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Understanding human values in adopting new technology—A case study and methodological discussion

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Abstract

This paper proposes a method for understanding and modelling human values in the evaluation of new technology in social settings, and analyses the validity of the proposed method in a specific use case. The method, which is based on the Schwartz universal model of human values adopted from social psychology research, is used in the context of value analysis of the adoption of a technology-supported attendance control system in a primary school. The results are based on an evaluation of a 14-week trial where two classes of elementary school children used an attendance control system that was implemented using networked technology components, including smart cards, NFC-enabled mobile phones and card readers, a web portal, and SMS messaging. The findings from the trial are analysed from the viewpoint of three end-user groups, namely children, parents, and teachers.
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1. Introduction

This paper proposes a method for modelling the subjective value perceived by users of new technology through the universal model of human values constructed by Schwartz (1992). The goal of the method is to help designers and decision-makers to better understand and articulate the perceived subjective value of new technology from the viewpoint of human values and different user groups. Schwartz's (1992) value model has been used extensively for analysing development of value priorities across time and between groups of people around the world, including Finland. The proposed method has been used to evaluate the adoption of a new technology system in a school environment. We were able to follow and study a system trial that took place in Finland in 2008.

The Finnish educational system is built upon public schools. The community authorities are responsible for ensuring that schools adhere to the educational and operational requirements set by the state. The public authorities, therefore, play an important role in the adoption of new technologies in schools. This means that investments are covered by public funding and decisions to adopt new technologies are made through public decision-making processes. In the case of public services, the goals and criteria for adopting technology may differ significantly from the private business environment, where the goals and criteria usually deal with maximising profits and have a financial rationale. It can be difficult or even irrelevant to gauge the value created in public services using financial measures alone.

In an environment that is fully financed by public authorities and serves a wide variety of people with different needs, assessing the value of adopting new technology is challenging. Schools do not operate in a business environment where the aim is to generate revenues and keep costs to a minimum. Instead, schools create value on a wholly different scale for society and the families using their services. The benefits of adopting new technology in such settings must include other value parameters in addition to traditional cost or time savings. Human values are often difficult to articulate unambiguously (Friedman, 1996).

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In this paper, we explore how Schwartz's (1992) value model could be used in modelling and articulating the value created for the end users. The analysis presented in this paper complements the analysis and findings of the same study reported previously in Ervasti et al. (2009a, 2009b). The first of the earlier papers reports findings and experiences on adoption of such a system, for example, (1) pointing out the importance of communicating how a new service affects the responsibilities of teachers and parents, (2) giving examples on how to involve teachers and children in the design and adoption process, and (3) discussing reasons for absence of privacy related concerns (Ervasti et al., 2009a). Based on the experiences from the study, the second of the aforementioned papers makes design recommendations about, for example, (1) participation of different user groups in the design of the service, related technical components, and trial setup, and (2) the role of the technological device and its ownership (Ervasti et al., 2009b). The present paper complements these findings by looking at the same study from a different angle, concentrating specifically on analysing human values related to adoption of the service, and discussing how Schwartz's value model could help in this respect.

With regard to how the paper is organised, the concept of value is discussed in the next section; Section 3 outlines the research setting, describing the methodology and processes of data collection, data analysis, and research validation, followed in Section 4 by a system description of the technology adoption use case. The value modelling framework used in this study is introduced in Section 5. Section 6 presents the results from the analysis of the data, followed in the next two sections by a discussion of validation of the results and the limitations and threats to their validity. The closing sections encompass the conclusion and discussion of possible future work.

2. The concept of value

The value of an information system or a product is a multidimensional concept. It is usually formed by users' actions, and thus their perceptions of the value of the system or product are critical. Jurison (2000) concluded that applications which are perceived to offer high value from the start are adopted rapidly while those perceived to be of low value are adopted slowly and are unlikely to gain acceptance in the long run.

In psychology, values are seen as conceptions of desirable behaviours or desirable end states (Verplanken and Holland, 2002). In addition, values are defined as cognitive representations of needs (Schwartz and Bilsky, 1987) and desirable trans-situational goals (Schwartz, 1994). Values are characterised as relatively stable individual preferences that reflect socialisation; some have suggested that they may be conceived as a type of disposition (Bilsky and Schwartz, 1994). Thus, as Verplanken and Holland (2002) point out, values are culturally shared, but individuals differ in terms of how they rank the importance of specific values, while values themselves may be an important part of a person's self-esteem.

Allen and Ng (1999) suggest that psychological values shape users' evaluation of products in two ways. Firstly,

users are assessing a product's *utilitarian meaning* and making a piecemeal, attribute-by-attribute judgement. Secondly, users are evaluating a product's *symbolic meaning* with *affective, intuitive and holistic judgement*. In summary, psychology considers values to be personal representations of goals that are important and appropriate to maintain in the long run. An individual's interpretation of the relative importance of certain values depends on the culture and socio-economic status of the person (Flanagan et al., 2005) and the practical context (Verplanken and Holland, 2002).

In marketing sciences, the concept of *customer perceived value* (Pura, 2005) refers to the value that customers perceive receiving or experiencing through the offering (Bettman et al., 1998). However, it is recognised that *customers may perceive value differently, based on their personal needs, preferences and financial resources* (Ravald and Grönroos, 1996). In addition, it is recognised that value perceptions may differ according to usage situation (Anckar and D'Incau, 2002). Sheth et al. (1991) have created an extensive framework of consumer values. The framework includes five value dimensions: functional, social, emotional, epistemic, and conditional. By applying a broader scope, values can be used to predict or explain the acceptance and attractiveness of new systems or products in organisations or by masses of consumers.

Value-sensitive design (VSD) seeks to design technology that accounts for human values throughout the design process, and is influenced by participatory design experiences (Friedman, 1997). On the other hand, value-sensitive design confronts a diversity of values. Nowadays western culture, no longer representing uniform values, instead comprehends pluralistic values (Gould, 2005). Thus, values may be conflicting, and incorporating them into design is difficult. Cockton (2004a) and (2004b) started to discuss the goals of HCI (human–computer interaction) and to speak for value-centred design (VCD). His main argument is that quality in use and adaptation to context is not enough, but that HCI should be broadened to include the concept of value as the ultimate goal of design. As Cockton (2006) refers to value as 'happy endings' in terms of system/product impact, the perceived value of the product is the final goal of the development work.

Kujala and Väänänen-Vainio-Mattila (2009) have clarified the concept of value from the user's point of view. According to these authors, the perceived value is not located in system/product properties but arises as a consequence of users' perception and experience of system/product. Thus, value does not automatically arise from product properties, but depends on the interaction of the user and the product in a particular context. In addition, users bring their psychological values, needs and goals to bear within that interaction. They argue that a product or system does not have any absolute value; instead, its value depends on the person who perceives it and that person's psychological values. As a conclusion, Kujala and Väänänen-Vainio-Mattila (2009) propose the term '*user values*' to describe users' psychological values that affect their views regarding the purpose, functions and characteristics that are important to them in a certain usage situation and context. Thus, user values are users' internal conceptions of what is

important in a certain usage context as opposed to their perceptions of products. They suggest that the plural form 'user values' is utilised to refer to user motivations as in psychology, and the singular form 'value' is used for the perceived value of the product or system. The concept of user values makes the motivational aspect of system/product usage visible to developers.

Value-sensitive design has called for the accounting for human values in a principled and comprehensive manner throughout the design process (Bochini et al., 2008; Friedman and Kahn, 2003). Human values may often seem to conflict with financial goals, and can often be difficult to describe unambiguously (Friedman and Kahn, 2003). In the work presented in this paper, we apply Schwartz's value model (Schwartz, 1992) for articulating and describing the values a new technology system can create for the different interest groups of the system, thus producing a method which can then be incorporated into the design and adoption decision processes of the system.

