Positive Technology and User Experience for Human Needs in Developing Countries: Some Considerations

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Abstract. The present paper highlights the importance of positive technology, user experience, and needs fulfillment in developing countries. It proposes a theoretical framework that enables engineers and interaction designers to develop products that help users to fulfill their interaction needs in this special environment. Put in other words: the proposed environment-sensitive user-centered design framework elicits positive technology for users in developing countries. Adequate methods corresponding to this framework are summarized and effects of positive technology in developing countries are discussed.

Keywords: Rural areas, developing countries, user experience, human needs, socio-technical system approach, user-centered design.

1 Introduction

In western, developed societies technological progress has often been discussed as a trigger to overcome poverty, starving, illiteracy, and social inequality. Comparably to western societies emerging nations like China, India, or Brazil reveal the empowering forces of technological change. Technological development boosted China's economy for example. Economically, China will gain influence in the next years and is likely to become the most powerful economy worldwide before 2030 [1]. However, developing countries seem to miss the boat of technological progress. Their technological level is assumed to be low and technologies are largely non-digitized. From the western perspective the constriction of starvation and poverty as well as of political and social instability can be supported by financial aids and development assistance. Technological progress comes second and is often ignored although it could become a growing resource for developing countries. Information and telecommunication technologies offer benefits for the developing world [2], especially in rural areas. They enable people to easily access knowledge and information via fast communication channels. Hence, information and communication technologies can improve peoples' education [3]. Moreover they give people in geographically outlying regions a voice to make their presence felt in other parts of the earth. Therefore technology can bridge infrastructural shortcomings and empower the lives of humans and help gratifying human needs.

Of course, special challenges on several layers must be kept in mind when developing technology for rural areas in developing countries. In this paper we focus on

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user experience (UX) and its requirements as one of the key phenomena of information and communication technology. In literature UX is a buzzword for the holistic quality of interaction between a user and a technology or service [4]. It has been argued that UX is essentially related to perceived usability and aesthetical aspects of an artifact [5] and that it impacts the usage of technical artifacts [6]. Moreover, UX influences user's preferences for a certain product [7]. In addition, both perceived usability and aesthetics affect the user satisfaction [8]. Thus, designing any piece of technology or service should involve the development and evaluation of UX.

Amongst many others, two things are of importance when considering UX in the product development process, the target group and their contextual setting [9]. There are main UX research strands in the western, developed areas that incorporate these issues when developing human machine interfaces. However, when designing for emerging nations the target group and their contextual setting change dramatically. This paper addresses these changes. It argues that elements of the socio-technical system approach should be integrated in the user-centered design process in order to build up UX-sensitive technology and services for rural areas in developing countries. The aim is to show how the western user-centered design process needs to be extended by a human-centered view to make it work for developing countries as well. Therefore this paper presents a new environment-sensitive design model. Subsequently the model will be discussed regarding its implications for the design of human-machine interaction (HMI) and evaluation methods in rural areas in developing countries.

2 User Needs

Technology is delivered in order to please the user and to improve his or her well being [10]. In terms of Maslow's hierarchy of needs [11], positive technology addresses the top of the needs pyramid; the top includes self-actualization and personal growth. Hence, all basic needs like physiological (e. g. food, water) or safety needs (security of the body, health) should be satisfied before people have the need to use pleasing technological artifacts. However, this position of positive technology in Maslow's needs pyramid must be treated with caution since it is culturally coined against a western, individualistic, and capitalistic background [12]. Nowadays it is assumed that needs of different hierarchy levels can co-exist. Therefore needs regarding technological progress may exist even if basic needs are not fully met. Hancock et al. [13] even put up a needs hierarchy for technical artifacts (Fig. 1). In this hierarchy Ergonomics form basic needs. As in Maslow's hierarchy, safety aspects are most important. Besides safety aspects, functionality, and usability aspects belong to ergonomic needs. Usability is to some extent part of the hedonic needs. Here personal preferences and pleasurable experiences play an important role for the user. Comparably to Maslow's hierarchy it can be assumed that the steps of the technological needs are not fully distinct as well. Hence, users might have strong needs regarding a pleasurable (user experience) and satisfactory interface (usability) even if the functionality of the device can be improved.

