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Abstract

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Completed Research Paper

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Abstract

Although persuasive technology is about influencing individuals without coercion, deception, or manipulation, ethical issues still must be considered in designing persuasive systems. In this paper, we utilized value sensitive analysis in evaluating a mobile application to examine how value sensitive analysis can benefit persuasive system design. The evaluated Milky Way application is meant for women with the intention to breastfeed. It supports the users in continuing to breastfeed for a longer period of time, being faithful to the recommendations by World Health Organization. Our results show, that value sensitive analysis brings new and valuable information to the design process of a persuasive system, which in turn can make it more meaningful for users as well as more efficient in supporting behavior change.

Keywords: Ethical analysis, Value sensitive analysis, Persuasive systems, Breastfeeding

Introduction

The purpose of any persuasive technology is to help people in their behavior or attitude change by the means of software designs (Oinas-Kukkonen 2013). The ethical side of persuasive technology remains a less-explored area (Oinas-Kukkonen 2013), despite the fact that persuasive technology may raise many concerns (Davis 2009). Defining persuasive technology to exclude coercion and deception does not mean that there is no ethical issues to be handled in the designing phase (Oinas-Kukkonen 2013; Oinas-Kukkonen and Harjumaa 2009). People may also have different perceptions of what coercion or deception include and whether persuasive systems voluntary use would compensate for any of its possibly coercive and manipulative features. To help designers to consider ethical aspects when designing persuasive systems, Karppinen and Oinas-Kukkonen (2013) proposed an ethical framework composed of three approaches, namely user involvement, guideline-based approaches and stakeholder analysis.

Stakeholder analysis takes the values of different interest groups into account in purpose to ensure that the system is ethical from all points of views. Technology becomes more relevant and meaningful when the stakeholders are given a role in the design phase (Frauenberger et al. 2015). In principle, stakeholder analysis is an easy way to address possible ethical issues, but, using it beneficially and coherently to gain useful and solid outcomes may require great effort. Especially when stakeholders have conflicting values, the question how to take these conflicting values into account in a way that all stakeholders are satisfied and understand the reasons behind the complex decisions is difficult to address.

In this study, we utilize value sensitive design to conduct an examination of the ethical side of a persuasive system. The system in itself had been developed based on the Persuasive Systems Design (PSD) model (Oinas-Kukkonen and Harjumaa 2009), and it has reached its first testing phase with real users. The purpose in this paper is to figure out what kind of information stakeholder analysis is capable of producing, and how it possibly can help in enhancing the system in an ethically acceptable way. Overall, we seek to figure out the benefits that value sensitive analysis may give to the designers of persuasive systems. To be able to answer this research question, we first need to perform persuasive system design analysis to the system under investigation. The persuasive system design analysis will describe the persuasive context and features utilized in the system.

Background

Ethical concerns are often one of the first issues that emerge, when discussing about persuasive technology with people new to the topic. Many of these concerns can be diminished by stating that users use persuasive systems voluntarily, and the system is not designed to be coercive or manipulative (Smids 2012). Voluntariness, however, does not mean that the system is ethical from all stakeholder's points of view (Karppinen and Oinas-Kukkonen 2013). For example, the motive of the system (e.g., gathering users' personal information to be sold to third parties) or the goal of behavior change (e.g., changing people's attitude negative towards an ethnical group) might be considered highly unethical, even though the users are using the system voluntarily.

In addition, in many cases persuasive systems are nowadays not used fully voluntarily, but they are built in (e.g., in cars or smart homes) or are being advised or mandated for use by third parties (e.g., by employees or insurance companies). Furthermore, to some extent, information technology always affects people's attitudes and behavior, whether intentional or not (Oinas-Kukkonen 2013; Ploderer et al. 2014). In these cases, the voluntariness and thus ethicalness of such systems can be questioned, even though the motive for their system would be considered good. Thus, considering the ethical aspects of information technology and persuasive systems is highly important.