Schwartz (1992) defines values as concepts of beliefs that pertain to desirable end states or behaviours, transcend specific situations, guide the selection or evaluation of behaviour and events, and are ordered by relative importance. This coincides well with our proposed method in which we try to identify the motivation for the behaviour of the users. In this research, we use the Schwartz value model to build a conceptual framework for matching the perceived value arising from the perception and experience of a technology-facilitated system with a model of human values that represents concepts of beliefs and the conceptions of people who are exposed to the system. The Schwartz value model provides one way of classifying values. Another classification has been proposed by Friedman et al. (2006) for investigating human values with ethical importance in system design. Value classifications have been criticised (Le Dantec et al., 2009) because they restrict the analysis to a set of preconceived values rather than inquiring about the values that appear and are relevant in the particular usage context. Furthermore, although Schwartz's value model, for example, can be considered extensive in that it is based on a vast amount of user research, doubts have been expressed as to whether any value classification confined to a paper could be comprehensive (Friedman et al., 2006). We recognise the importance of value analysis based on a context-specific description of values. There is a real danger that value classifications can reduce the scope of analysis, therefore leaving out important context-specific details. We thus propose that both of these approaches – preconceived values and a context-specific description of values – be used and considered as complementary to one another rather than as alternatives.

Ross et al. (2008) have used Schwartz's value model to provide a common ground for understanding people in order to design technology-mediated interaction. They use human values as a means for understanding the ethics of individuals. They argue that human value theory can meet designing for meaningful mediation, as human values can be used for achieving desirable end states and behaviours.

Schwartz's value model has been used before in the context of designing technology-based services and systems

as tools for analysing value preferences of future user groups (Ross et al., 2008). However, the model has not been applied to an *ex post facto* (as defined by Le Dantec et al., 2009) analysis as presented here. The value classification presented by Friedman et al. (2006) has been used for a similar purpose. However, as Friedman et al. (2006) themselves note, the values in their classification are not fundamentally distinct; the classification is a collection of human values with ethical importance collected from various sources. Therefore, we believe that Schwartz's model can provide not only an additional analytical tool for value analysis, but also an expressive communication tool for modelling values for the purpose of comparison and decision-making, as it establishes a vocabulary and conceptualisation that can be used to describe value for different stakeholders.

3. Research focus and methods

As the focus of the study was on analysing and exploring the adoption of a novel technology-enabled service, we chose to use a case study method in order to gain information about a real-life context. We were able to follow and analyse the adoption of an attendance control system that was tested in a primary school in Oulu, Finland. The trial phase lasted for 14 weeks, from September 2008 to December 2008. Participating were two classes and a total of 23 pupils between the ages of six and eight (most of whom were just starting school). Before the trial, we requested permission from the parents for their children's participation in the trial and the related research. One of the participating classes represented a 'normal' first grade class. In this class, 16 children out of 19 took part in the trial. The group consisted of nine girls and seven boys, the parents of three children choosing not to allow them to participate. The other trial class was a special needs class. All seven children in the special needs class were boys. Four of the boys were first-graders and three second-graders. All children in the special needs class participated in the trial. The special needs children were diagnosed with minor conditions affecting their learning, such as dyslexia, difficulties with concentration or troubles with perceptive skills. A similar trial (not covered in this paper) was carried out concurrently at a local secondary school; the technology used in this trial was more advanced and its features more complicated.

Our research focus was two-fold. Firstly, our goal was to evaluate the subjective user experience and value created for the end users. The results could then be exploited in making decisions on designing or adopting similar systems in other contexts. Secondly, our goal was to test the potential of Schwartz's value model (Schwartz, 1992) for evaluating value creation in these kinds of contexts. If the model seems to help in understanding and modelling end-user values, it could be further explored to understand and model value creation in the adoption of new technologies or services.

The methods we used for evaluating and modelling the value created for the user by the new system were based on collecting information on subjective user experience.

We assume, therefore, that the value for the end users comprises the perceived, subjective experience of their interaction with the service and technology. In this study, we concentrated solely on perceived value, i.e. the value the users themselves judged, experienced and interpreted. We define the subjective user experience to cover both the sensory experience evoked by the interaction and the subjective interpretation of the experience. Ramachandran and Blakeslee (1998) call this 'qualia': the raw feeling of subjective sensations. We have adopted a phenomenological approach for understanding user experience, i.e. we understand user experience as a subjective, first-person phenomenon (Greenfield, 2000) that cannot be experienced directly by another person. Methodologically, the problem is how to capture objective research data about subjective experience that can be interpreted accurately and correctly by the researchers. In our study, the primary sources of data were the direct stakeholders (Friedman et al., 2006), i.e. the people who engage directly and actively with the system and subjectively interpret the experience. The direct stakeholders included three user groups: teachers, children, and their parents. Our research approach both recognises and adopts the principles of interpretive phenomenology used in psychology (Willig and Stainton-Rogers, 2008) to emphasise the role of interpretation on different levels. Firstly, the research subjects interpret their subjective experiences as stories and dialogue that can be shared and observed by the researchers. Secondly, the researchers interpret the data capture and explore meanings. Finally, the interpretations of researchers are validated in follow-up interviews with the key research subjects; in this case the teachers and coordinators of the trial.

Research on psychology and experience design shows that describing subjective experiences has its challenges; these include the recall problem (Robinson and Clore, 2002) and the difficulty of verbally describing one's emotions (Desmet, 2002; Reijnveld et al., 2003). However, our hypothesis is that subjective, first-person descriptions of an experience are nevertheless the most reliable source available for understanding and characterising subjective user experience (Greenfield, 2000).

3.1. Data collection methods

The data was collected within the context of a large multinational research project. The work described here was performed by researchers who were not responsible for the design or implementation of the adopted system. The role of the researchers was restricted solely to analysing the success of the adoption from the viewpoint of the direct users of the system. However, two out of the four authors of this paper were members of the project organisation, were able to attend design meetings as observers, and were active in communicating the results of the adoption within the project organisation after the trial had ended.

Druin (2002) has developed a typology of roles that children may have in the design of new technologies: user, tester, informant, and design partner. For each role, she also presents three underlying dimensions: the relationship to

Table 1
Summary of data collection methods and number of valid cases for each method.

Data collection method	Number of valid cases
First classroom observation and interviews with the first grade class	16 pupils 1 teacher
Second classroom observation and interviews with the first grade class	16 pupils 1 teacher
Classroom observation and interviews with the special needs class	7 pupils 1 teacher 1 special needs assistant
Telephone interviews with the parents of special needs children	6 parents
Paper questionnaires for the parents of 16 first-graders who participated in the trial	14 parents
Paper questionnaires for the parents of 3 first-graders who did not participate in the trial	3 parents

adults, the relationship to the technology and the goals for enquiry. The role we sought for the children was essentially that of an informant, i.e. the children provided us with information that could then be used in the design process. As the trial objective was concerned with the potential benefits of the attendance control system, it was essential for the children actually to use the technology in order to be able to articulate its potential uses and serve as informants. In the case of this trial the children's role was therefore both that of a user and an informant.

Given the difficulties that need to be overcome in describing and understanding user experience, we decided to collect data during the actual use of the system and to combine a variety of complementary data collection methods (Yin, 2003) in order to increase the reliability and validity of the results (Isomursu et al., 2007). The data collection methods used and the data collected during the field study are presented below.

The data collection methods and number of valid cases for each method are shown in Table 1.

3.1.1. Classroom observations

Classroom observations were made to collect information about how the children learned to use the technology and service, the kinds of routines they established after having used the system for some time, and the kinds of spontaneous reactions and discussions that took place when they used the attendance supervision service. Children in the first grade class were observed twice over the course of the research. The first visit took place during a very early phase of the trial: the attendance supervision system had been introduced only a day before the visit. At the time of the second visit, the attendance supervision service had been in use for 2 weeks.

The special needs class was observed only once, when they had been using the attendance supervision service for 2 weeks. No visit was conducted at the start of the trial because of practical difficulties in arranging a time for observation when the system was taken into use.

