status or progress of specific tasks.
Availability Information	Making assertions about the availability of a certain person usually requires the combination of different types of information. In workplace environments, for example, availability information could be derived by interrelating information about the presence of a user and his current activity.
Biometric Information	In general, biometric information includes a variety of different data types. Regarding the functionalities described in the scenario elements, biometric information was mostly reduced to data about the current mood or stress level of a user.
Personal Preferences	In the context of smart office environments, personal preferences incorporate different types of information from various areas of everyday life. Personal preferences range from very private information, which is usually not available to co-workers (like, e.g., personal interest) to shared workplace information, which could be easily perceived by most colleagues in a shared work environment (for example the preferred room temperature or lightning).
Agenda Information	Information gained from personal calendars, agendas or task lists are necessary to predict up-coming activities and events. In addition, knowledge about existing personal appointments is necessary to enable automatic meeting planning among multiple users.

3.2 Data Capturing Mechanisms

When looking at context-aware services, it becomes obvious, that designers have different views about the level of control, which users should have over these services. Although the degree of system support could be adapted in numerous steps, it seems useful to distinguish between three general approaches: autonomous, user-approved and user-controlled services. Table 2 briefly describes the different concepts.

Table 2. Different levels of control over context-aware services

Control	Description
Autonomous Action	Autonomous services provide the lowest degree of user control. Processes are fully automated and users do not have a chance to control (e.g., acknowledge or reject) the functionality that is provided. In most cases, the service is automatically provided as soon as the user is identified by the system or a special event occurs (e.g., a user reaches a specific location).
User-Approved Action	Unlike autonomous services, user-approved services are not providing any functionality, unless the user approves it. Instead, the system fulfills an auxiliary role and acts in form of a digital assistant, which offers functionalities that might be helpful for the user in his current situation.
User-Controlled Action	In user-controlled services users maintain the full control over the service and can decide when and where a certain service is provided. In contrast to functionalities, provided by traditional computer systems, the provided services are mostly personalized and adapted to the current context of the user.

Similar to personalized user services, the collection of context information allows considerable variability in its degree of automation. While fully automated capturing mechanisms seem to be preferable at first sight, several studies, e.g., [34] showed, that users often feel uneasy if they are not in control over the data collection process. Therefore, it is important to test the users' willingness to provide personal information with respect to different data capturing mechanisms. The previous distinction between autonomous, user-approved and user-controlled services proved to be useful for the majority of 'high-level' services, where users gain concrete benefits from the usage of a certain application or system. With regard to the collection of context information, a distinction between user-approved and user-controlled mechanisms is not required as no direct service is provided to the user. For the purpose of the user study only two possible ways for the collection of context information are considered:

- **Automated Capturing:** The required information is continuously collected by the system. While there is not effort required from the user, the control over when and where personal data is being captured is very limited.
- **Individual Control:** The information being provided to the system can be individually controlled by the user. While this increases in the degree of control over the flow of personal data, it requires continuous effort from the user.

As the acceptance of the different data collection mechanisms is expected to depend on the type of information that is being collected, the preferred level of control over the data collection process is individually tested for each information type.

3.3 Inter-personal and Inter-cultural Differences

As stated earlier, the users' personal and cultural background is the third factor, which is expected to influence the willingness to provide individual context information. Prior to the investigation of potential correlations, existing technology adoption studies were reviewed to identify relevant personal characteristics. The following sections briefly discuss the different characteristics, which showed significant differences in previous evaluations and which will therefore be addressed in the user study.

Gender. Several studies explored the effect of gender on the adoption of different technologies and found significant differences between men and women. For example, Gefen and Straub [17] studied gender differences in the perception and use of e-mail and found, that gender had a significant impact on the perceived ease of use and usefulness. Studying technology usage decisions, Venkatesh and Morris [37] found, that the decision of women to use a specific technology is mostly influenced by the perceived ease of use, while those of men were strongly influenced by their perceptions of usefulness.