Persuasive Systems Design

One of the most used design approaches for developing persuasive systems is the PSD model (Oinas-Kukkonen and Harjumaa 2009). It provides a framework for designing and analyzing persuasive systems. PSD model utilizes many theories from psychology and information systems, such as elaboration likelihood model (Petty and Cacioppo, 1986) and technology acceptance model (Davis, 1989). The PSD model consists of three phases: understanding the issues behind persuasive systems,

analyzing the persuasion context, and persuasive system features. The first phase clarifies main issues behind persuasive systems, such as the persuasion should always be open and the systems useful and easy to use. In the second phase, the intent (persuader and change type), the event (use, user, and technology contexts) and the strategy (message and route) needs to be analyzed to create an overall picture of a persuasive system. To further design or describe a system, the list of 28 persuasive system features grouped in four categories (primary task, dialogue support, credibility support, and social support) can be utilized.

The use, user and technology contexts need to be investigated in a robust manner in order to gain deep understanding on the persuasion context. However, ethical issues are not addressed in the PSD model in depth, but rather with a mention that the overall goal of the system should be made clear and the use voluntary. Thus, we believe, that the value sensitive analysis could benefit persuasive systems design by adding stakeholder and value analysis with ethical aspects. Strengthening the PSD model with them may form a comprehensive approach for designing ethically analyzed persuasive systems.

Value Sensitive Analysis

Value sensitive design is a theoretically grounded method to design technologies, and it takes into account human values throughout the entire design process (Friedman et al. 2006). The method is an iterative tripartite methodology that encompasses conceptual, empirical, and technical investigations, which, together, help create a comprehensive picture of all relevant stakeholders' values and ensure that these are considered in the developed system (Friedman et al. 2006). In conceptual investigation, the direct and indirect stakeholders are identified, their values concerning the information system under analysis are recognized and the central value constructs are analyzed in a philosophically informed manner. Empirical investigation exploits the quantitative and qualitative methods used in social science to obtain insights of the stakeholders, for example, by observing or interviewing. Technical investigation ties the value sensitive design method to information system design, because in technical investigation the focus is on how the technological properties can support certain values without hindering other important values. (Friedman et al. 2006.)

According to Friedman et al. (2006), a value is what “a person or group of people consider important in life”. Value can then be anything from objects and living creatures to abstract constructs, such as a car, child, or beauty. Some of the values are more important than others, when it comes to a persuasive system. For example, privacy is often considered as an important value in the case of technology (Friedman et al. 2006). Regarding on the context and users of a persuasive system, different values emerge and value sensitive analysis is one potential tool to identify them.

Value sensitive design has drawn researchers' attention and is has also received critique. Davis and Nathan (2015) have made numerous critiques regarding the core aspects of the method. These critiques are focused, for example, on the claim by Friedman et al. (2006) that certain values are universal (Borning and Muller 2012), the lack of a specific ethical theory (Albrechtslund 2007), and the lack of a systematic stakeholder identification method (Yetim 2011). However, although value sensitive method is not yet a fully rigorous method, it is considered a potential method for taking the stakeholders and their values into account in the development process of a technology (Davis and Nathan 2015)

The first step of the value sensitive analysis (Friedman et al. 2006) is to start with a value, technology, or the context of use, depending on the case at hand. In the second step, the direct (individuals directly interacting with the technology or its output) and indirect stakeholders (individuals affected by the system but are not actually using it) are identified. These stakeholder groups may have subgroups, and an individual may belong to several groups (Friedman et al. 2006). The value sensitive analysis does not give clear guidance on where to stop in the stakeholder identification, as there might be numerous groups affected by the system.

Improvements have been suggested to the value sensitive method by many researchers. For example, Yoo (2017) introduces stakeholder tokens to understand stakeholders and their dynamics better. Yetim (2011) claims, that in identifying the stakeholders, knowing where to stop is difficult. Even when the persuasive system is meant for a specific user group, numerous direct and indirect stakeholders and their values may be involved. In addition, even just in the main user group, the values of users may vary

significantly, because of these people's different cultural backgrounds, goals, and other reasons. Thus, Yetim (2011) suggests the use of a checklist of boundary questions by Ulrich (2000) to supplement the value sensitive method by guiding the identification of relevant stakeholders and their effect on the system (Yetim 2011).

Ulrich (2000) defines 12 boundary categories (client, purpose, measure of improvement, decision-maker, resources, decision environment, professional, expertise, guarantee, witness, emancipation, world view) grouped in the following four boundary issues: sources of motivation, sources of power, sources of knowledge, and sources of legitimation. He argues, that by defining these boundary issues and categories one can set the context of the system, and as suggested by Yetim (2011) find the relevant stakeholders.