To compensate, a discussion was held with the teacher about her observations on early experiences related to adoption. The teacher's subjective interpretation of the children's experiences cannot, of course, fully substitute for the direct observation and capturing of children's stories. However, as the focus of this paper is not explicitly on analysis of issues related to the very early phases of adoption, we believe that the absence of an early visit to the special needs class had no major effects on the results presented here.

Observations of both classes were conducted during a normal school day by attending the first lesson in the morning. The login process was observed from the back of the classroom to minimise the disturbance caused by the researchers' presence. The children's behaviour and actions were videotaped during the observation.

3.1.2. Interviews

All the children participating in the trial as well as their teachers were interviewed in order to investigate their thoughts and experiences regarding the technology and service under evaluation. The interviews took place on the same days as the classroom observations. After attendance had been recorded and the children had started their schoolwork, interviews were conducted very informally by chatting with a few children at a time, either in the classroom or at a separate location. The interviews were semi-structured with an interview framework designed by the interviewers to guide and support the discussion in advance. The actual discussion, however, was largely free-formatted and followed the natural flow; the order of issues discussed, for example, varied between participants. The first-graders were interviewed twice over the course of the study.

The teachers were interviewed informally, partly in the midst of teaching and partly during breaks between classes. These interviews were also semi-structured, but followed a more formal and sequenced framework. Numerous opportunities, however, were reserved for the teacher's stories, observations, and interpretations.

The parents of six (out of seven) participating special needs children were interviewed over the telephone (two fathers and four mothers). The parents of the other child did not provide contact information for the interview. Interviews lasted from fifteen minutes to half an hour and were conducted a month and a half after the experiment began. Structured interviews were employed, with both open-ended and closed questions.

The aim of the telephone interview was to collect parents' thoughts on the service, opinions about the possible added value the attendance supervision service brought to their families, and suggestions as to how the service could be developed further to have a positive impact on their lives.

3.1.3. Questionnaires

Two separate short questionnaires were created for the first-graders' parents, one for the parents whose children participated in the trial and the other for parents who chose not to allow their children to participate. Questionnaires were made available to the parents a month and a half after the trial began. A total of 17 parents (out of 19) answered the questionnaires. All the parents of the non-participating children returned their questionnaire.

The goal of the questionnaire sent to the parents of the children who participated in the trial was to collect stories about their experiences during the trial period, opinions and attitudes towards the concept, and possible development ideas. The questionnaire was designed so that parents could explain their experiences and motivations for participating in the trial in free format, e.g. in the form of stories or opinions. The goal of the questionnaire sent to the parents of the non-participating children was to explore the reasons behind their decision to decline. Both questionnaires included closed as well as open-ended questions.

3.2. Data analysis process and methods

The data analysis process followed the general principles outlined by interpretative phenomenological analysis (Reid et al., 2005), which means that analysis was an inductive 'bottom-up' process that progressed from the participants' detailed descriptions and interpretations of subjective experiences towards transparent and plausible research results through interpretative (subjective) analysis.

Data collection activities performed during field work resulted in a set of transcribed observations, interview recordings and notes, and data collected through questionnaires. Data collection was performed by two researchers. These two researchers also participated in the data analysis, assisted by two additional researchers who did not take part in actual field work. The goal was to improve validity by combining both the reflexive accounting of researchers involved in data collection and an account of researchers outside the study (Creswell and Miller, 2000).

Data analysis started with case analysis meetings (Miles and Huberman, 1994). In case analysis meetings, two researchers participating in field work presented the material collected to a third researcher who did not participate in data collection. The meetings were guided by critical questions on case material, e.g. unexpected observations made, recurring themes within the subject group, etc. The themes arising from the case analysis meeting were backed up by examining the original field work material for illustrative examples, e.g. observation notes or excerpts of answers given to open questions.

The data were coded and recoded concurrently with case analysis meetings. The focus was on identifying coherent themes and discrepancies from the collected data through content analysis (Weber, 1990). It is important to note that at this point the data analysis was purely bottom-up; Schwartz's value framework was not used during the first phases. Coding was primarily done by one researcher, who then presented the results of her analysis in separate analysis review meetings for peer debriefing (Creswell and Miller, 2000). In the analysis review meetings, discussion took place on the coding and results of content analysis; as a result, recoding was discussed, proposed and later carried

out. The material was analysed as a consequence of this phase, and the results of the bottom-up analysis process reported in two separate publications. The first publication summarised the findings on subjective user experiences, describing how the user groups experienced the benefits and drawbacks of adopting the system (Ervasti et al., 2009a). Le Dantec et al. (2009) refer to these empirically derived contextual value descriptions as 'local values' to emphasise how contextualised and local descriptions of value are captured and respected. The second publication analysed the findings to suggest design implications for similar services (Ervasti et al., 2009b).

We realised, however, after completing the bottom-up research analysis and publishing the results of the interpretative analysis of subjective user experiences and related design implications, that the research material could still provide new insight, particularly with regard to the question of subjectively experienced value. In an extensive survey of models and methods for modelling human values, we came upon the Schwartz value framework. The case material was then examined and analysed again using the Schwartz value framework as an analytical tool. Coded and analysed data was re-examined with the specific goal of analysing the experienced value of each user group. The initial analysis was performed by a researcher who had not participated in the field work but had participated in the analysis process. Her analysis results were presented to two researchers who had participated in the field work and then again to a new researcher who had not yet participated either in field work or analysis to improve analysis validity. Once again, the analysis results were backed up with original field work data. Several iteration cycles took place during joint analysis meetings and cooperative analysis work.

3.3. Validation process and methods

Validation of the data was carried out in two phases. In the first phase, the goal was to validate how accurately and credibly our results represented participants' realities during the trial (Creswell and Miller, 2000). This was conducted by process validation through addressing threats to validity in planning of the whole research process, including different viewpoints taken into the analysis (Ervasti et al. (2009a, 2009b)), from the data collection to analysis activities and finally validation procedures through the means described in Sections 3.1–3.3.

In the second validation phase, about 1 year after the trial, we had two-fold goals for the validation. Firstly, we wanted to validate the interpretations created with the help of the Schwartz value model through the process of member checking (Creswell and Miller, 2000), by taking the results back to the subjects involved in the trial. Secondly, we wanted to evaluate the descriptive power and usefulness of the model in supporting the design and the decision-making processes. The validation was carried out through discussions with one of the teachers participating in the original case study, and with the original case study coordinator.

In addition, some issues requiring further clarification were checked in a telephone interview with a teacher responsible for practical arrangements at the school where the case study took place. These three persons were selected because they had a good overview of the whole process, from planning phases to use of trial experiences in the decision process on adoption and through to further development of trialled service. The validation interviews followed a three-stage structure. Firstly, the interviewees were asked to describe the value of the attendance control system for each user group in their own words. This data was used to determine whether our analysis performed with the Schwartz model would cover and address all value parameters identified by the interviewees. Secondly, the Schwartz value framework and the results of the value analysis using this model were presented to the interviewees, and they were asked to comment on the analysis performed by the researchers. This data was used to determine whether the analysis credibly described the participants' experiences. Finally, the interviewees gave their opinions on the usefulness and descriptiveness of the Schwartz model for analysing and describing human values in the context of adopting new technology, both in design and decision-making.

Bringing the results back to the children was also considered; we decided against this notion, however, as explaining the Schwartz value framework and the results of the value analysis to children of this age would have required careful methodological consideration. It was not possible to address the children's parents as the school administrators specifically asked that the parents be interfered with as little as possible. All validation interviews were carried out, transcribed and coded by one of the researchers who conducted the original data collection for this research. The data was then analysed in a joint analysis meeting with three of the authors of this paper.

