Towards a Research Agenda on Cultural Influences on the Acceptance of Ambient Intelligence in Medical Environments

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ABSTRACT

Ambient intelligence facilitates the performance of medical staff in health care services, but these technologies also create surveillance concerns. Little prior attention has centered on such issues. Based on 16 in-depth interviews, this article identifies various problems associated with users' acceptance of such systems, though these results conflict with prior contributions from other countries, especially Denmark. Applying the TAM and the cultural dimensions of the GLOBE study, this investigation also identifies cultural influences that may explain those differences. The findings thus lead to specific hypotheses proposing a research agenda regarding how national culture influences the users' acceptance of ambient systems in medical environments.

Keywords

Ambient Intelligence, Culture, GLOBE, Ubiquitous Computing, Technology Acceptance Model (TAM), User Acceptance

INTRODUCTION

In the field of health care services, ambient systems can enhance the efficiency and effectiveness of medical treatment. Applying such technologies can reduce the risk of complications for the patient and ensure the efficient location of patients and staff. In the case of an emergency, the closest nurse or physician could reach the affected patient quickly and more easily (Bardram, Baldus and Favela, 2006).

Yet acceptance problems are likely, because an ambient system that enables new means to monitor and control the staff in a working environment may lead to staff anxieties about the invasion of their privacy. In this research, we identify several application areas that have earned overall positive evaluations, though in areas linked to opportunities for greater control over patients or staff members, the perceived usefulness is very low. When users perceive the system's usefulness as limited, they experience reduced intentions to use the system, though this effect may depend on their cultural background. For example, cultural influences could work as a barrier against ambient systems, reducing their benefits and resulting in competitive disadvantages for a culture. This research therefore investigates the potential reasons for such cultural differences in user acceptance of ambient intelligence. We focus on the cultural dimensions of the Global Leadership and Organizational Behavior Effectiveness (GLOBE) study, the broadest recent analysis of cultural influences on organizational behaviour (House and Javidan, 2004).

We start by introducing the research fields addressed herein, namely, ambient intelligence, the Technology Acceptance Model (TAM), and the GLOBE study. Next, we describe the design and methodology of our qualitative survey. After outlining the corresponding results, we identify potential reasons for the differences between studies from Denmark and our results. Using the cultural dimensions of the GLOBE study, we develop hypotheses regarding cultural influences on the user's acceptance of a system. Finally, we discuss some limitations of our study, the main research results, and suggestions for further research activities.

THEORETICAL BACKGROUND

In this section, we provide a brief introduction of the covered areas, with the objective of developing a theoretical basis for understanding national differences and their effect on the perceived usefulness of an ambient system. The user acceptance could be influenced by cultural diversities. For that reason, countries could fail to keep up in ambient intelligence leading to disadvantages.

Ambient Intelligence

Ambient intelligence refers to a technological development in information and communication technology. As a result of the ongoing miniaturization of computer systems, an ambient system can be embedded in natural surroundings to support a user seamlessly from the background. Numerous devices, from sensors to notebooks, include ambient systems that collect information about the real world, analyse that information, and then derive flexible reactions. These systems also are tailored to each user's context-related needs, so they support human activity by offering information and guidance in various application areas (Aarts, 2004; Bohn, Coroamă, Langheinrich, Mattern and Rohs, 2005).

In contrast to this positive vision of ambient intelligence, negative user associations exist as well. The increasing transparency and associated prospects for monitoring and controlling people in particular emerge as negative possible consequences. Among end customers, the implementation of ambient and ubiquitous technologies has gained a bad reputation (Spiekermann and Berthold, 2005). The application of ambient intelligence in business environments also can introduce user acceptance problems that may result in the rejection of such systems.

Cultural Dimensions: GLOBE

Culture is often defined as shared norms and values (Raitoharju, 2007). The GLOBE study instead examines culture as practices and values. Practices ("as is") explain the way things are done in a certain culture, whereas values ("should be") describe how things should be done in a specific culture (House and Javidan, 2004). The main thrust of the GLOBE study has been to measure the differences and similarities between cultures on nine dimensions (see Table 1).