After identifying the relevant stakeholders, next step is to determine the benefits and harms of the application to each stakeholder group and map these onto corresponding values with ethical import. As the definition of a value in the value sensitive analysis is somewhat abstract, in most cases numerous values can be identified. By mapping them to the ones with ethical import, the list becomes more manageable and useful for the designers of an information system.

Methods

Study setting

We use the Milky Way application to study how ethical evaluation identifies the possible ethical issues, which can be used to further develop the application in future. The Milky Way application (see Figure 1) is part of University of Wollongong's (Australia) project and was designed based on the lessons learned and intervention developed in The Milky Way Program research project. The original Milky Way Program had three antenatal face to face educational sessions and two postnatal telephone follow up consultations to support mothers with breastfeeding (Meedya et al. 2016). Self-efficacy theory and birth territory were used as the conceptual background at the Milky Way program (Meedya et al. 2016). The program increased the likelihood of breastfeed by nine times at one months and three times at six months among the intervention group compared to the standard care group (Meedya et al. 2016). The Milky Way application was designed and implemented to test whether a mobile application is feasible mean to deliver such program successfully to larger audience than the program could reach due the restrictions such as long distances.

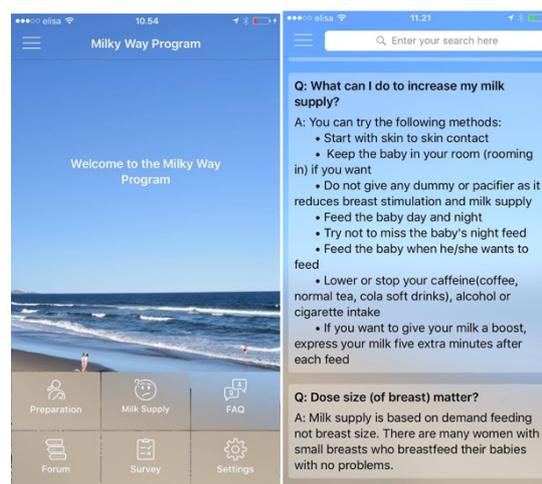


Figure 1. Look and feel of the Milky Way application

The application is meant to support nursing mothers' confidence to breastfeed their infants for longer period of time where there is a high breastfeeding initiation rate (90%) with low breastfeeding rates at six months (50%) ("2010 Australian National Infant Feeding Survey: Indicator Results" 2011). Although breastfeeding has many short and long-term health, economical, and environmental benefits for the mothers, the infants, and societies (Rollins et al. 2016), the topic is still sensitive as women may

feel pressured to breastfeed (Balaam et al. 2015). Thus the ethical analysis of an application, which influences women's breastfeeding behaviour, is important.

Persuasive Systems Design Analysis

The application under value sensitive analysis (Figure 1) utilizes persuasive systems features (Oinas-Kukkonen and Harjumaa 2009) to support users' breastfeeding confidence. The persuasion context of the application is summarized in Table 1. The intent of the persuasive application is clearly stated as the designer and intended outcome are disclosed in the application. The persuaders are the university researchers, who developed the application co-operating with other stakeholders. The problem domain of the application is early breastfeeding cessation. The potential users have intent and motivation to breastfeed, but they lack of practical experience and information to feel confident. The application provides support for the users to feel more confident in breastfeeding. The message of the system is clear throughout the application, and not least since it is provided via direct route, meaning the user is persuaded by appealing to reason and intelligence (Oinas-Kukkonen and Harjumaa 2009). The application utilizes many software features, from which the users can use the ones they prefer. For now, the application is offered only in Apple iOS platform, for which reason some of the potential users are not able to use it.

Table 1. Persuasive system design analysis with regard to the persuasion context (cf. Oinas-Kukkonen and Harjumaa 2009).