4. System description

Designed to simplify attendance monitoring and to replace roll calls, the trialled attendance control service does not require teachers to mark absences manually in the backend system, thus leaving more time for teaching. In the attendance supervision trial, pupils were given contactless smart cards named 'Robo', containing the pupil ID. Similar trials had been carried out earlier, for example in the United States (San Francisco Chronicle: Lucas G., 2005; Illuminati News, 2008). The system was developed and evaluated in a large research cooperation project called SmartTouch. The city of Oulu was responsible for coordinating system development and piloting, using subcontractors for constructing the system described here. The case study described in this paper and the related value analysis were performed by researchers and organisations not involved in the actual construction and adoption of the attendance control system and related services. Two authors of this paper were involved in the SmartTouch project, but the other two were from organisations not involved in the actual project.

The role of the researchers contributing to the research presented in this paper was solely to examine what happened during the adoption and piloting phases. They did not participate in the design and construction of the system, or in the related decision-making.

Separating this technology from many other RFID-based school attendance control trials was the fact that the system was based on NFC (Near Field Communication, see definition at http://www.nfc-forum.org) technology. This means that the identification embedded in the smart card cannot be read from a distance. The user is required to either physically touch or bring the card very close to the reader in order to allow the identification number to be read (as shown in Fig. 1).

Upon arriving at school, the first-grade pupils touched a smart card reader with their cards (as shown in Fig. 1) and the special needs pupils touched a mobile phone integrated with an NFC reader (as shown in Fig. 2) to mark that they had arrived at school. One of the goals of the trial was to evaluate and compare the use of stand-alone readers with mobile phones as reader devices. However, this evaluation is

Fig. 1. Pupil touches a reader device with a contactless smart card in order to log in at the school.

Fig. 2. Children logging in at the school in the morning by touching the teacher's NFC phone with their contactless smart cards.
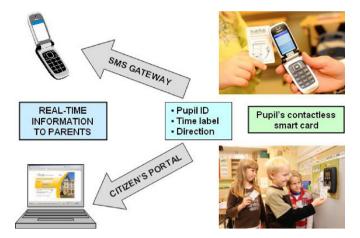

Fig. 3. Overview of the attendance supervision system.

outside the scope of this paper. At the end of the school day, the pupils touched the readers again to mark their departure. The same attendance control system was used in extended day care programmes to which some children went after school.

In a concurrent trial at a local secondary school, students followed a similar procedure for marking their class attendance, in this case using NFC-enabled mobile phones. The younger primary school children used smart cards instead of mobile phones because their parents and teachers were worried that the children might lose or accidentally break the more expensive mobile phones. In fact, none of the children lost a smart card during the trial period.

A log of arrivals and departures was automatically compiled by a background system. The teacher could read the log in real time in the classroom. If there was no login, the child was marked absent by default. If a child logged in late, the backend system recorded the time when the child marked the arrival.

Parents were able to obtain information on their children's attendance details via an online 'citizen's portal', and also, in the later phase of the trial, through text messages sent to their mobile phone. The school health department, special education teachers, curator and other school staff members could update the backend system if, for instance, the pupil had a dental appointment. In this case, the pupil did not need to worry about being absent. The service could then be used to detect truancy by informing tutors, administrators, and parents of absences in real time, enabling instant intervention.

Fig. 3 shows an overview of the attendance control service at the primary school and in the extended day care programmes.

5. Value creation model

We apply Schwartz's value modelling framework (Schwartz, 1992) for modelling and creating an understanding of the value created by the new system for the end users. We have defined the end users in this case to be (1) the children using the
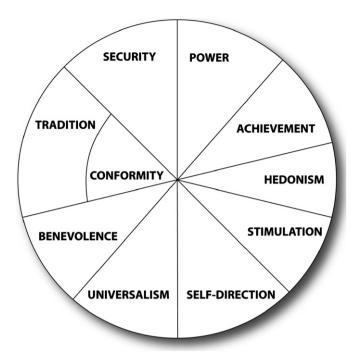
Fig. 4. Schwartz's value types (adapted from Schwartz, 1992). The representation illustrates the conflicts between value types, e.g. hedonism versus conformity and tradition.

attendance control service, (2) their parents, and (3) the teachers of the children who used the system.

Schwartz's value model structures human values into ten value types, and nearly 60 individual values (see Fig. 4). His view of values is that people use them as criteria for evaluating and justifying actions. The criteria are utilitarian—they represent goals that respond to the needs of individuals as biological organisms, the requisites of coordinated social interaction, and the survival and welfare needs of groups. Utilitarianism is based on intrinsic value—things are seen as good or bad in themselves. Utilitarianism makes happiness or wellbeing of humans a moral standard—that which increases our happiness or wellbeing is morally right (Shaw, 1999). Our phenomenological analysis of value emphasises the subjective experience of intrinsic value, that is, interpretation of the value by the users. Our analysis reveals how the participants of the study themselves interpreted (according to the interpretation of the researchers) the way in which their subjective experiences increased or decreased their happiness or wellbeing. Although originally derived from a utilitarian perspective, Schwartz's value model forms such an extensive classification of values that it can provide an analytical tool for a phenomenological examination of values.

Schwartz's value model is based on the principle that values are always ordered by relative importance. Interaction or technology that helps users engage in behaviours or achieve end states that correspond with the values that are high on their personal hierarchy of importance can provide the highest value benefit. On the other hand, if the technology successfully provides value in an area that does

not rank high in the personal value hierarchy of the user, the perceived benefit for that person is not significant.

The value types Power, Achievement, Hedonism, Stimulation and Self-direction primarily serve individual interests. The Power value type includes values related to wealth, authority, social power, preserving public image and social recognition. The Achievement value type emphasises demonstrating competence, especially with a view to obtaining social approval. Hedonism includes values related to pleasure and sensuous gratification, whereas the Stimulation value type is based on a need for arousal and variety that keeps activation and attention at an optimal level. The Self-direction value type includes values related to independent thought and action, e.g. freedom, creativity and choosing one's own goals.

Benevolence, Conformity and Tradition primarily serve collective interests. Benevolence refers to values contributing towards the wellness of the people one interacts with closely on an everyday basis, including, for example, helpfulness, loyalty, honesty, and responsibility. The Conformity value type includes values related to not performing actions that are likely to harm or upset others or violate social norms. The Tradition value type emphasises respect towards customs and ideas that have been accepted to represent shared experience and fate.

Schwartz locates Universalism and Security on the boundary of values serving individual and collective interests, and hypothesises that they have features of both. The goal of Universalism is to appreciate and protect the welfare of all people and nature. The Security value type contributes towards safety, harmony and stability in society. It can have both an individual (e.g. health) and a group focus (e.g. family or national safety).

We have not used Schwartz's model and related survey instruments for modelling or analysing the value priorities of our trial users. Instead, we have applied the value model to analyse how the value created through adopting the new service corresponded to the value priorities of our trial users. Our hypothesis was that the value priorities of the users would become evident from their subjective descriptions of the user experience and their analysis of perceived value.

We base our method on Schwartz's value model for various reasons. Based on a vast amount of research data from different cultures, the model is an ambitious attempt to identify the universal structures and content of human values. Finland has been one of the studied cultures from the very beginning (Helkama et al., 1992) and the theory has been successfully applied to a long-term study of Finnish consumer attitudes (Puohiniemi, 1995, 2002). We also felt that Schwartz's graphical presentation of the key features in his model (i.e. relations among motivational types of values, higher order value types, and bipolar value dimensions) could provide a good basis for the visualisation of the subjective values and their user priorities that can be found using our method. The visualisation we developed can be seen in the pie charts appearing later in this paper. We felt that these visualisations would provide an excellent tool not

only for the researchers' own analysis work but also when discussing or analysing the results with the users or presenting the results to other interest groups unfamiliar with value analysis.