Age. The implementation of new technologies in workspaces is often accompanied by a change in existing work practices [30]. Over the last decades, a variety of studies found substantial evidence, which indicates that older workers tend to resist technological changes and avoid adopting new technologies [10]. There exist several attempts to explain, why age negatively affects technology adoption. One possible explanation is computer knowledge, which many older workers lack in comparison with their younger colleagues (see, e.g., [2]). So, even if older employees might be willing to adopt new technologies, they are likely to find it more difficult to actually use these technologies [18]. This might be supported by the fact, that cognitive skills decrease as people get older [7]. Another fact, that might contribute are personal habits and routines, which become stronger in age, and are therefore more difficult to change [20]. Nevertheless, there are also some studies, which found a positive correlation between age and adoption behavior. For example, Rai and Howard [29] studied the adoption of computer-aided software engineering tools and found, that age is positively related with adoption. One possible explanation is, that older professionals with more years of experience are more likely to perceive the benefits of new technologies [28].

Computer Literacy. Empirical evidence suggests, that there is a positive correlation between computer literacy and computer usage for traditional computer systems. For example, Alshare et al. [3] found, that computer literacy is a significant factor affecting the usage of computers by students. Based on this observation they conclude, that once users become more computer literate, they tend to develop a positive attitude and perceive computers as helpful tools, which are easy to use. The same behavior is likely to be true for context-aware systems, and users with more knowledge about computers and technology in general are more likely to adopt the new functionalities. But computer literacy in general is hard to quantify, and a variety of

different definitions and measurements have been used in the past. Following the approach of Alshare et al. [3], two different measures for computer literacy are used in this paper: the duration of computer usage per day and the participants' individual assessment of their personal computer knowledge.

Educational Level. Similar to computer literacy, several studies (see, e.g., [35]) suggest, that the education of a user is positively related to the adoption of new technologies. Burton-Jones and Hubona [10] investigated the adoption behavior of new e-mail and word processing applications and found, that the educational level directly effects the usage of the application. Again, there are several theories to explain this correlation. In general, a higher educational level is likely to reduce anxiety [22], and at the same time enables users to better judge the benefits of new technologies [2]. In addition, the educational level of users generally reflects their internal capabilities, such as technical skills and intelligence [25], which in turn enables more effective learning [4].

Nationality. As culture has a significant impact on organizational theories (see, e.g., [21]), Mao and Palvia [24] argue, that it would be erroneous to assume that new technologies are accepted equally well in different cultural settings. One recent example for cultural differences in adoption process of new technologies are mobile internet applications. For example in Japan, the i-mode system attracted more than ten thousand new customers per day, after it was introduced in 2001 [26]. In June 2002, the system was launched in Taiwan, and by May 2003 more than 900.000 users subscribed to the service [5]. In contrast, most mobile phone customers in Europe and the US are still not using the technology, although mobile internet applications have been introduced several years ago and are widely available today. And also regarding the protection of personal data, inter-cultural differences seem to exist. For example, Cvrcek et al. [14] found that Greek participants rated location privacy significantly higher than participants from other European countries.

Other Factors. Besides the individual user differences illustrated above, there are several other factors that might have an influence on the willingness to provide information and the acceptance of the different capturing mechanisms. Especially in group situations, the relation to colleagues as well as the general trust towards the company might have considerable effects on both aspects. A variety of studies (see, e.g., [12] or [13]) showed, that the climate within a company and its corporate culture can significantly effect organizational innovations. Although these factors are important, they are rather difficult to incorporate in a user study, as objective and reliable measures are very difficult to determine. Therefore, these factors will not be evaluated in the context of this paper.

4 Evaluation

4.1 Evaluation Scenario

As illustrated above, the this paper aims to analyze the general willingness of users to share context information in technology-enhanced work environments, in order to identify essential user requirements regarding the design of future office systems. In

the past, the majority of evaluations concentrated on individual services and specific system prototypes. Consequently, the insights gained in these evaluations, are mostly application and technology specific, and therefore have only limited validity when it comes to the design of new applications. Generalizing the findings obtained in these evaluations might result in misleading conclusion. For example, the rejection of personalized and context-adapted information presentation in multi-user applications does not necessarily mean, that such services would not be appreciated by the same group of users in an individual work situation. So while it is of particular importance to abstract from specific technologies and concrete or singular application situations, experiences in the past also showed, that individuals tend to overrate their privacy sensitiveness if questions are posed out of the context of a specific application or service (see, e.g., [11], [19] or [36]).