The Intent	
Persuader	The university researchers, with professional experience in lactation, primary health care, public health, and nutrition are the main persuaders. However, the application is designed to be autogenous, enabling the users to change their behavior and attitude by themselves, without the need for active participation by the professionals
Intended Outcome/Change	The main aim of the application is to increase the breastfeeding confidence and continuing to breastfeed for a few months after birth. The intended outcome/change is R-Outcome (reinforcing outcome) and A/B-change (attitude and behavior change) (cf. Oinas-Kukkonen, 2013).
Designer bias	The aim of the application and the motives of the developers are disclosed clearly
The Event	
Use Context	The problem domain is early breastfeeding cessation. The potential users are interested in breastfeeding, but lack the practical experience and confidence. Thus the application provides evidence-based information related to for example infant nutrition and breastfeeding event
User Context	The application offers information and support in multiple ways to be suitable for variety of users. For example the application explains, what happens during the first few days after the birth in a very pragmatic manner. It offers also practical information, if the user is in doubt of her milk supply. In addition, the anonymous discussion board offers social support from others in similar situation
Technology Context	The application in its current state is offered only on Apple iOS platform. Thus it is not available for all smart phone users, but demands certain kind of smart phone
The Strategy	
Message	The aim is to increase the confidence to breastfeed for longer period of time. The application provides information about the advantages of breastfeeding. However, the mother is not blamed for not breastfeeding
Route	The application provides evidence-based information, which supports the users in the behavior and attitude change. Thus direct route is used in the persuasion

The content is highly tailored to women with the intent to breastfeed, making it potentially more persuasive for users i.e. the women who are pregnant or breastfeeding and want information and/or support regarding breastfeeding. The application provides trustworthy, evidence-based breastfeeding information, for example how to best prepare for breastfeeding; what happens after the infant is born; and what to do if the milk supply is low. Some of the information is provided with sources to scientific literature with the expectation of increasing the persuasive power (Oinas-Kukkonen and Harjumaa 2009). The use of common language makes it easier to approach. In addition, the application offers social support through a discussion forum, where users can anonymously discuss about breastfeeding related issues. The social learning and co-operation can motivate users to adopt the target behavior or attitude (Oinas-Kukkonen and Harjumaa 2009). Naturally, the use of the application is voluntary. The persuasion features of the Milky Way application are summarized in Table 2.

Table 2 Persuasive system design analysis with regard to the software features (cf. Oinas-Kukkonen and Harjumaa 2009).

Category	Feature	Implementation
Primary task support	Tailoring	The application offers tailored information and features for this specific user group such as question and answers list, discussion forum, and lots of information regarding breastfeeding
Dialogue support	Similarity	The use of common language makes the application easier to approach. The sensitive topics, such as exhaustion or sore nipples, are also discussed
System credibility support	Trustworthiness	The application provides evidence-based and relevant information
	Expertise	The sources of the information is provided. In addition, the developers, their expertise, and intent are disclosed
Social support	Social learning	At discussion forum users can learn from each other's experience
	Social comparison	Users can compare their experiences with people similar to them
	Co-operation	Via discussion forum users can feel, that they are part of a community with common interest

Conducting Value Sensitive Analysis

For the value sensitive analysis we followed the guidelines by Friedman et al. (Friedman et al. 2006) – introduced earlier in the article – supplemented with Ulrich's (2000) boundary questions, as was suggested by Yetim (2011). The analysis was quite straightforward process, although many iterations had to be made to recognize the relevant stakeholders and their values. The first and second author began the value sensitive analysis by identifying the core value of the application, namely breastfeeding. The second and third authors are in the development and research team of the mobile application, having together also years of practical experience in medical health care and breastfeeding, making them experts regarding the system and its context. After the core value identification, we proceeded to the stakeholder identification utilizing the Ulrich's (2000) boundary questions. After which we could map the benefits and harms the application could bring to the identified stakeholders. In this phase we utilized the knowledge the second author had gained during the Milky Way Programme research project and discussing about the application together with the other experts from related fields. The first author could also utilize her experience as persuasive system researchers and a breastfeeding mother.

benefits and harms could then be grouped into corresponding values, which we further grouped into the key values presented in next chapter. The first and second author first identified the stakeholders, values,

and the benefits and harms independently, after which they combined their thoughts, which all four authors commented.. As part of our value sensitive analysis, we did not conduct the empirical investigations by e.g. interviewing the potential end users, since the users' experiences with the application will be analyzed and taken into account in the testing phase with real users. In addition, the feedback from the participants in the project the application is based on, was already taken into account in the design.