6. Analysis of value creation

Schwartz's value model (Schwartz, 1992) was used to interpret and structure the subjective user experience data from the perspective of value creation. In this section we analyse value creation from four viewpoints:

1. The value that the end users were expected or assumed to gain by adopting the new service. This is the viewpoint of the designers during the planning, design and implementation phases. During service design, participatory design methods were used, where the teachers and school administration played a strong role as the design partners of the technology providers.
2. The value created for the children using the service. Two groups of children participated in the trial studied here.
3. The value created for the parents of the children participating in the trial. To better interpret the results, we also used the data explaining the reasons why some parents chose not to allow their children to participate.
4. The value created for the teachers who taught the children using the service during the trial period. The children usually had only one teacher during the school day.

We restricted our focus to first-hand users of the system. For example, other family members and people working in the school administration were left outside the scope of this paper. We also explored value creation from the viewpoint of subjectively experienced value only, i.e. the value that can be identified through the subjective experiences of the users. Here, we do not evaluate the created value through objective measurement, e.g. we did not evaluate whether the adoption of the system actually decreased the amount of calls parents made to teachers to check on their children, nor did we objectively measure whether the service saved time for the teacher.

In our analysis, we concentrate only on value types that were relevant for the users in the context of the trialled service, and exclude other value types from the discussion. We also prioritise the value types to reflect the order of their importance for the user group in question.

6.1. Expected value

Traditionally, teachers monitor pupil attendance every morning with roll calls, and mark absences and delays in the backend system. This requires time and effort every school day that could be used for teaching. Human errors in attendance markings are possible and difficult to prevent. Children beginning school in Finland travel to school (after the first few weeks) largely on their own, either on foot, by bicycle, or by bus. The parents of young children therefore regularly call their children's or teachers' cell phones to ensure the child has made his/her way to school safely. The daily journey between school and home has been found to be important for families of school children, especially from the time management viewpoint (Fraser et al., 2006). Answering parents' calls takes up teachers' time, consuming resources that could be used for teaching. Some research indicates that modern parents are getting more worried about the road safety of children, even though accidents involving children have in fact decreased during recent decades (Jensen and Hummer, 2002).

The guiding design goals used during the design phase were therefore as follows:

1. To increase the reliability of absence control by eliminating errors caused by manual recording.
2. To save the teacher time in marking absences by giving full responsibility for marking arrivals and departures to the children.
3. To provide parents with real-time information on whether their children have arrived at school or not, and when they have left the school.

6.2. Value for the children

In this section, we present the analysis of user experience data from the point of view of the children using the service. The relevant value types (shown in Fig. 5) identified during the analysis are presented in the order of relative
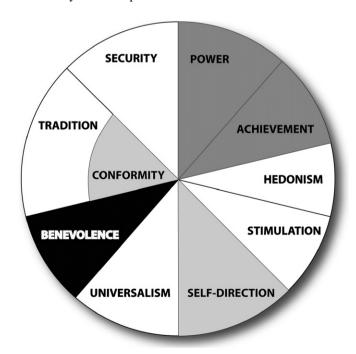
Fig. 5. Summary of the value types found relevant for children using the attendance control service. Black represents the highest priority and lighter shades indicate lower priorities.

importance. The value type that we analysed to be the most important and relevant for the children, i.e. Benevolence, is described first. The other value types that were identified as relevant for the children in the context of attendance control service adoption are Achievement, Power, Conformity and Self-direction. The Achievement and Power value types seemed to be somewhat stronger than the last two.

6.2.1. Benevolence

The value that was most profoundly evident when the children described their experience with the service was Benevolence. The children appreciated that they could be helpful and use the service for positive interaction in order to assist people they had close contact with, i.e. their parents and teachers. It was very important for the children to receive feedback from the system of a successful marking of arrival or departure. They took notice if feedback on a successful transaction was not received because of a system failure, and wanted to correct the situation immediately.

When asked why they used the service, the children usually replied that the service was in use so that their parents could obtain information about their school day. The following comment made by a child during classroom observation and related discussion was a typical response:

> "Mum and Dad know at what time you have arrived at school and left home, and if you have stayed in detention." (Comment made by a child participating in the trial.)

6.2.2. Achievement

The technology-supported service seemed to provide the children with a way to demonstrate competence. The children were proud that they were given responsibility for taking care of their very own smart contactless cards and that they were able to master the technical components. For many children, the trust of the adults seemed to be a boost for their self-esteem, which has also been shown by previous research in a school environment (Attewell, 2005). Schwartz also argues that the Achievement and Power value types together contribute to self-esteem (Schwartz, 1992).

One of the teachers showed two children how to operate the reader device and its PC application, which allowed the children to master the whole process of recording attendance, from turning on the reader to being in charge of marking their own arrival at and departure from school. The children were proud that they were able to master the system without help from the teacher. This also saved time as the children had already done their check-in procedures even before the teacher arrived in the classroom.

The service and related technology provided children with special opportunities for achievement. One of the children in the special needs class designed the visual look of the smart card and named it. This was a source of special pride for the whole class and especially for that particular child. It is also seen that the children who were taught to operate the reader were able to demonstrate their special skills with technology

by being trusted with this task. This can be seen in the following comment made by their classmates:

> "…they were chosen because they use computers for more than just playing games." (Comment made by a child in the first-grade class where two children were taught to operate the reader.)

6.2.3. Power

As the trial did not involve the whole school, it provided the trial users with a means for status differentiation. The children felt that it was 'cool' to possess a smart card and this was a source of pride for them. Using the service gave them social power and recognition among their peers. This is well illustrated in the following comment made by the teacher of the class participating in the trial:

> "This has been a big thing for the children, since not all the classes have these cards in use. It has given the children a chance to stand out. They have something that others do not have." (Comment made by the teacher during informal discussion related to classroom observation.)

As many children had seen their parents carrying similar identification cards for use at work, they associated the card with power and authority. However, some parents saw this in a negative light, as they thought that children should not be hurried into adulthood, and smart cards are better suited to adults. One parent stated in the feedback questionnaire:

> "Children of this age should not need to be rushed into the world of cards and codes. They can do that later. First-graders already have enough new things to deal with in their world." (Comment made by the parent of a non-participating child in the feedback questionnaire.)

It also became evident that the technology was used as a means of status differentiation and positioning oneself in a social system when the children compared their smart card-based service with the same service that was used in the secondary school. In the secondary school, the user identification was done with an NFC-enabled mobile phone—not a smart card. The mobile phone clearly possessed a higher status value than the smart card, and children complained about that:

> "The secondary school children should have been given the smart cards so we could have the touch cell phones." (Comment made during an interview by a child participating in the trial.)

Power values were observed on a smaller scale in cases where the service was used as a tool of control and dominance. The child could choose not to record his or her arrival at school as a sign of rebellion. However, using the service to create authority value did not come out strongly in our trial group, as the Benevolence value type was much stronger in our trial groups (also observed in children of this age group by Borland et al., 1998).

We assume that this might be different with older children and teenagers.

6.2.4. Conformity

The children did not seem to question or impugn the use of the service, but rather conformed to the expectations of the teachers and parents. They seemed to think that using the service was 'part of the game' if the teachers and parents said so.

6.2.5. Self-direction

Even though Benevolence was found to be the most important value for the children, the service also gave them opportunities for self-direction. There seems to be a conflict between Benevolence and Self-direction combined with the Power value type. The children seemed primarily to value Benevolence, but sometimes showed signs of rebelling by abusing the power the service gave them over their parents (e.g. throwing the smart card away and regretting it soon after); on the other hand, they appreciated the fact that they were given an opportunity to be independent and responsible for marking their attendance.

The service enabled the children to act autonomously and independently when marking their attendance, and even choose not to do so, if they wanted. Also, the children were trusted to keep the smart card with them. The children usually took pride in taking care of the card and stored it in a special place so that they would always remember to keep it with them. One parent commented:

> "My proud and eager child has remembered it well." (Comment made by a parent in the feedback questionnaire.)
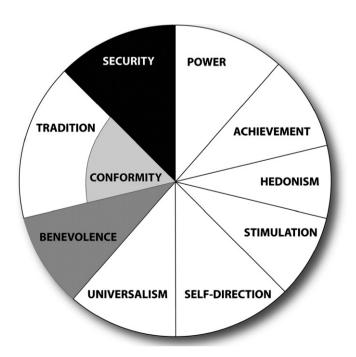

Fig. 6. Summary of value types found relevant for parents using the attendance control service.