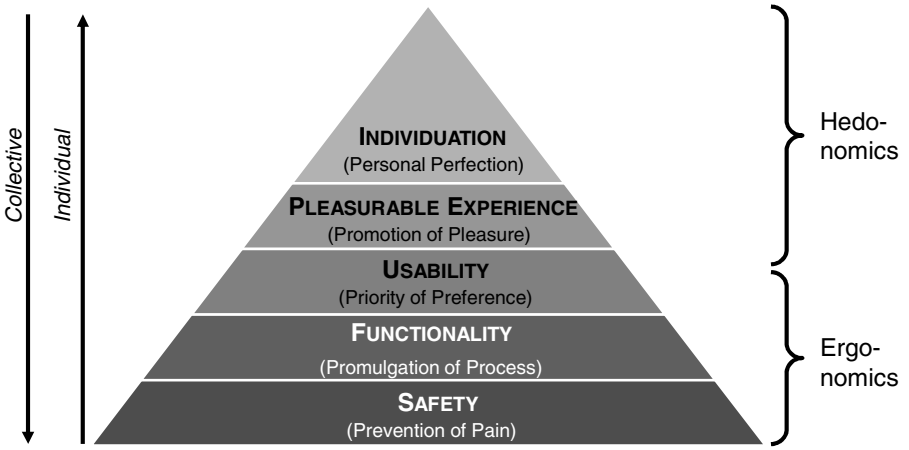

Fig. 1. The technology hierarchy of needs (from [13])

3 User-Centered Design

User-centered design starts with the needs of users [14]. Since users interact with the system via its interface, user needs should be reflected in the interface as well. Users should know where to look for important information. Moreover, they should understand how to access this information. Positive technology and positive UX resolve from interfaces that fulfill user needs. These interfaces can be realized by engineers and interaction designers through user-centered frameworks [e.g. 15–17]. User-centered frameworks define an iterative process and stress that user needs are centered in the middle of the design challenge. Therefore the focus on user needs has to be set very early in the product development process. Users have to participate in each step of the process [18]. Decisions whether the design of an artifact is completed or not, are made based on the degree of the fulfillment of user needs. Usually user centered design frameworks emphasize an iterative design cycle that comprises of four steps: (1) context and demand analysis, (2) requirements definition, (3) drafts, prototyping, and (4) prototype evaluation (see Fig. 2). In addition the user-centered design process proposes a whole lot of methods that can be applied to gather information in each step of the process. Step one of the user-centered design considers the context of use and users demands. However this step loosely subsumes context factors of the environment like lighting conditions [17]. Broader issues like the users' cultural settings are not taken in account. Most methods of demand analysis propose to simply ask users. Hence they assume reflective users and a good understanding between users and the usability engineer. Demand requirements and prototyping may work without too much user involvement. In contrast the prototype evaluation does hardly work without users. For a prototype evaluation it is typically assumed that users are able to read and write. Users should be able to verbalize their thoughts in terms of usability or user experience issues. It is evident that especially the first and last steps of the user-centered process heavily rely on cultural and user characteristics. Hence the

theoretical framework has to be adapted in order to account for differences in context and target user groups of developed and developing countries.

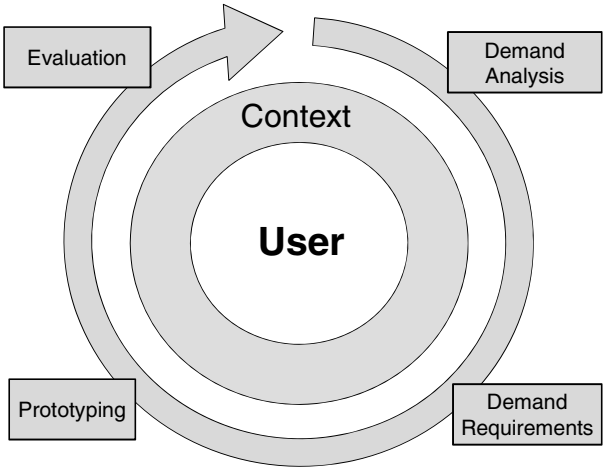

Fig. 2. An exemplary user-centered design process

4 The Socio-Technical System Approach

In HMI research, the perspective of the socio-technical system approach evolved years ago in the wake of the famous Tavistock Studies [19]. It focuses on a holistic perspective on human-machine interaction incorporating man and machine in their respective contexts. In contrast engineers and system designers often emphasize just one single part, either the human or the machine of the HMI system [20]. Tavistock Studies showed that changing either technology or human effects the other part, too. This leads to the credo of the socio-technical HMI definition: Human and machine work together (they interact) to solve a task in a goal-oriented way [21]. This cooperative system generates outputs like services or products. This view of an HMI emphasizes its local environment at a certain time and place (narrow definition in Fig. 3).