To counteract the apparent dichotomy [1] between privacy attitudes and actual behavior, without neglecting the overall research goal, a scenario-based evaluation approach was chosen. Instead of evaluating a particular prototype, a group of systematically constructed scenario elements was used for the study. This enabled participants to assess generic functionalities of context-aware applications, independent from the underlying technologies, interfaces and visualizations techniques, and guaranteed, that the feedback, gained from potential users, is not influenced by the way the functionalities or user services are implemented. At the same time, presenting a descriptive scenario prior to the actual evaluation process assures, that the concerns associated with the collection of personal information and weighted against the potential benefits of context-aware systems.

Before defining the test scenario, existing applications and usage situations were analyzed in order to identify representative functionalities of future office systems. Altogether, N=516 scenario elements coming from 68 different literature sources were examined. In the course of the analysis 39 different types of functionalities were identified, which could be clustered into 6 application areas (see [31] for more details). Looking at the frequency distribution of the different functionalities revealed, that the 8 most implemented functionalities cover approximately 44% of all analyzed scenarios. To ensure that the evaluation scenario remains understandable for a broad user population, it was decided to concentrate on those 8 functionalities and incorporate them into a coherent storyline, describing a working day of two knowledge workers in a technology-enhanced office environment.

4.2 Materials and Methods

The scenario was presented to participants using a questionnaire. In the first part of the questionnaire the evaluation scenario was presented and the different data collection mechanisms were explained. The participants were then asked to assess their willingness to provide different types of information, necessary to provide the functionalities illustrated in the scenario. For each of the seven information types, automated as well as user-controlled capturing mechanisms had to be assessed individually on 10-point rating scales. Prior to the assessment, an example question was shown in order to illustrate how the feedback scales should be used.

4.3 Participants and Evaluation Schedule

In order to identify inter-cultural differences, participants from Germany and the United States were involved in equal parts. For each country, N=100 paper-based questionnaires were personally given out to participants with work experience in office environments. In total, N=161 persons returned their questionnaire, which resembles a return rate of 80,5%. Out of this group, N=95 came from Germany and N=65 from the United States. The overall population (see Table 3) was nearly evenly distributed over male (49,1%) and female participants (50,9%), with slightly more males (52,1%) in Germany and slightly more female participants (55,4%) in the United States. While the American participants were nearly equally dispersed over the three age groups, most of the German participants (42,7%) were between 30 and 39 years old, followed by the group of 40-years-old and older (38,5%). The degree of computer literacy seems to be higher for the American participants, reflected by longer hours of computer usage per day and a higher level of self-assessed computer knowledge. Over 84% of the American participants use computers for more than 3 hours per day, compared to 61,5% of the German participants. Regarding their level of computer knowledge, nearly half of all American participants (49,2%) rate their knowledge as 'excellent', while this is only the case for 11,5% of the German participants. The educational level of the American participants is slightly higher, with 60% of the participants holding a master's or doctoral degree and only 1 participant with a high school degree.

5 Results

5.1 Willingness to Provide Context Information

As explained above, the participants were asked to state their willingness to provide different types of personal information, depending on the level of control they have over the data collection process. A value of '0' on a 10-point scale means, that a participant is absolutely not willing to provide the corresponding information, while a '10' indicates, that he would undoubtedly provide this information. Table 3 gives an overview over the willingness to provide personal information if the data collection process is controlled by the system. The mean values (M) and standard deviations (SD) are separately shown for German and American participants as well as the overall group.

An average overall willingness of M=3,49 shows, that the participants are quite reserved regarding the usage of automated capturing mechanisms. Looking at the national mean values reveals a considerable difference between the German and American group. With an average mean value of M=4,89 the willingness of American participants to provide context information is nearly twice as high as the willingness of German participants (M=2,55). With ratings smaller than 5 for all types of information, there is a tendency of German participants rather not to provide any context information if the data capturing process can not be controlled by the user. Although the willingness of American participants is higher for all information types, only 3 out of 7 ratings are above 5.

