

# CONTRIBUTION OF AMBIENT INTELLIGENCE TO THE SUBJECTIVE WELLBEING: AN OVERVIEW OF THE ADVANTAGES AND DISADVANTAGES

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## ABSTRACT

There is and has been a great deal of research in the field of Ambient Intelligence. However, not many have been conducted in which Ambient Intelligence is described from the viewpoint of construction; thus little is known about the contribution of Ambient Intelligence in regards to the influence on the resident's subjective well-being through the design of the living environment. Based upon a literature review, this paper gives an overview of the advantages and disadvantages of the applications of Ambient Intelligence in the built environment in relation to the occupant's subjective well-being, viewed from the health point of being built into the environment. Through this research, the contributions of Ambient Intelligence to the subjective well-being of the residents are determined; thus contributing to the debate about the validity of its applications in Intelligent Homes.

## KEYWORDS

Ambient Intelligence, Intelligent Homes, Subjective well-being, Health, Built Environment.

## 1. INTRODUCTION

Ambient Intelligence (AmI) is put forward as a vision for future generation Intelligent Homes to meet the requirements of the residents [Aarts et al 2009; Garde-Perik, 2009]. It evolved from the paradigm of Ubiquitous Computing at the start of the 90's of the last century. AmI was first introduced by Eli Zhelka during a Philips Research Workshop in 1998 [Wright et al, 2008]. In line with Zhelka, Weber et al. [2005] describes AmI as: "*Ambient intelligence is the vision that technology will become invisible, embedded in our natural surroundings, present whenever we need it, enabled by simple and effortless interactions, attuned to all our senses, adaptive to users and context-sensitive, and autonomous.*" [Weber et al, 2005]

Using the definition by Weber et al [2005], five characteristics (Figure 1) of AmI can be composed: *AmI is embedded in the surroundings; AmI is aware of its environment; AmI can adapt itself to the requirements of the residents; AmI can be more personalized, because it can adapt itself; AmI can anticipate on the requirements, without the user being consciously aware of changing the system.*

According to literature [Aarts et al, 2009; Friedewald et al; 2005, Weber et al, 2005], AmI influences the residents subjective well-being. Diener [2009] states that the definition of Bradburn [1969] is the; which states that the subjective well-being "is a preponderance of positive effect on negative effect." It emphasizes the presence of pleasant emotional experience.

Current studies of AmI mostly focus on the pros and cons of potential applications of AmI process, [Aarts et al, 2009, Augusto et al, 2010; Araya, 1995; Friedewald et al, 2005] and the adoption process of AmI technology by people [Mohammadi, 2010; Allouch, 2008]. Given this context, AmI is described as 'embedded in our natural surroundings', it is remarkable that very little research has been conducted from the view point of design and influence on the living environment. This paper describes this relationship by composing five characteristics of AmI (Figure 1), and gives an overview of the advantages and disadvantages of the application of Ambient Intelligence in the built environment, and creates a theoretical model of the resident's subjective experiences of such an environment.

## 2. SUBJECTIVE WELL-BEING

Based upon literature [Frijda,2005; Allouch,2008; Mohammadi, 2010], a theoretical model is created that describes the subjective experience as defined by Diener [2009]. In this study the model is used to observe the interaction between residents and Intelligent Living environments as AmI, on determining the subjective well-being of the occupant.

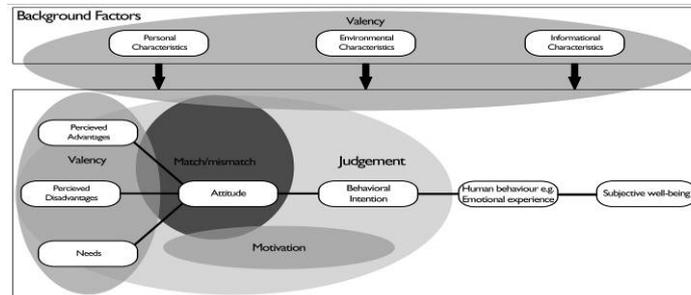


Figure 2. Interaction between inhabitant and intelligent living environment as AmI on determining the subjective well-being of the occupant

In relation to the previously described definition of subjective well-being, it can be argued that subjective well-being can only arise from a positive intention with subsequent positive emotional experiences [Allouch, 2008; Diener, 2009; Frijda, 2005; Mohammadi, 2010]. Frijda [2005] states that the subject observes a situation in his/her own specific way therefore making emotional experiences very subjective which is also determined by their perceived advantages and disadvantages [Mohammadi, 2010; Allouch, 2008]. Mohammadi [2010] adds that the subject's needs as well as background factors determine the emotional experience.