However, the global environment affects socio-technical systems as well. There are contextual factors that might be invisible at first sight but have large effects on the over-all system. Integrating the tangible and intangible environment of the HMI leads to a broader view on socio-technical systems (broad definition in Fig. 3). Several factors of the tangible and intangible environment influence both, human and machine. In this paper we emphasize intangible factors like cultural or societal issues and tangible factors, i.e. directly observable factors like weather conditions or the infrastructure of an area where an artifact is implemented. Both shape a HMI implicitly but in a clearly recognizable way and therefore have to be considered in the product development process. Product engineers and product users mostly share large parts of their tangible and intangible world. Therefore considerations of the global environmental (broad definition in Fig. 3) of the socio-technical system are negligible. But as

soon as engineers adopt their products and product development processes in culturally different backgrounds, the global environment turns out to be vital and must be taken into account.

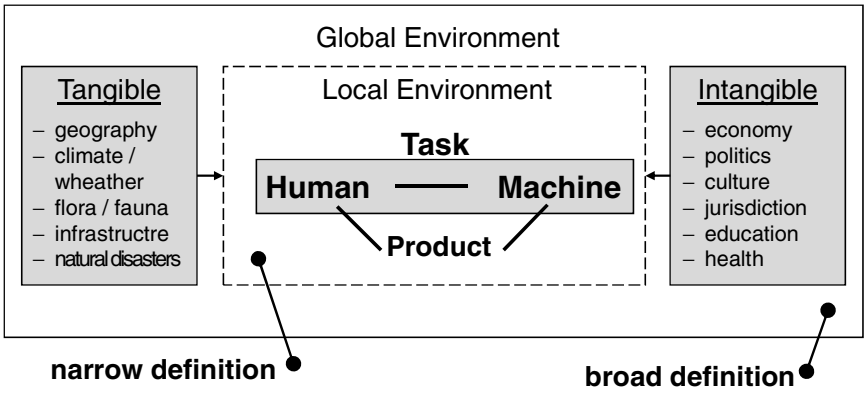

Fig. 3. Framework of socio-technical systems

The adaptation of the socio-technical system approach to developing countries calls for a certain understanding of key factors of this special environment of HMI implementation. Following [22], many developing countries share a number of common characteristics that affect the tangible and intangible properties of the global environment (see also [23], [24]):

- *Economic characteristics:* Due to low aggregate value added, no accretion is attained. Developing countries tend to rely on the primary economic sector (retrieval and production of agricultural and mineral raw materials).
- *Ecological characteristics:* Developmental countries are often faced with ecological problems (species extinction, soil degradation, wood clearing, and high exposure to natural disasters).
- *Demographical characteristics:* The dynamics of the population is coined by a high birthrate, a high (but declining) death rate and infant mortality rate, as well as a low life expectancy, leading to uncontrolled population growth and migration.
- *Public health characteristics:* Unhygienic conditions, shortcomings in medical care and education, and malnutrition often lead to different diseases and pandemics (HIV/Aids).
- *Socio-cultural characteristics:* The coincidence of cultural, societal, and religious behavioral patterns lead to several aspects like sex discrimination or social inequality. Furthermore things like illiteracy, hoarding of the upper classes, child labor can be subsumed under this topic.
- *Political characteristics:* A low efficiency and stability of political institutions and a lack of presence in decentralized regions are often prominent in developing countries. Other aspects cover illiberal regimes, violent conflicts, or civil wars.

Of course not all of these characteristics apply for all developing countries anytime. Oil-exporting countries often have a flourishing economy with a huge social inequality. Newly industrialized economies are defined to be developing countries but miss typical characteristics being at the threshold to an industrialized country. The characteristics of developing countries should be kept in mind when designers and engineers work at new products for developing countries because these characteristics frame the user-centered product development process.