Assertiveness	Degree people are encouraged to be tough, confrontational, assertive, and competitive versus modest and tender
Future orientation	Social encouragement and rewarding of future-oriented behaviours by members
Gender egalitarianism	Gender role differences that are dominant in a society and the extent to which inequalities are seen as normal
Uncertainty avoidance	Society's reliance on social norms and procedures to alleviate the unpredictability of future events.
Power distance	Society members' expectations concerning unequal power sharing and the extent to which inequality is maintained by members in terms of power relations
Institutional collectivism	Degree to which individuals are encouraged by societal institutions to be integrated into groups within organizations and the society.
In-group collectivism	Degree to which individuals prefer memberships in small groups such as the family or prefer to identify with the collective rather than the individual sphere.
Performance orientation	Rewarding of performance and excellence by members of a society.
Humane orientation	Degree to which a society encourages and rewards individuals for being fair, altruistic, generous, caring, and kind to others.

Table 1. Dimensions of Culture, According to GLOBE (Javidan, House and Dorfman, 2004)

User Acceptance

The well-tested and widely accepted Technology Acceptance Model (TAM) by Davis (1989) and Davis, Bagozzi, and Warshaw (1989) as well as its extension (TAM2) by Venkatesh and Davis (2000) describes the influence of external variables on the *perceived usefulness* and *perceived ease of use* of a technological innovation. In the past decade, 45 empirical studies have tested TAM in many different contexts and confirmed its validity, reliability, and robustness (King and He, 2006; Ma and Liu, 2004). In the field of health care in particular, various studies have investigated technology

acceptance among nurses and physicians. However, TAM cannot address the influence of external variables and barriers on user acceptance (Yarbrough and Smith, 2007).

The enhanced TAM2 (Figure 1) therefore integrates two additional theoretical concepts, *cognitive instrumental processes* and *social influence processes*, that substitute for the previously used external variables. Venkatesh and Davis (2000) identify four cognitive factors that affect the perceived usefulness of an application: *job relevance*, *output quality*, *result demonstrability*, and *perceived ease of use*. Furthermore, they note three social factors that influence perceived usefulness: *subjective norm*, *image*, and *voluntariness*. Regarding cultural influences, social influence processes appear culturally embedded, whereas cognitive instrumental processes seem more likely to underlie other external and individual factors.

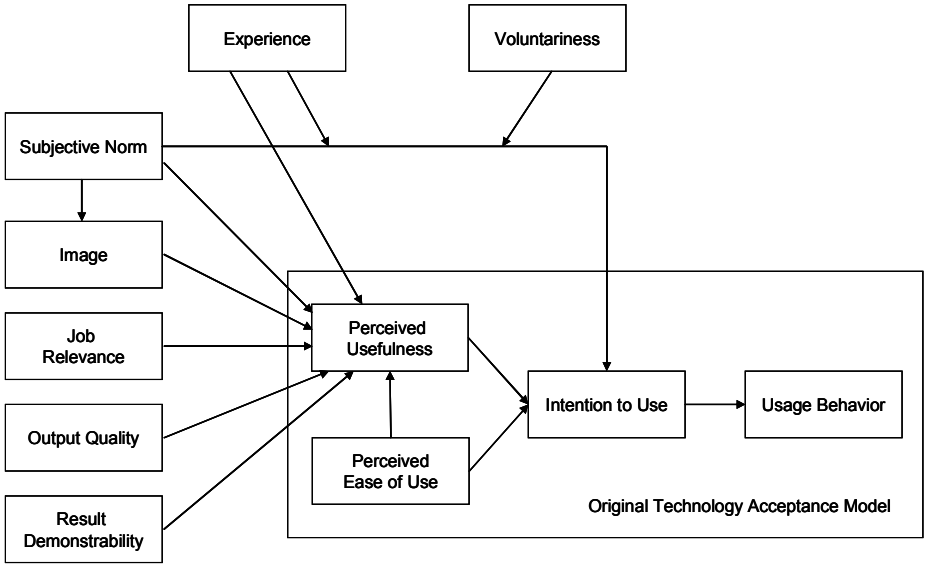

Figure 1. Enhanced Technology Acceptance Model – TAM2 (Venkatesh and Davis, 2000)

In comparison with most analyses in the field of health care acceptance, ambient intelligence seems particularly problematic in terms of user acceptance. Social and cognitive influences may be determined by the culture and lead to differences in perceived usefulness and thus usage intentions. In this case, cultural influence may function as a barrier, reducing external variables such as perceived job relevance, which in turn could create competitive disadvantages for a particular culture.