The judgement of a particular situation, according to Frijda [2005] and Mohammadi [2010], could translate into an internal emotional experience, when a situation is of sufficient importance to the subject to function as stimulation. The assessment of a situation depends equally on multiple valences of the characteristics of a situation and the motivation of the subject.

The relationship between subjective well-being and emotional experience is emphasized by the alleged properties of subjective well-being [Diener 2009]: i) *the extent to which welfare results is subjective*, ii) *there are positive aspects present*; iii) *all features in the life of the individual can play a role*.

The presence of the above described three properties is confirmed by other studies. The latter property comprises of aspects in which a large amount of research has been already been done and shown shortcomings in. Because of the large numbers of elements, they remain limited; and interrelationships between the factors are often not made [Diener, 2009]. This study focuses on health issues within the built environment in terms of the interaction between humans and Intelligent Living Environments.

## 3. PROS / CONS OF AMI AND RESIDENT'S HEALTH

The following paragraphs will deal with the advantages as well as the disadvantages of AmI to the resident's health. The six factors mentioned below are:

**Convenience** - Ambient Intelligence provides a range of practical benefits of a computer system taking over the common daily activities of human beings [Araya, 1995]. It becomes possible to create self-cleaning/healing materials and maintenance systems, resulting in improvements of the housing quality. Hence this eventuates in the better mental- and physical health of residents [Evans, 2003; Northridge et al, 2003; Matte et al 2000; Sundell, 2004]. A counter argument to this is that the implementations of new domestic technologies does not always lead to a reduction in the amount of household work [Friedewald et al, 2005].

**Otherness** - Due to the interaction between man and the 'ubiquitous' character of AmI, there is potential to profoundly transform our perception of the 'other'. Technology will fade into the background and become unconsciously used by the residents [Araya, 1995]. Once technology starts to adapt to the resident and

improves the well being of these residents the goal of Ambient Intelligence is achieved. [Aarts et al, 2003]. Araya [1995] on the other hand suggests the ethical argument that the world around us transforms by means of sensing machinery attached to items, thus the 'thing' loses some of its 'otherness'. This applies not only for objects but also for environments [Araya 1995]. This ethical aspect of AmI provides possible advantages because the world around us becomes predictable, causing less mental stress. However, excess predictability and uniqueness, might cause a lack of stimulation which can affect mental health negatively [Evans et al. 1998].

**Personal Control** - It becomes possible for different environmental variables to adjust automatically to the physical condition of the occupant. For example, the environment can adjust the environmental variables during the sleep cycle to optimise sleep conditions and rest, and optimise time spent on sport and physical activities; enabling elderly, sick or disabled people to live independently for longer [Friedewald et al, 2005]. The ability to regulate environmental aspects promotes comfort, which affects mental health in a positive way [Evans 2003]. According to Friedewald [2005], the integration of various functions could distract one from the task. As a consequence a lack of control in such systems can lead to mental health problems [Evans et al 1998; Evans, 2003; Lowry, 1989]. It seems that Intelligent Living Environments can clarify the interaction between the environment and residents by empowering the resident with personal control.

**Social Contact** - Northridge [2003] states that an increase in social interaction improves mental health where as social isolation affects mental health negatively. Since Information is no longer fixed in time or space, it can be instantly distributed. This increases the possibilities for social contact. AmI can provide interactive and autonomous systems, which can help one to create social contacts and relations which may arise in real time and therefore enrich their social life [Friedewald et al, 2005]. However it must be noted that AmI is only a digital medium, which cannot (yet) be compared to real life social contacts.

**Restorative Elements** – Restorative aspects, as Evans et al. [1998] says, are therapeutic and healing elements which reduce stress and cognitive fatigue. AmI can aid by projecting images of natural elements so as to renew the cognitive energy of the occupant [Evans, 2003]. In contrary it could have a negative effect on residents because of its technological nature.

**Privacy and Security** - In order to realize the above mentioned advantages, systems will need to store personal information. This may cause data security and privacy problems for residents. Literature [e.g. Ackerman, 2004] states that the amount of stored personal data will rise and that people will no longer be able to remain anonymous because of biometric identifications. Punie et al. [2005] describes identity theft, disclosure of personal data, surveillance and risks from implicit user profiling as possible risks.

However, from literature it is not clear what influences privacy violations and the lack of digital security, and the effect cybercrime has on our health. A house's primarily function is to protect against outside influences and cybercrime is one such outside influence. Evans et al. [1998] declare that security is one of the underlying processes that explain how the built environment affects our health. It therefore seems likely that the lack of security could have a significant negative impact.