Results

Identified Stakeholders

The value sensitive analysis produced a long list of stakeholders, which can be seen at Table 3. The direct stakeholders and users of the application are pregnant women and those who hope to receive support for breastfeeding whether it is in the form of evidence-based knowledge, courage, or peer support. These individuals are also the sources of motivation (Ulrich 2000), together with their infants, possible spouses or close relatives, as well as society, in general. These stakeholders enjoy the main benefits of the application in the form of many breastfeeding benefits, as discussed, for example in (Victora et al. 2016). The potential users's concerns have been carefully listened and taken into account the development process of the application. In its current state (being tested by real users), their voice will be heard even more, since the lessons learned from the test phase are being implemented to the application in the next development phase.

The decision-makers with regard to the application are the information technology academic, the project leader and the application developers. The project leader and information technology academics have the main authority in making the decisions about the application's design. They also carry the responsibility of the trustworthiness of the information provided via the application. However, the decisions regarding the application are based on information also from other stakeholders.

When designing the application, many experts, such as those in the field of breastfeeding from academia and public health care, were involved to ensure that the latest evidence-based information was incorporated and that all the stakeholders' concerns were considered. In addition to the project leader specializing in breastfeeding, many stakeholders were included in the design team: a public health academic, president of Public Health Association of Australia, professor of primary health care, academic in nutrition and academic in health informatics. The marketing staff can also be considered as sources of knowledge, but their point of view is very different from that of breastfeeding experts. Their expertise encompasses issues, such as copyrights, potential marketing value, and the right way to use the university logo. These issues are important and should not be neglected, even if they do not directly affect the efficacy of the application with regard to its the main purpose of supporting breastfeeding.

According to Ulrich (2000) one boundary category is sources of legitimation. That is, who argues for those, who are affected but not involved, and what ought to secure their emancipation. For the development of the application, 250 women's, with intention to breastfeed, feedback from the original study, where the Milky Way Program was delivered by face to face education sessions and phone consultations, were utilized. However, the design team of the mobile application have not yet received a broad feedback from women who have tried the mobile application. Two important indirect stakeholders are the infants and societies, in general. They are impacted by the Milky Way, but their interests cannot be heard. Therefore, we argue that the legitimacy lies mainly with the experts. They have both practical and evidence-based knowledge with regard to breastfeeding benefits and thus it is important to hear their concerns.

Table 3. Identified stakeholders

Boundaries	Group	Stakeholders
Sources of motivation	End users	Pregnant women with intend to breastfeed Women needing support for breastfeeding
	Indirectly affected groups	Infants Spouses/close relatives The society as a whole
Sources of power	IS/IT experts/decision-makers	Information technology academic Project owner Head of faculty App developer
Sources of knowledge	Care providers	Midwifery academic Parent educator Clinical educator Lactation consultant Former medical officer Maternity unit manager
	Allied health academics	Public health academic Primary health care academic Nutrition academic
	Commercialization staff	Marketing officers of the university Copy right manager and legal advisor Analyst Programmer Head of IT department Branding and commercialization manager Copyright manager and legal advisor Marketing academic

Identified values

The identified human values with ethical import are presented in Table 4. The key values unveiled a number of surprising issues behind the application. Some of these conflict with one another. For example, the designers need to balance between supporting women to breastfeed and not making them feel pressured to do so. The same need for finding a balance is present in designing other persuasive systems: some of the identified values will most probably conflict and difficult decisions needs to be made. The context of breastfeeding is especially sensitive, since there are lots of emotions and opinions involved (Balaam et al. 2015).

Table 4. Identified human values with ethical import

Value	Explanation in the context
Accountability	The owner of the application is responsible for the correctness and trustworthiness regarding the information provided via the application. However, the disclaimer states, that if the user suspects that something is not right with the baby or the user, the medical advice should be sought to get a professional opinion
Autonomy	Users should be able to decide themselves whether they will use the application or to breastfeed
Breastfeeding	The application should support users in breastfeeding, but it should not make anyone feeling guilty, if she does not want to or is unable to breastfeed
Courtesy	Cultural differences need to be considered by, for example, choosing appropriate images for the application
Human welfare	The application should offer information to mothers so that they gain the benefits of breastfeeding.
Elaboration	The application should not prevent users from making their own considerations, but to provide the necessary and evidence-based information that the user can utilize in her decision making regarding the breastfeeding
Evidence-based knowledge	All the information in the application should be evidence-based, trustworthy, and up-to-date
Ownership	The application is owned by the University of Wollongong, with the possibility of updating the content but with the responsibility of providing evidence-based, up-to-date information. The ownership needs to be stated openly in the application
Privacy	The application should support privacy, such as protecting the identities of the users in the discussion forum by allowing them to discuss anonymously
Unobtrusiveness	The application should not disturb the user, by for example sending unneeded notifications