This is a value that did not come up strongly within our trial group. However, we assume that Self-direction values would become more profound among older children and teenagers.

6.3. Value for the parents

Even though Security was the value type most visibly observed in the data collected from the parents, the trial service caused mixed feelings towards the value created for Security. The parents saw the possibility that the service could provide Benevolence value by giving them timely information that could be helpful if the child skips classes or is repeatedly late, but they considered this value to be somewhat hypothetical in the case of children of this age. The parents appreciated the efforts the school put into trying to improve communication and cooperation between the school and families, and wanted to participate in the trials because they wanted to conform to the rules of the school. The value types that were identified as relevant for the parents are shown in Fig. 6.

6.3.1. Security

The value that was most profoundly evident when parents described their experience with the service was increased Security, leading to peace of mind. The most prominent individual values were safety and family security. Worries about the safety of children were described by one parent as follows:

> "…life changes all the time, it becomes fiercer." (Comment made by a parent during a telephone interview.)

In the cases of families where family members were separated, the service also provided value by increasing the sense of belonging, by giving distant parents access to information about the daily routines of their children. This increased their feeling of being more involved in the lives of their children.

However, even though the guiding design principle of the service was to increase the feeling of security, the trial revealed that in its current form, this design goal was not always met. For example, as the children mark their arrival at school inside the classroom, the time between leaving home and marking their arrival was occasionally rather long. The children sometimes played for a while in the school playground before going inside; in other cases, system failures might cause a delay. Here the service could lead parents to worry. In some cases, parents called or sent a text message to the teacher to check to see if their children had arrived at school, because of the delay in the arrival message. Furthermore, some parents faced information overload in their work environment, and having yet more information to follow up actively served to provoke concern and anxiety. This is illustrated in the following comment from a parent:

> "In this insecure world, it is good to know where your child is, but parents already have their hands full dealing

with the flood of information and reading messages. So I feel that the 'traditional' way should be enough. But naturally, if there is a fear that the child is skipping classes or thinking of wandering away from school, then the attendance supervision service is a good thing." (Comment made by a parent in the feedback questionnaire.)

The three parents who chose not to participate in the trial all criticised technology as a tool for security, as they were concerned it would decrease human responsibility and safety-ensuring activities. This is well illustrated by the following quote:

"The safety of the child is created through the genuine presence of an adult and not through a control system." (Comment made by the parent of a non-participating child in the feedback questionnaire.)

Even though the parents were interested in the service and thought positively of it, the current implementation of the system still seemed to create some confusion and insecurity rather than make the parents feel more secure.

6.3.2. Benevolence
The parents saw the service as a means of having instant access to important information for making responsible and timely decisions if something goes wrong with their children. This dealt not only with the security issues, but also detecting whether the child skipped classes or was repeatedly late. However, as the children in our trial group were very young and had just started school, skipping classes was not a real problem. The parents in the trial therefore thought the service could be more useful to the parents of older children.

6.3.3. Conformity
The request to participate in the trial was made by the school. The parents seemed to honour the requests made by the school in order to maintain smooth interaction and wanted to contribute towards functional cooperation between school and home. Where the parents did not have a strong opinion or interest towards the trial, they usually agreed to take part due to Conformity. Only those parents who had strong opinions and reasons for not joining the trial chose not to take part. The social expectation seemed to be that declining a request made by the school could be socially disruptive.

However, there were three families in the first grade class who chose not to participate in the trial. They all explained their reasons for declining in the feedback questionnaire. Conformity appears not to have been a very strong value affecting the decision to take part in the trial. Of course, the fact that parents were aware that the trial lasted only for a fixed period means that the experiences from adopting the service cannot be applied as such to long-term use situations.
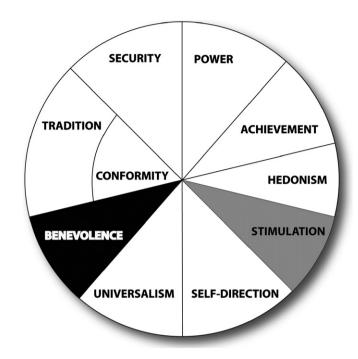

Fig. 7. Summary of the value types found relevant for the teachers of classes that used the attendance control service.

6.4. Value for the teachers

The teachers experienced that the service could support them in fulfilling their responsibility for recording absences by automating both the entry process and reporting, thereby eliminating manual work and decreasing the chance of human error. The teachers participating in the trial were open to new ideas, and volunteered for the trial. However, if the service were to be deployed on a wide scale, it cannot be expected that all teachers would be as open and willing to explore new practices as the teachers participating in this trial. The value types that were identified as relevant for the teachers are shown in Fig. 7.

6.4.1. Benevolence
The teachers saw the service as a helpful tool as it provides both school and home with information that may be helpful in making better decisions related to children and their lives. It is the responsibility of the teachers to report children's absences, and the service could help them to do so reliably. It helped them, therefore, to fulfil their responsibilities.

The teachers did not raise the possibility of the tool removing or decreasing their responsibilities by transferring from the teacher to the service, for example, the responsibility for informing about children being repeatedly late, or even absent from school. On the contrary, they emphasised that the system should not remove their obligation in the active communication between school and home. However, this concern was raised by some of the parents who were critical towards the service, as can be seen in the following comment:

"If parents cannot trust that the teacher knows where the children are (ill, at school, on holiday, etc.), something is

really wrong." (Comment made by the parent of a non-participating child in the feedback questionnaire.)

The teachers also felt that all means should be used for increasing the communication between school and home. The teachers' viewpoint was that all additional data was therefore welcome, and would help the cooperation of teachers and parents.

6.4.2. Stimulation

The participants had a very positive attitude towards new technology in general. The teachers welcomed technology-supported services as they brought variety to everyday teaching routines and provided opportunities for teaching technology-related skills to children in a stimulating and interesting way. The children were excited about the new service, sparking enthusiasm and interest towards technology and related processes.

The trial had also triggered thought processes about the possibilities of attendance control systems, as well as the wider use of technology in the school environment. These thought processes continued after the trial. The teacher interviewed one year after the trial recounted that, because of the trial, she had been thinking a lot about technology and its possibilities. She had a lot of ideas for further development of the trial system and novel ideas for using technology in other contexts. These ideas had clearly evolved after the trial. She considered the trial application useful in bringing technology close to children's everyday lives and routines. She believed this especially important because she thought children learn to use technology mainly through entertainment applications; these, in her opinion, give children a very limited and even distorted image of the possibilities of technology.

The teachers participating in the trial were very open to new ideas and were ready to explore new working practices. This was probably because participation in the trial was more or less voluntary. It would not be fair, however, to conclude that all teachers would be as open to new ideas and practices. Schwartz has extended his value model with bipolar value dimensions that propose that people who give high priority to the Stimulation and Self-direction value types are more open to change than people who prioritise Tradition, Conformity and Security (Schwartz, 1992).

7. Validation of the interpretations and analysis results

Although no major errors or misinterpretations in the initial results, compiled solely on the analysis performed by the researchers, were uncovered during the second phase of the validation taking place about 1 year after the trial, the validation of the interpretations and analysis results presented in this paper nevertheless revealed many additional details.

In the validation interviews the interviewee was first asked to describe in her own words the value of the attendance control system for each user group. No new value

parameters compared to the Schwartz model emerged from these discussions. The end result of the pilot was considered to be very successful for all the user groups:

"I think that the pilot was very successful. It was needed and the parents liked it and it wasn't too troublesome for the teachers and all the feedback I got from it was positive." (Comment made by the teacher responsible for practical arrangements of the trial.)