Table 3. Willingness to provide personal information if the data collection process is controlled by the system

	Germany		USA		Overall	
Type of Information	**M**	**SD**	**M**	**SD**	**M**	**SD**
1. Identity Information	4,35	3,49	5,61	2,77	4,86	3,27
2. Location Information	2,28	2,65	4,94	3,47	3,35	3,27
3. Activity Information	1,91	2,51	3,95	3,41	2,73	3.07
4. Availability Information	2,95	3,02	5,39	3,21	3,94	3,32
5. Biometric Information	1,24	1,62	3,27	3,29	2,06	2,62
6. Personal Preferences	2,17	2,77	6,36	3,23	3,85	3,60
7. Agenda Information	2,97	2,77	4,68	3,17	3,66	3,05
Average Willingness	**2,55**		**4,89**		**3,49**	

In all three groups biometric information got the lowest rating with a mean value of only M=1,24 in the German sub-group. This is followed by information about the current activity of a user with an overall mean value of M=2,73. The information type, which received the highest rating is identity information. With an overall mean value of M=4,86, the participants are more than two times more willing to provide information about their identity than information about their current physiological state (M=2,06). The ratings of the remaining four information types differ between the German and American sub-groups. While the difference is usually only one rank, there are considerable differences regarding the willingness to provide information about personal preferences. With a mean value of M=6,36 American participants are nearly three times more willing to provide personal preference information than German participants (M=2,17).

Table 4. Willingness to provide personal information if the data collection process is controlled by the user

	Germany		USA		Overall	
Type of Information	**M**	**SD**	**M**	**SD**	**M**	**SD**
1. Identity Information	7,21	2,61	8,14	1,76	7,59	2,34
2. Location Information	6,24	3,36	7,94	1,91	6,93	2,98
3. Activity Information	5,67	3,23	7,30	2,07	6,32	2,92
4. Availability Information	7,08	2,63	8,20	1,97	7,53	2,44
5. Biometric Information	2,47	2,52	4,98	3,65	3,47	3,26
6. Personal Preferences	4,89	3,09	7,70	2,65	6,02	3,22
7. Agenda Information	6,33	2,77	7,80	1,85	6,92	2,54
Average Willingness	**5,70**		**7,44**		**6,40**	

For all three groups the average willingness to provide personal information is higher, when the data collection process can be individually controlled by the user (see Table 4). Similar to the previous situation, biometric information received the lowest rating of all information types with an overall mean value of M=3,47. The participants are most willing to provide information about identity and current availability.

A detailed comparison between automated and user-controlled capturing methods is done in the next section.

5.2 Influence of the Level of Control on the Willingness to Provide Information

An overview over the influence of the level of control on the willingness to provide context information is shown in Table 5. Two-tailed t-tests were computed for all questionnaire items to compare the mean values between the different capturing mechanisms. For each information type, the mean difference (MD) and significance level are presented separately for both sub-groups as well as for the overall group. The p-values were calculated up to three positions after the decimal point, p-values smaller than that are shown as '0,000', which means that the difference is significant on a level smaller than p=0,0005.

Table 5. Overview of the influences of the level of control on the willingness to provide personal information

	Germany		**USA**		**Overall**	
	MD	**Sig.**	**MD**	**Sig.**	**MD**	**Sig.**
1. Identity Information	-2,8589	0,000	-2,5262	0,000	-2,7238	0,000
2. Location Information	-3,9542	0,000	-2,9687	0,000	-3,5600	0,000
3. Activity Information	-3,7573	0,000	-3,3431	0,000	-3,5901	0,000
4. Availability Information	-4,1250	0,000	-2,8108	0,000	-3,5944	0,000
5. Biometric Information	-1,2323	0,000	-1,7516	0,001	-1,4400	0,000
6. Personal Preferences	-2,7229	0,000	-1,3438	0,010	-2,1712	0,000
7. Agenda Information	-3,3594	0,000	-3,1250	0,000	-3,2656	0,000

The results show that the tested data capturing mechanisms have a considerable influence on the participants' willingness to provide context information. For all three groups the level of control has a highly significant effect on all of the seven tested information types. The table also shows that all mean differences are negative, which means, that the rating of the second question, describing individual control mechanisms, is higher for all types of information. The biggest variation in mean differences is observable in the German sub-group, with differences ranging from MD=-1,2323 for biometric information to MD=-4,1250 for availability information.