DESIGN AND METHODOLOGY

Our research focuses on the successful application of ambient intelligence in hospitals. We chose a qualitative research design to explore the attitudes of the medical staff and possible reasons they react in certain ways. In this context, we used semi-structured interviews that, because they are flexible and open by nature, provide a suitable means to contrast areas of application, as described in the literature by users, and to identify new areas of application. The study took place in the surgical clinics of three German teaching hospitals. To provide a high degree of contrast, we chose hospitals that differ in size and organization, though the number of beds is similar, each with approximately 30 beds. The respondents in the interviews were physicians and nurses in different leading positions, because we assume people in these responsible positions have better knowledge of the relevant tasks and can better evaluate the involved staff. Thus, a total of 16 persons were interviewed by two researchers. The interviews lasted between 40 and 50 minutes on average and were digitally recorded, with the participants' permission, then later fully transcribed. The transcripts were coded separately by two researchers. At first, we adopted Strauss and Corbin's (1998) Open Coding method, followed by axial and selective coding. During the coding process, both researchers discussed their codes and combined them into a final version. Finally, we used Atlas.ti version 5.2, computer software for analysing qualitative data by codes, in line with the research methodology.

A general problem in this qualitative setting is the existence of a response bias between the real attitude of the interviewee and the attitude that he or she communicates in the survey. Negative as well as positive responses could exhibit this bias. For example, is it very possible that an introduced form of technology could be evaluated by an interviewee as not useful for the hospital because he or she suspects that the technology could substitute his or her job. On the contrary, positive responses could be affected by social desirability. Therefore, it is necessary to take these biases into account and try to identify whether or not there is evidence for it.

RESEARCH RESULTS

In this section, we present the main acceptance problems identified during our analysis process. By comparing these results with other qualitative studies of another culture (Denmark), we can identify differences in the degree of acceptance among staff members. Specifically, we analyse the identified differences on the basis of the cultural dimensions of the GLOBE study. Nevertheless, we note that our objective is not to gain significant and representative data but rather to take an initial step in exploring culturally endorsed differences in the acceptance of ambient intelligence. With regard to the objective of this paper we propose a first set of hypotheses in order to derive a starting point for a research agenda in this area.

Results of the Qualitative Study

The results of our study fall into three broad categories (Bick, Kummer and Rössig, 2008): areas of application viewed overall as *predominantly positive*, areas of application deemed both *positive and negative*, and areas of application that were assessed as *predominantly negative*. Table 2 summarises the central results according to this formula.

Evaluation	Area of Application	Implementation / Example
Category 1 Predominantly positive evaluation	Collaboration	Filtering phone calls according to context
	Logistics	Test for completeness of surgery instruments
	Object tracking	Location of swabs in the framework of operative intervention
	Clinical pathways	Alignment to and reminders of standard treatments
Category 2 Inconclusive evaluation	Patient identification	Avoidance of incorrect treatment
	Authentification	Support in the registration and checkout procedures in the hospital information system
	People tracking	Location of patients
	Patient monitoring	Assessing the mobility of patients
Category 3 Predominantly negative evaluation	People tracking	Location of staff
	Object tracking	Support in the search for medical equipment
	Patient monitoring	Collection of vital data

Table 2. Areas of application and examples of ambient support

Category 1: Predominantly positive evaluation. The areas of application in the first category were suggested independently by the respondents or received very positive ratings after a discussion of them. Therefore, they mostly relate to the potential of very particular, clearly defined areas of application. Because the assessments were generally positive, response bias is relatively low. On closer observation of the fields of application, we find that the positive evaluation of object tracking requires further consideration, because in this case, the safety of the patient is not the only concern. Respondents noted an additional problem, namely, that the existing controls were very time consuming and could lead to delays. The ambient system should surely exclude the possibility that objects could be left inside a patient.