5 The User-Centered Design Process in Developing Countries

As pointed out earlier, designers of technology mostly derive from a developed, western-oriented culture. If they build technical artifacts for developing countries they need to become culturally reflective and sensitive for the factors of the global environment of the socio-technical system. Because the user-centered design process is geared to the local environment of the socio-technical system (see Fig. 3), it is desirable to integrate the factors of the global environment to the user-centered design process. Figure 4 shows the environment-sensitive user-centered design framework. The user and his interaction with the technical artifact are located in the center of the concept. This user-machine dyad, with the task being immanently present, is also called the local environment in the narrow definition of the socio-technical environment. In contrast to the standard user-centered design process the present model proposes that the user and his local environment are itself located in the global environment. As in a multi-shell model, the interaction between user and artifact is not just influenced by his or her immediate surroundings, but also by the large-scale factors of the global environment. These large-scale factors constrain the user's local environment and set the boundaries for the user and his or her possibilities to accomplish his or her needs in an interaction with a technical artifact. Hence, the user-centered design process needs to be sensitive to both, the local and the global environment. This assumption has implications for the user-centered design methods also.

6 Methods

Methods for user-centered design in developing countries should take the HMI local and global requirements in account. Several methods of analyzing the different needs fall short in meeting these requirements. However, some of them may be adapted to these requirements of developing countries.

6.1 Methods and Tangible Requirements

Tangible requirements constrain the type of methods applicable to developing countries. Especially in rural areas there is only little equipment or infrastructure for the methodological approach to HMI. Depending on the degree of urbanization vs. ruralization, there may be no facilities like buildings for testing or interviewing potential

users. Methods should be feasible at many different places without a complex setup. Extreme weather conditions call for robust and made-to-last, weatherproof equipment. If electronic technology is used, durable batteries or solar-powered devices should be used to avoid blackouts. Wireless data processing should be kept to a minimal level since the network coverage is often not very high. For example methods like event-related diary studies might work for the documentation of needs (Fig. 4, step 1: demand analysis) and usability problems (Fig. 4, step 4: evaluation)

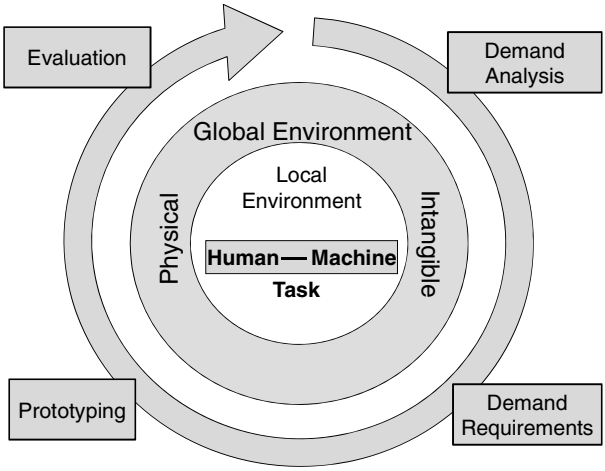

Fig. 4. The environment-sensitive user-centered design framework

6.2 Methods and Intangible Requirements

Intangible characteristics like the ones presented in Fig. 3 form the second set of constraining factors for selecting applicable methods in the environment-sensitive user-centered design process. Especially cultural influences need to be considered. As to that gender roles can play an important role during recruitment of participants and implementation of methods. Women might interact more openly with other women and men feel more respected by male interviewers; in extreme cases woman might even be prohibited to talk to foreigners at all [25]. Another challenge in cross-cultural interaction deals with criticism and feedback. In some cultures it is not appropriate to criticize others, especially people from other cultures. Hence, needs elicitation methods or evaluation methods need to embrace more than just verbal statements like think aloud protocols. Moreover, participants' educational background should be regarded since illiteracy prevents using standard questionnaires. Language barriers can be compensated via translators but the quality of translation and motivational issues of the translator need to be thought of. Minor prior experience with technical devices constrains subjects in their ability to use prior knowledge for interacting with the technical artifact. This might lead to ceiling or floor effects when judging the usability of a technical system. Politics, jurisdiction and peer pressure can influence

participants' behavior due to prohibitions and the fear of punishment and embarrassment. Thus methods should always be applied in confidential settings that represent a safe place for communication. Since all intangible factors have a rather soft character, it is advisable to take time to deal with them. For example methods could be integrated into the community before using them.