In an ethical persuasive system, someone always needs to be responsible for the system and its content. In this case, the accountability and ownership were established through the discussions with the care providers, as they were worried about who is responsible for the information and ensuring that it is always up-to-date. The provided information should also be evidence based and trustworthy. However, the information must be offered in a way, that does not prevent the users to use their own thinking, but enables elaborating and form the decision regarding breastfeeding independently.

Breastfeeding has many health benefits for both mothers and their infants, as well as societies, in general (Rollins et al. 2016), so human welfare is one of the found key values. In the application, the value is visible on the provided information. The designers also wanted to follow the International Code of Marketing of Breast-Milk Substitutes (“International Code of Marketing of World Health Organization” 1981), and not market breast-milk substitutes in any part of the application, but to emphasize the benefits of breastfeeding. To follow the code, the designers has to be sure, that not even a logo of a company producing milk substitutes among other products, is visible in any part of the application, not even for promoting the other products.

Autonomy was also one of the issues that emerged. Regarding the analyzed application, both using the system and breastfeeding should be totally voluntary. The user should be allowed to stop using the application and/or breastfeeding whenever she wants to without the application trying to persuade her to continue or trying to make her feel guilty.

The privacy of the users is another concern. In the application, users can discuss with one another anonymously sharing information they may not want to share, if their identities were known by other users. This aspect of the information security remains problematic, as users always leave a mark when taking part in a discussion forum. The privacy of users needs to be highly secured, so that the comments cannot be associated with a certain person even in case of a security breach.

Many cultural differences are also involved with regard to the practice of breastfeeding. In some cultures, for example, breastfeeding in public is not regarded as acceptable behavior. In the case of the application, images were carefully selected to ensure that no culture is offended by, for instance, by showing too much skin. The vocabulary has to be inoffensive, to not make the users feel uncomfortable.

The application should be unobtrusive and not disturb users by, for example, sending notifications when the user does not want to receive them. The analyzed application does not send any notifications to the user, therefore it can be said to be unobtrusive in this manner.

These found values were considered in the application design, and, thus, the application can be considered ethical. The research team was formed of senior academics and clinicians who were expert in the field of primary health care, public health, information technology, marketing and breastfeeding. Therefore the ethical issues were considered very closely without any systematic approach. Considering that not every mHealth app developer has the same expertise, value sensitive analysis is very important to provide a clear criteria for a diverse app developers.

Discussion

The value sensitive analysis provided useful information about the Milky Way application in a form of identifying stakeholders and their relevant human values, such as autonomy and human welfare. The developers of the application hadn't used value sensitive design or participatory design approaches when they designed the application. However, they did involve many experts from various relevant fields to ensure that the application fulfills the diverse needs of different stakeholders. In addition, they utilized the feedback from the successful breastfeeding program, which they had studied before this application. The value sensitive analysis probably would have been most beneficial when conducted in the beginning of the development process, since it provided a means to recognize the important stakeholders, their values, and related issues and to guide the development of the application.

Value sensitive analysis benefited persuasive systems design in multiple ways. First of all, the value sensitive analysis produced a larger set of stakeholders than just a persuader and a target user group, which are the main stakeholders in persuasive system design. Especially Ulrich's boundary questions helped identify also other relevant groups such as experts, which have a huge influence to the design. The boundary questions also forced the designers to consider the legitimation issues, which are not taken into account in the more traditional systems design process.

Secondly, with the value sensitive analysis, a set of possible concerns and benefits could be identified. By conducting the analysis, not only the potential users' salient values for the system were identified, but also the experts' voice is heard. Recognizing such values may help designers to understand the Use and User Contexts in more depth and potentially develop a system which users feel more personal and more persuasive.

The list of identified values is an important and useful instrument for the system developers; the values can be used as requirements for the persuasive system. As always in designing an information system, the requirements should be justified and documented. Value sensitive analysis, as it produces a set of requirements, is a beneficial method for creating justified requirements, for which the designers can always come back later on in the designing process. The list can also be utilized when describing or marketing the system.