"In spite of the technical problems it was a very nice experiment. […] Children liked to log in and out and they understood the idea behind it. […] Afterwards children inquired why we weren't doing it any more." (Comment made by the teacher involved in the trial.)

The Schwartz value framework and the results of the value analysis using this model were then presented to the interviewee, and she was asked to comment on the analysis performed by the researchers. All the interviewees agreed with the analysis results. However, at this stage the validation revealed that the interviewees' experienced value had clearly evolved, even after the actual trial phase. The interviewees had processed the experiences after the trial, and this had resulted in experiences that could not have been observed or collected during or immediately after the trial. In particular, the teacher who was involved in the trial recounted that the trial had led her to think more about the possibilities of the attendance control system and similar technology-supported services:

"It has stuck in my mind… It would be nice if some applications of the technology would come into everyday use." (Comment made by the teacher involved in the trial.)

She had become aware through this process of potential cases where the attendance control system could bring value for its users. An example of such value potential related to the possibility of locating individual children quickly in the case of emergencies, where evacuation or other emergency actions were needed:

"… As the school buildings are rather large, students go from one part of the building to another… it would be possible to know – if there was a need to know – where that child was at a given moment." (Comment made by the teacher involved in the trial.)

The trial coordinator had also thought of other uses for the system. She talked about a 'city card' where smaller children could use the card for attendance monitoring, and then for other purposes when monitoring was no longer necessary:

"When it is no longer needed for attendance monitoring, they could use it for payment on buses. […] Some age groups use a card in this way, but the same card could be used later for the swimming hall or in the library. It would be a comprehensive service system, and attendance monitoring of first-graders could be just one part of it." (Comment made by the trial coordinator.)

These are definite examples of experienced value that did not appear during the trial period. Totally new value

parameters (compared to the ones researchers had analysed based on the original data) had emerged because of trial-related incidents that had taken place after the actual trial phase. For example, the school involved had received positive attention and interest from other schools in the same school district, and also from abroad:

"We had visitors at school [from Italy and Germany, after the technology trial had ended] and I showed them the video that was made of the technology trial, and the visitors were extremely interested in the subject." (Comment made by the teacher involved in the trial.)

"This case activated other [local] schools. [...] Especially in schools having emphasis on, for example, art or sports the teaching staff asked 'When can we get this? We want this right now!'. In those schools students go in and out of the classroom during regular teaching. Teachers have problems knowing who is in the classroom and who is not, and where the students are." (Comment made by the trial coordinator.)

This resulted in value experiences related to Power value, as the school and its employees realised that they had participated in something that was appreciated by their peers outside the school. These observations show that experienced value is highly dynamic, and will evolve even after the actual technology-supported service is abandoned.

At the last validation interview stage the interviewee was asked her opinion on the usefulness and descriptiveness of the Schwartz model for analysing and describing human values in the context of adopting new technology both in design and decision-making. All the interviewees participating in the validation process thought that the Schwartz model was easy to grasp and understand, and that the supporting graphical presentations of the experienced value were descriptive and could be useful in supporting the communication to decision-makers of the experiences from technology trials. The trial coordinator commented that there is a need for compact and readable methods for presenting experiences from trials to decision-makers (usually politicians), and she saw the Schwartz model as one good candidate for such a method:

"Nowadays a cost-benefit analysis is made of all the new technologies. [...] Things that can't be measured in Euros are difficult to put forward. [...] We should be able to evaluate the value index [of a new technology]. Politicians, having very different backgrounds, all understand numbers. It's easier to make decisions then. It would be a really helpful tool." (Comment made by the trial coordinator.)

The interviewees also thought this kind of tool could be useful in technology trials during the early phases of the design process, to help system designers note and take into account different viewpoints on system use:

"Of course. Definitely this would be useful. [...] It would be good in these kinds of trials to have something like this included, some kind of 'value consulting'. If we were able to plan [value-related issues] it would be possible to maximise and direct the trial in a very different way." (Comment made by the trial coordinator.)

"The trial would have been a good tool to discuss technology-related issues with children. If we had been able to think about these beforehand we could have created some supplemental material for the school." (Comment made by the trial coordinator.)

Thus we conclude that by using the Schwartz model as a framework for discussion, subjects were able to bring forward details that had not previously been verbalised or observed. This may indicate that the model could be helpful as a tool for collecting data on experienced value, as it structures the discussion and may help the user to verbalise tacit knowledge related to experienced value. However, even though there was no indication in our validation that the Schwartz value model would exclude any experienced value areas in this case study, it must be noted that the Schwartz model specifically aims to model human values that are global and not culturally dependent. If followed strictly, some culturally specific value areas could go unnoticed.

8. Limitations and threats to validity

As the users were aware that they were being studied and observed during the trial, the variables suggested as being responsible for the Hawthorne effects – such as special treatment or attention, change in routine, novelty, enthusiasm related to trying out something new, etc. – probably affect the results. The parents, children and teachers all knew that the goal of the trial was to study the effects of adopting the attendance control system, and therefore knew that their behaviour was being observed and opinions taken into account. In particular, the young children's reactions to testing situations, curiosity over strangers, changes to normal routines and their teacher's attempts to ensure they perform well in testing situations, all set challenges in arranging a controlled testing environment and interpreting the results (Diaper, 1990). In this setting, the following steps were taken to tackle these challenges. Firstly, the uncontrolled novelty effects were addressed through a relatively long trial period, i.e. 14 weeks. Studies made on the novelty effect of media comparison studies with pre-teen and teenage children suggest that longer duration studies dissipate the novelty effect. In studies lasting 4 weeks or less, novelty effects were estimated to be half the standard deviation. This declined to two-tenths of the standard deviation after eight weeks of data collection, accounting for less than one per cent of the variance (Clark and Sugrue, 1991). Secondly, to reduce the effect of special attention from interesting outsiders, the researchers did not interfere visibly with the trial during the 14-week trial period. Data collection requiring face-to-face interaction with the trial users was arranged at the beginning and end of the trial.

In addition, the users knew that the trial was planned to last for a fixed period. This reduced the need to create strategies for integrating the new practices into the everyday lives of the users, and probably affected the psychological processes related to the irrevocability of the decision. Psychological research indicates that the irrevocability of a decision is likely to intensify (Cummings and Venkatesan, 1976) the processes that reduce the cognitive dissonance (Festinger, 1957) caused by the decision, and thus aligns attitudes towards the decision to match the behaviour. In addition, our observations indicate that users were quite tolerant towards minor inconveniences, as they knew they would not have to deal with them for long, and therefore chose not to invest time and energy into attempts to correct them.

Using a specific framework (here, Schwartz's value model) to analyse and interpret the findings from qualitative research can lead to confirmation bias. In this work, peer debriefing and member checking (Creswell and Miller, 2000) were the main tools for dealing with the confirmation bias (see Sections 3.2 and 3.3 for further details). The first analysis and interpretation with the Schwartz model was reviewed by the two researchers originally responsible for collecting the empirical data, and by one additional researcher who had not previously participated in this work. Member checking was carried out to examine how the participants and people involved in the trial judged the degree to which the resulting descriptions and interpretations represented their view of reality.

Since the scope of Schwartz's value model is very broad, there is the danger of over-generalising the results of our study. This paper examines the impact of a particular technology in a particular environment, and our research has not addressed the use of the model outside the scope of this particular setting.

9. Conclusion

As our research goal was two-fold, we present our conclusions in two parts. The first part discusses the issues we learned from exploring value creation in the adoption of technology-supported attendance control in a school environment. The second part concludes the methodological findings on using Schwartz's value model (Schwartz, 1992) in understanding and modelling the value created by adopting technology to support everyday life.

9.1. Adopting attendance control in school

Our analysis shows that a technology-supported attendance control system can bring value for all end-user groups. Initially, it seemed that the system would primarily serve teachers and parents (see the design goals in Section 6.1), whereas the children would do all the work without obtaining direct benefits. Perhaps surprisingly, the children were the group that seemed to be most pleased with the service. The children's descriptions of their experiences were positive and enthusiastic. With Schwartz's model of human values, we were able to interpret and understand the value children themselves perceived receiving from the use of the service.