Category 2: Inconclusive evaluation. The second category contains less clear-cut evaluations. Negative evaluations emerge in that sense that the respondents did not deem ambient support of these application areas as sensible. However, their negative attitudes might be expressions of their unwillingness to accept the technology. Because of this possible response bias, we consider both the context and the statements of other groups of respondents in each case. The results pertaining to patient identification differ greatly across clinics. In the very large public hospital, which already uses barcodes to identify patients, the interviewees deem the sensory technology, including its linkage to electronic patient files, generally positive, despite possible patient acceptance issues. The two other clinics perceive this scenario rather negatively, largely because of their uncertainties regarding data protection and access to patients' private records. Furthermore, these respondents expressed their fears that the personal contact between patient and physician, as well as with the nursing staff, would suffer. This result suggests various interpretations. In particular, it prompts the suspicion that the respondents did not recognize the corresponding use potential fully. Thus, the acceptance of ambient technologies in this area should not be taken for granted by hospitals that have no prior experience with computerised patient identification systems. Similarly, the results with regard to the location of patients by sensors were quite ambivalent; the respondents initially indicated negative reactions and serious problems with patients' acceptance of the technology. However, virtually all of them also favoured the implementation of ambient technologies that would increase the safety of spatially and temporally disorientated patients. Nevertheless, this area of application remains very limited.

Category 3: Predominantly negative evaluation. The third category comprises fields of application that received very negative ratings. However, we also consider a possible response bias in interpreting these results. In particular, technology that can locate staff was not desired, because the monitoring and controlling opportunities connected with this technology did not reflect the practical relevance of the problem, according to the respondents. The respondents also unanimously expressed negative reactions to technology used to locate technical medical equipment and medical consumables. Because these items generally appear in specifically defined locations, the respondents did not envisage any search associated with acquiring such objects. The consistency of these statements suggests that the answers reflect actual facts, as is the case for the acquisition of vital data with regard to patient monitoring. The interviewees in all the hospitals assessed this capability negatively, because they perceived the permanent acquisition of vital data as relevant only in the intensive care area. Because intensive care requires patients to maintain strict bed rest, traditional acquisitions of relevant data are sufficient. Finally, tracking staff using these technologies received negative evaluations from all physicians and nurses, for reasons ranging from inadequate usefulness to rejections of surveillance.

Analyzing Differences Using the GLOBE Cultural Dimensions

In contrast to the preceding results, studies from Denmark indicate, for example, that medical respondents evaluate the tracking of patients and colleagues positively (Hansen and Bardram, 2007; Kristensen, Kyng and Nielsen, 2005). Another study shows that physicians and nurses consider additional monitoring processes, including information about the status and activities of staff, positive benefits (Bardram, Hansen, Mogensen and Soegaard, 2006). Whereas our results suggest acceptance problems for the identification and monitoring of patients, the Danish studies produce positive evaluations (Andersen and Bardram, 2007). Other results, such as ambient system support for communication, are similar (Bardram, Hansen, Mogensen and Soegaard, 2006). However, even if these contributions describe only single case studies and summarise results obtained from already implemented prototypes, it seems remarkable that none of these previous studies mentions problems with user acceptance – problems that we identify in all three German hospitals.

We propose several reasons for these differences in user acceptance between Germany and Denmark. According to the GLOBE study, the countries locate in different cultural clusters: Germany is in the Germanic European Cluster, whereas Denmark appears in the Nordic European Cluster. The differences between these clusters are generally moderate, but relevant distinctions emerge in the humane orientation, power distance, institutional collectivism, in-group collectivism, and assertiveness dimensions (Table 3).