6.3 Methods Applicable to Developing Countries Settings

Given the tangible and intangible constraints of the global environment, qualitative methods should be favored for gathering information in the environment-sensitive user-centered design process. Qualitative methods have a lot of advantages [26]:

- Due to less standardization and equipment needs, these methods are very flexible and can be easily adjusted to the subjects and the situation.
- Qualitative methods are very open and exploratory to unravel new and unknown issues. Without constraints of the method, subjects often react more freely and openly giving more subjectively information to the interlocutor. Especially for demand analysis, the content focus of the method is chosen by the respondent [27].
- That enables him or her to talk freely about his or her needs and wishes. The respondent can highlight what he thinks is important.
- Qualitative data requires fewer respondents but produces a lot of detailed data.

The disadvantages of qualitative methods should be addressed, too [26]:

- Qualitative methods require much time to approach the respondent.
- The requirements for the interviewer in qualitative settings are very high. He has to be very empathetic, sensitive, and eloquent towards the respondent.
- This requirements increase in developing countries since the interviewer involved in qualitative methods should be familiar with the intangible, cultural background of his or her respondents.

A number of qualitative methods might be appropriate for the situational background of developing countries with none or little adaptation. Qualitative interviews (non-structured) may be used to analyze the wishes, needs, or opinions towards a certain topic in an open way. These interviews may vary in their form. Episodic interviews may deal with a specific situation. For example in HMI this may be the situation of a problem or critical incident that the product is going to address [28]. Narrative interviews inquire a topic very intensively and request the respondents to tell stories [29]. A similar method, using larger samples, is the focus group or group discussion. A moderator leads a discussion concerning a certain topic or issue. Here social interdependencies may drive the discussion [28]. Applying this method one has to be careful because different cultural backgrounds may influence the quality of the method. Many ethnographical methods deal with the topic of observation of respondents. Here respondents are observed in order to gather insights as to the behavior, actions, and the effect on other respondents or persons. The collected data may be used to analyze situations in which a product is used (demand analysis, demand requirements in

Fig. 4) or to analyze the interaction of respondents with an artifact or prototype (prototyping, evaluation in Fig. 4). The interaction can be observed participatory or non-participatory (i.e. the engagement of the observer in the observation), direct and indirect (i.e. recorded/reported or live), and may be open or covert (i.e. the respondents know about being observed). Observational methods often require a large amount of involvement with the people in an environment to analyze their motives and needs deeply.

Whereas qualitative methods bear many advantages for testing and evaluating, some research objectives require a quantitative approach. Quantitative methods aim at generalizability and have their main advantage in the possibility of hypothesis testing [29]. Quantitative data is often based on standardized testing materials. To adjust these methods to developing countries, one needs to anticipate possible obstacles in the subject's interaction with the material. Coping with illiteracy could be implemented via reading questions and items aloud and replacing verbally or numerical anchored scales using a visual analogue scale. Depending on the content visual analogue scales can vary from continuous lines with two end-points to simple pictures or sound files [30]. Emotional content that has a vital relevance in UX testing, can be sampled with a set of different smileys since emotional expressions are assumed to be cross-cultural [31]. However, an unavoidable consequence of adjusting standardized methods is pretesting them.

7 Discussion and Outlook

This paper argued that it is important to develop positive technology for developing countries. Positive technology leads to positive user experience that in turn is related to feelings of competence and the motivation to learn [10]. Hence positive technology might help to motivate people to use technical artifacts and therefore to overcome gaps between developing and developed countries. However, most of the paper focused on a theoretical approach that enables engineers and interaction designers to cope with the special characteristics of developing countries. The environment-sensitive user-centered design framework places the user and his needs accomplishment in the middle of the product development process. In addition the model highlights the role of the global environment. In contrast to other researchers [32] we believe that the environment-sensitive user-centered design framework demonstrates the feasibility of the user-centered design approach in developing countries. However, empirical evidence is still needed to validate the model. This is subject to further investigation.

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