While everyone certainly shares the goal of improving communication between school and home, this trial showed that merely increasing the amount of information and data transfer does not necessarily improve communication. Parents may feel that automated information delivery decreases the responsibilities of school personnel. Furthermore, unclear and misleading information can cause needless misunderstandings and worry. Information overload is a problem faced by many people working in a modern office environment, and parents may feel they are given responsibilities they cannot fulfil from a distance.

Of course, the value evaluation presented here does not prove that the system actually changed or improved the children's security, or saved teachers' time for something more important. Subjective perception of value does not necessarily correlate with objective measurements of the same parameters. For example, previous studies have revealed that while statistics show a reduction over recent decades in the number of road accidents involving children, Danish parents report an increase in their concerns about their children's road safety (Jensen and Hummer, 2002). Furthermore, it is difficult to gauge the time saved through roll calls not having to be performed in the mornings, as it is not easy to compare this with the time needed for instructing users on how to use the system, configuring and repairing the readers, ordering new cards to replace lost ones, etc. As the focus of this paper is solely on subjective perceived value, the trial presented here does not show if the system actually increased security and safety or saved teachers' time.

It is absorbing to consider the role played by understanding and modelling value through a framework such as the one presented here with regard to decision-making in the context of public services. How should human values be considered in the decision-making process? In the economic marketplace of individual consumers and professional business services, perceived value can be a very important factor affecting adoption (Kim et al. 2007), repurchase decisions and user satisfaction (Patterson and Spreng, 1997). However, in the political marketplace of citizens and the collective decisions of representatives of democratic institutions, assessment of the role of the subjective value perceived by the users, or the clients of the public service in question, is tricky. Public services cannot be evaluated solely from the viewpoint of their users. Rather, their value must be investigated from the viewpoint of society and its citizens. By way of illustration, healthcare services cannot be evaluated only from the viewpoint of patients and correctional treatment cannot be evaluated only from the viewpoint of prisoners (Moore, 1995).

9.2. Methodological conclusion

Schwartz's value model (Schwartz, 1992) provided us with a framework for modelling and understanding the subjective, individual value perceived by the end users in the trial. The model can help articulate human values as it provides a
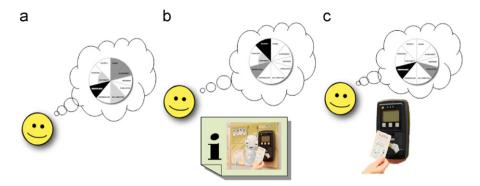
Fig. 8. Three perspectives on the modelling of perceived value for the individual. (a) value priorities; (b) existence value and (c) experienced value.

structure and vocabulary for modelling and describing value. Our experience shows that the model can be a powerful tool for identifying and prioritising the values that are relevant for each user group.

Our experience of using the model for the evaluation of the value created by adopting new technology indicates that there are three angles to value modelling that need to be recognised, evaluated and synthesised in the analysis process (Fig. 8). Firstly, the users and user groups in question each have generic value priorities (Fig. 8a) that are not directly associated with the system to be adopted, but are generic values that guide humans in their lives. The Schwartz value model (Schwartz, 1992) was originally defined to model these value priorities. These values exist before the user is in any contact with the evaluated system. Some users value stimulation over security, while others value conformity over hedonism. The value priorities can indicate the value types that provide the greatest potential perceived value for individual users: users who prioritise security over other values are likely to value technology that increases security more than technology that delivers hedonic pleasures.

Secondly, a technology or a service can provide value simply because it exists (Fig. 8b). All people exposed to technology or service have value expectations based on what they know about it, and they can perceive that it is of importance even if they do not use it directly. For example, people can recognise the value of public services related to the arts, such as theatres, museums or galleries, even when they do not visit them (Bakhshi et al., 2009). Similarly, people can value a high-quality, safe public school system even if they do not use the services of public schools. Our experiences show that most members of the community had strong value expectations towards the trial system, even though they were not taking part in the trial and were not in direct contact with people who used the system. The trial seemed to trigger strong emotional responses and value discussions that came to light in public discussion channels and presentations.

Thirdly, the users actually experience the value created by the system or service by using it (Fig. 8c). Experienced value is built through interaction and can evolve with time through daily interaction with the system and the social

setting. Experienced value is interpreted and quantified through the value priorities of the user; the more effectively the technology or service can provide value that is highly prioritised by the user, the greater is its experienced value. Experienced value, therefore, is always relative. This is well illustrated in our case example, where the parents expressed that the access control system added most value in creating security and it is thus shown as highest priority, i.e. in black in Fig. 6. However, the parents also felt that the system did not meet their own needs for added security very well and would likely be more useful elsewhere. They therefore rated even the value of security rather low, although higher than the other values.

Even though the original design goals assumed that the service would create value primarily for the parents and teachers, the result of the value analysis showed the richest set of experienced value to be for the children. This can be caused partly by unbalanced data collection (i.e. the user experience data collected from children might have been richer than the data collected from parents and teachers). However, we feel that it can also be caused by the poor understanding of values that were not directly related to the functional utility of the service, and the lack of attention given to them in design. The design goals of the service were very much focused on utility (as can be seen from the design goals described in Section 6.1). For example, the role of technology as a component in creating social power structures was neither understood nor addressed during the design phase.

In addition to perceived value, the value of a technology or a service can be evaluated through 'objective' measurements of the impacts of its adoption. For example, in the case of the attendance control system, objective measurements can include measurements of the time saved during lessons because the teacher did not need to perform roll calls or because the number of check calls from parents decreased. Long-term, large-scale adoption of the system could provide an opportunity to measure if its adoption improves security by, for example, decreasing the number of cases where children are reported missing.

The trial conditions clearly affected the users' value priorities and could also have had an effect on what values

each user group considered relevant. For example, if the service were to be used by all the classes in the school, it would no longer provide the same level of social power and would not act as a status differentiator. The children would therefore assign lower relative importance to the Power value type. On the other hand, the trial showed how technology can act in very versatile ways in the social power play of children. Knowledge of this fact at the design phase could have resulted in a more subtle and creative system design.

10. Future work

It is obvious that value creation was not fully understood during the design phase, i.e. the designers of the system were not able to envision the values experienced and prioritised by the end users. Even though we believe it is impossible to predict and understand all the details of value creation before actually adopting the service, as human values seem to unfold and become visible through interaction and use, it would be interesting to explore the use of the value model at the design phase.

As discussed in Section 1, our first papers on this study (Ervasti et al., 2009a, 2009b)) did not consider Schwartz's value model. The analysis of human values related to adoption of the service, and discussion on how Schwartz's value model could help in this, was carried out post hoc. If the goal of the study from the start had been to evaluate the Schwartz model, methodologies and metrics targeting this question very specifically could have been used. In his original paper, Schwartz (1992) presents a survey instrument that can be used for measuring people's value priorities. This and similar instruments could be used at the early design phase to identify relevant values and model the value priorities of different user groups. The identified values and their priorities could then be used for directing design decisions towards creating value that is highly prioritised by the end users.

Schwartz (1992) also argues that the set of value types introduced in his model is rather comprehensive, including all the types of values to which individuals are likely to attribute at least moderate importance as a criterion of evaluation. This makes it possible to identify dynamic relations among the value types. For example, adjacent value types in Fig. 3 are compatible because the values that define the types are assumed to have similar motivational goals. Similarly, value types on opposite sides of the diagram are likely to cause conflict. Also, cultural structures can be identified in the value types.

It would be interesting to study the use of the above-mentioned interdependencies for the early identification of potential additional key values or value types for the user. This could make the early design of the system more on-target, resulting in better user feedback during the design process and, finally, in a product that would better meet the target users' value preferences.

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