## 4. AMBIENT INTELLIGENCE IN THE BUILT ENVIRONMENT

Throughout the development of AmI-like systems, the Built Environment has played a central role as the facilitator of the possible applications. This study presents a project, which shows some of the possible influences AmI can have on the subjective well-being of the residents, illustrating the role of architectural designs in: improving social contact, reducing stress, improving convenience, improving personal control, and making people choose an inconvenience over a convenience.

In this project, funded by the Province of North-Brabant (Dutch Provincial Government), AmI is imbedded in the homes of the elderly. This can be seen in the form of the NetBOX Live (figure 3) which allows for the addition of domotics applications to be added onto the monitoring of the elderly. This device will sort the need for internet connections on priority i.e. an alarm is more important than the streaming of surveillance video. This automatization of care services and Smart technology should enable inhabitants, for example the possibility to live independently at home and deal with their health in a comfortable manner and with convenience. Such embedded, environment aware, personalisable, adaptable, and anticipational intelligence can only make this possibility of a networked tele-care system achievable.



Figure 3. Left. NetBOX Live a example of AmI which provides a plug and play solution for safety and comfort services and the monitoring of the elderly in the home.

## 5. RESULTS & DISCUSSION

Literature indicates that the described advantages and disadvantages, and the potential implications on the health of residents, are predominantly associated with the hedonistic experiences of pleasures and pain. This makes it plausible that AmI can function as an 'emotional' experience [Frijda, 2005]. The analysis of the pros and cons of AmI and its implications on health shows that the categories of 'convenience', 'otherness', 'social contact' and 'restorative elements' have a preponderance of advantages over disadvantages. The category 'privacy and security' has a predominance of disadvantages over benefits, while 'personal control' can be described as neutral. Some advantages or disadvantages may be deemed more important than others by the subject thus influencing one category or the whole outcome [Allouch; 2008]. The five characteristics of AmI have a large overlap and the various categories have interrelationships between them. The final result has a neutral view due to the likely variations in intensity of AmI.

Although the results largely correspond to those of the pros and cons of the characteristics of the situation, it seems that the health implications are particularly dependent on the intensity of the present stimuli from the built environment [Bergmann et al, 1997; Evans, 2003; Matte et al, 2000]. Research confirms that the intention of the residents to adopt AmI is low due to possible risks towards mental health. Viewed from the health point of the intelligent built environment, this intention has - with the adoption of AmI - no significant improvement in the subjective well-being effect.

It should be noted that the degree that AmI affects the residents' health cannot be fully determined due to lack of research, which arises from the fact that AmI is still a relatively young vision and the development of its applications are still in their infancy state [Allouch; 2008]. The diversity of potential applications is so large that it does not seem possible to study the influences of all. A second note is that subjective well-being, is valued and perceived differently by everyone. Thus, some advantages or disadvantages can be more important than others for some residents.

Research shows that due to the current financial feasibility and techno centism a slow integration of AmI is necessary [Aldrich, 2003]. Historically seen, the acceptance of technologies by users is spread over time, underlining the fact that people find only minor changes pleasant in the short term. Important questions must therefore be put to the sustainability and security of AmI. Technological developments in electronics and computer technology are occurring one after another in rapid succession [Augusto, 2010]. But what does this mean for the future?

Professionals who are active in construction need to start thinking about the implementation of AmI in people's homes. With the rapid pace of developments it is no longer a question of if, but when AmI technologies will be applied in buildings and homes. Other questions are where, when and what exactly in the environment needs to be automated. Such choices must be left to the experts in the field of human behaviour in the built environment. It offers architects and designers the ability to identify the challenges within the living environment and develop Intelligent Living Environments which respond to these challenges. In addition, Araya [1995] states that our perception of a 'place' can transform by making information obtained from a specific location accessible anywhere via mobile devices. How does this affect a discipline based on the design of specific places and environments with specific functions? An answer to these questions and the possible consequences that follow are still unknown.

The research brings to light that individual control is an important aspect in the interaction between man and an Intelligent Living Environment. Can choices be changed at the last minute? Is it possible to remain anonymous? How do children respond when they are already playing at fooling the system as an experiment?

The amount of questions might show the great potential of AmI to Intelligent Living Environments as a significant impact on the subjective well-being of the occupant, but also the ‘fear’ of the unknown. Improperly designed or used in Intelligent Living Environments, applications may have the opposite effect and thus reduce the welfare of the resident. As a result of this darker side and the many standing questions regarding AmI it is considered to have a moderately negative to neutral impact on the subjective well-being of the resident when looked at from the health aspect. By conducting further research into AmI as an architectural object in our environment or as our total environment, the concerns may be allayed in regards to the potential of Ambient Intelligence, which is inherent in the vision, as persuuable.

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