5.3 Analysis of Individual Differences

The differences regarding the influence of the various personal characteristics on the willingness to provide context information are illustrated in Table 6. The participants'

nationality seems to be the most influencing factor regarding the willingness to provide context information. For all 14 questions there are significant differences (5%-level) between the answers provided by German and American participants. In nearly 80% of the cases the differences are still significant on a 0,1%-level. The participants' self-assessed computer knowledge is another factor that seems to have a relatively strong influence on the willingness to provide context information. Nearly two third of the questions show significant differences between the answers provided by participants with different degrees of computer knowledge. For 8 of the 14 questions the differences are even significant on a 1%-level. The influence of the remaining four factors is considerably lower. With significant differences in the responses of three (age and computer usage per day) respectively four questions (gender and education), only one forth of the questions show significant effect on the willingness to provide context information.

Table 6. Overview over the influences of inter-personal differences on the willingness to provide context information

	Items with p≤0,05		**Items with p≤0,01**		**Items with p≤0,001**	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
Nationality	14	100,0%	12	85,7%	11	78,6%
Gender	4	28,6%	2	14,3%	2	14,3%
Age	3	21,4%	2	14,3%	1	7,1%
Computer Usage per Day	3	21,4%	1	7,1%	0	0,0%
Computer Knowledge	9	64,3%	8	57,1%	2	14,3%
Education	4	28,6%	3	21,4%	2	14,3%

As illustrated above, American participants are generally more willing to provide personal information, independent of the information type and the way the information is collected. One possible explanation for these obvious differences might be the general awareness about the potential consequences of data misuse. Compared to the United States most European countries have strict data protection laws, which prohibit unnecessary collection and storage of personal data. The violation of these laws is mostly accompanied by extensive media coverage, which might increase the valuation of personal information privacy within the German society. In addition, American participants are much more used to the disclosure of personal information in everyday life. For example, personalized bonus or pay back cards have a long tradition in the American consumer world. In Germany such bonus systems are relatively new and the willingness of the consumers, to disclose their personal shopping behavior in order to receive a discount on their purchases, is still quite low. Both aspects might contribute to the apparently higher comfort level of American participants to disclose data about personal interests and habits to co-workers or superiors.

Another explanation might be a confundation of the participants' nationality and their computer literacy. As shown in Table 6, the participants' self-assessed computer knowledge has a rather strong influence in the willingness to provide personal information. Looking back at section 4.3 shows, that nearly half of all American

participants (49,2%) rated their computer knowledge as 'excellent', while this is only the case for 11,5% of the German participants. With a mean value of M=4,22 on a 5-point scale the self-assessed computer knowledge is considerably higher in the American group compared to the German group with an average rating of M=3,15. Hence, it is possible that the large influence of the participant's nationality is not only caused by cultural differences, but also by dissimilarities in the level of computer knowledge between German and American participants.

6 Conclusion and Future Work

The results of the study show that potential users are rather reluctant to provide context information, especially if the data is automatically captured by the system. However, the personalization of context-sensitive applications will always require, that the system is aware of the personal preferences of the individual user as well as the current context in which the service is provided. This discrepancy between technical necessities and user preferences is likely to lead to considerable acceptance problems when installing context-aware systems in work environments.

The study also shows, that there seem to be different requirements regarding the protection of private data between users with different cultural backgrounds. The analysis of inter-personal differences shows, that the willingness to provide personal information differs enormously between German and American participants. In this context, the results of this study are inline with the findings by Cvrcek et al. [14], who found significant differences regarding the valuation of location data among participants from different European countries. In addition, the level of self-assessed computer knowledge has significant influences on at least one third of all questionnaire items. This shows that there are considerable differences regarding the design requirements of context-aware applications between user groups with different cultural backgrounds and different degrees of computer knowledge.

The information types used in this study represent only a very limited selection of information, which is usually available to co-workers in a shared work environment. In order to develop successful applications it is important to know, if general characteristics exist, which determine whether a certain type of information is freely provided or not. The evaluation showed considerable differences among the various types of information. Nevertheless, the data tested in this paper are not sufficient to clearly determine the characteristics, which influence the user's willingness to provide certain types of information. For example, it seems as if users are quite willing to provide information, which is visible to others in shared work environment (e.g., identity information), while information that is usually not visible to others (e.g., the current physiological state), is only reluctantly provided. However, this hypothesis does not hold true for all types of information. For instance, the participants were rather hesitant to provide activity data, even if employees are typically aware of the current activities of their colleagues. Therefore, further studies with additional information types are necessary in order to get a broader data basis, which enables the definition of higher-level design guidelines.

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