Value sensitive analysis suggests various methods to conduct empirical investigation for finding answers to questions about stakeholders' values and their prioritization. For example, interviews, surveys, and observation can be utilized depending on the case (Friedman et al. 2006). Involving potential users among other stakeholders will most likely increase the persuasive effect of the developed system, since it will be more relevant for the users.

Yet, we feel that the need to find a philosophical basis for all recognized key values, as the value sensitive analysis often recommends, is not necessarily needed. The values bring practical value for the persuasive system design even without such philosophical investigation. However, for obtaining the practical benefit of the found human values, the values need to be clearly described in the context of the persuasive system.

Disadvantages of Value Sensitive Analysis for Persuasive Systems Design

The value sensitive analysis, together with Ulrich's boundary questions, provided quite a rigorous method to identify the relevant stakeholders and their values. These found values, with the on-going study with real users, are expected to be useful in the next phase in the development of the Milky Way application. However, this identification of the relevant direct and indirect stakeholders turned out to be rather a complicated task, as there were many different groups involved in the design phase of the Milky Way application. Ulrich's (2000) boundary questions were needed to ensure that all important stakeholders were found and categorized in a reasonable manner.

The identification of the values took several iterations in the terms of grouping the found potential benefits and disadvantages under suitable human values with ethical import. The list provided by Friedman et al. (2006) helped to find suitable values, although this might have somewhat biased the value identification process because staying with the provided list and not looking for other important values could have been encouraged. The value sensitive analysis would benefit from a guidance for finding the relevant ethical values among all the numerous issues emerging from the identification of the potential benefits and disadvantages.

Our research did benefit significantly from the fact that the second author was the project leader and thus the main decision maker in the application. The evaluation would not have been as broad as it was without inside knowledge regarding the application. Therefore, it seems questionable whether value sensitive analysis would be appropriate for ethical analysis of an existing persuasive system if the researcher would not have in-depth knowledge regarding the context of the target system.

Furthermore, the value sensitive analysis method does not offer tools to solve conflicting values. In this study, many of the issues related to conflicting values were already solved before the value sensitive analysis was conducted. However, we could identify some conflicts that may affect the next steps of the development of the application. Autonomy versus persuasion is one of the questions that need to be considered, because although the system usage should always be voluntary, it needs to persuade those who have not made the decision on whether to breastfeed. The application needs to be convincing enough without making the users feel, that they are being pushed toward something they do not want to do.

Limitations and Future Work

Since the Milky Way application is now in a stage, where it is tested first time with real users and the results of the value sensitive analysis have not been applied in a form of persuasive features, we cannot yet say how the analysis affects to the final form of the application. To study the effect of the analysis to the application and with real users requires future studies. To further examine the benefits of the value sensitive analysis in identifying potential ethical issues and considering these in designing persuasive systems, more studies with different contexts need to be conducted.

Conclusions

Addressing ethical concerns remains as an important issue with all information systems development and especially so with developing persuasive systems that aim to influence users' behaviors. In this study, we utilized value sensitive analysis to conduct an ethical analysis of the Milky Way application, whose purpose is to support women's confidence in long-term breastfeeding.

In our analysis, we found that value sensitive analysis, together with Ulrich's boundary questions, does help persuasive system designers in identifying relevant direct and indirect stakeholders as well as key human values, thus we would encourage for using the value sensitive analysis together with PSD model

when designing persuasive systems. The stakeholders and their versatile values can help in developing systems with greater persuasive power. The analysis, and especially the boundary questions, highlighted the importance of experts of the context regarding the developed persuasive system. The experts have in-depth knowledge regarding the context, and thus together with users they can provide useful information for the system design.

Value sensitive analysis should be carried out in the beginning of the development process to obtain the maximum benefit from it. The identified values should be described with enough details and they should be explicated clearly enough with relation to the contextual factors, since generic values such as autonomy or accountability can be interpreted in too many different ways. Through explaining the values properly, designers can then feel more assurance about the intent and they can proceed with the design of the system accordingly. Systems design may thus benefit from the various ways of collecting information about users and ideally match the design with each individual user. In sum, value sensitive analysis on par with boundary questions can help make successful persuasive systems designs.

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