	Practices (As Is)			Values (Should Be)		
	Germany (Average East & West)	Denmark	Mean (all countries)	Germany (Average East & West)	Denmark	Mean (all countries)
Power Distance	5.40	3.89	5.17	2,62	2,76	2.75
Humane Orientation	3.29	4.44	4.09	5,45	5,45	5.42
Collectivism I (Institutional Collectivism)	3.68	4.80	4.25	4,75	4,19	4.73
Collectivism II (In-Group Collectivism)	4.27	3.53	5.13	5,20	5,5	5.66
Assertiveness	4.64	3.80	4.14	3,16	3,39	3.82

Table 3. Results of the GLOBE Study (Germany and Denmark)

Work in hospitals and shared attitudes may relate to a *humane orientation*, which describes the degree to which a person receives encouragement to be caring and kind to others in the society. Denmark displays higher values on the humane orientation dimension, which may suggest that caring for others takes on greater importance among members of this society than it does in other cultures. Following from that supposition, we note some evidence that ambient intelligence and technological support that provide better health care conditions may be accepted more easily in Denmark than in Germany. Many German interviewees stated that they oppose ambient intelligence because the human being should be the centre of health care treatments. They argued that a patient is already connected to various technological instruments, which leaves insufficient time to focus on the human being as such, because constant control and technology monitoring has become the

main activity of nurses and physicians. This situation is perceived as unsatisfying and seems contradictory the ideal concept of a patient–physician relationship; the interviewees instead advocated a human-centred approach. In contrast, the Danish practices ("as is") that adopt a humane orientation, according to the GLOBE study, already are higher than those of Germany (scores of 4.44 and 3.29, respectively). Perhaps the German understanding of the technology differs and is more results-oriented, which could lead to the respondents' conclusion that the technology will ensure highly reliable medical treatment. The German view may also be influenced by more recent discussions in health care policy, which focus predominantly on ongoing reductions of costs. Reducing costs could lead to less time for the patient. In addition, the introduction of technical support in health care settings may be associated with a fear of retrenchment among health care staff, which certainly would reflect the promotion of a human-centred approach.

All the differences regarding the acceptance of ambient intelligence also can be linked to control mechanisms; that is, location, monitoring, and identification all refer to issues of control. For example, location technology appears acceptable only when the focus rests on the location of patients. The differences between the German and Danish study thus may result from differences in *power distance* scores. Technological location of staff provokes associations with technology-based surveillance, so the possibility of location technology means a higher degree of control by superiors, which could induce negative evaluations, regardless of the high power distance practices. The German scores differ between the practices and values of power distance; the GLOBE study describes greater higher power distance, but low power distance is more desirable. This evidence suggests that control is interpreted as negative, something to be avoided. Power distance practice in Denmark is lower than in Germany (3.89 versus 5.40). However, power distance values are lower in Germany than in Denmark (2.62 versus 2.76). This distinction could be interpreted as a rejection of the existing power distance by German interviewees, which would imply that a participative leadership style enhances users' acceptance of tracing and monitoring technologies, which then stimulates otherwise negative associations in countries that demonstrate a higher degree of power distance.

The differences in technology acceptance also might have their origins in two other dimensions: *institutional collectivism* and *in-group collectivism*. For these dimensions, the GLOBE study identifies contrasting results for Denmark and Germany. Whereas Denmark's practices are higher in the field of institutional collectivism, Germany demonstrates lower practices (4.80 versus 3.68). The in-group collectivism practices, however, are higher for Germany than for Denmark (4.27 versus 3.53). Our German interviewees demonstrated a high rate of acceptance of technological assistance in situations in which doing so would alleviate their workload or improve their working conditions, such as for the filtering system for incoming phone calls, but they expressed different perceptions in situations in which technology could function as a control mechanism. In-group collectivism when these respondents identify with a smaller group (e.g., group of nurses, personnel of the hospital) may be higher, whereas institutional collectivism, which emphasizes identification with the larger social institutions, may be lower. Many interviewees differentiate the in-group with which they mostly work from management as unique interest groups, with a substantial gap between them. The nurses rejected the use of surveillance technologies, based on the assumption that the staff committee would not support the introduction of such devices. Perhaps the Danish participants focused more on the institutional benefits of implementing ambient intelligence, whereas the Germans concentrated on in-group benefits. Thus, they relate the introduction of new technologies with a higher potential for control, which would have more negative consequences for the in-group, even if the benefits for the out-group (management and the hospital as a whole) might be great, in that the organization could reach cost saving targets and patients would experience more reliable medical treatment. Denmark's higher score on institutional collectivism practices ("as is") also could reflect a more holistic vision, focused on the general institutional benefits of implementing ambient intelligence. In contrast, studies that use the individualism/ collectivism dimension described by Hofstede (1980), e.g., (Srite and Karahanna, 2006), find no relationship between this scale and acceptance of technology across cultures.

In TAM2 (figure 1), cultural influences appear to have a particular impact on social norms and cognitive job relevance, which determine perceived usefulness. Social norms reflect a cultural background and affect people's attitudes. What people assume that others expect from them also depends on cultural dimensions. The influence of cultural factors on job relevance clearly emerges in our interviews. In these hospitals, the German medical staff regarded ambient technologies as more threatening for their potential to be used as instruments of control and therefore less relevant for their job than did their colleagues from Denmark.

On the basis of these results, we formulate the following hypotheses:

H1: National cultural influence factors have a significant effect on the perceived usefulness of ambient intelligence.

H2: National cultural influence factors have a significant effect on social norms and cognitive job relevance.

The relationship between perceived usefulness and, social norms as well as that between job relevance and perceived usefulness, thus is moderated, as follows:

H3: The relationships are moderated by the cultural dimensions of (a) humane orientation, (b) uncertainty avoidance, (c) power distance, (d) institutional collectivism, and (e) in-group collectivism, such that higher scores in these practices leads to greater acceptance of ambient technologies.

Even if these hypotheses appear acceptable, we note that they represent only a first step towards a research agenda in the investigation of the different degrees of acceptance of ambient technologies. As a next step we are planning to test these hypotheses in a quantitative research design via questionnaires. With regard to the hypotheses adjusted question items from GLOBE will be included in the questionnaire as well as a concrete area of application of category 2 (Table 2). We will introduce this scenario to addresses acceptance problems as well as benefits. The potential users (e.g., physicians or nurses) will evaluate the scenario on basis of TAM2. We plan to test our hypotheses with regard to the following limitations.

Limitations

Our study follows a qualitative approach, so the results are not representative and defy predictability. Nevertheless, we offer some hints about which cultural dimensions might influence the acceptance of technologies in Germany. The comparison across various studies in different cultural contexts occurred ex post and on the basis of a literature review. It therefore may contain some methodological limitations, including variance in the subject matter, though we believe this variance may be acceptable for our purpose, namely, to generate hypotheses for subsequent testing. Another bias may arise from the sample selection; more interviews with medical personnel in other positions may generate divergent results. Finally, the GLOBE study contains certain limitations, including the assumption that culture is static and predictable. Other approaches to cultural studies employ dynamic concepts of culture that emphasise contextual influences on human behaviour (Schütz, A. and Luckmann, 1975; Swidler, 1986).

CONCLUSIONS AND FURTHER RESEARCH

The objective of this research has been to propose a research agenda indicating that national culture might influence clinicians' attitudes to ambient intelligence. Applying a qualitative design, we analyse how German clinicians evaluate the usefulness of various application areas for ambient technologies. In doing so, we have discovered some substantial problems with regard to user acceptance of modern information and communication technologies. In particular, the respondents evaluate every technology that could be used for surveillance negatively. Using results from Danish studies, we assess these differences in terms of the perceived usefulness of the technology. Furthermore, on the basis of the cultural dimensions of the GLOBE study, we derive hypotheses about potential cultural influences and identify four likely candidates: power distance, humane orientation, in-group collectivism, and institutional collectivism. A high degree of power distance seems to work as a barrier against ambient systems, especially if the GLOBE ("should be") value is very low. In contrast, high humane orientation practices ("as is") could work as a positive influence factor. The main findings pertain to the differing scores for in-group collectivism and institutional collectivism. In contrast with other studies that use Hofstede's cultural individual/ collectivism dimension, we distinguish this dimension according to the GLOBE study approach.
The next step should be testing the generated hypotheses and their significance. It will be important to determine whether differences in user acceptance might be minimised through the introduction of adequate efforts that take cultural backgrounds into account.

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