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ORIGINAL RESEARCH

A situation-aware safety service for children via participatory design

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Abstract Children are mostly neglected as technology end users, even though they have needs and requirements that should be taken into account in the design of new products and services. This paper introduces a process for a designing situation-aware safety service for children with a unique combination of novel participatory tools, a brainstorming workshop, and scenario writing. The design process includes five phases where the service design team, with multi-science expertise, uses the participatory design tools to gather the needs, fears, and hopes from the end users in the very early phases of the design. We report the lessons learned from the usage of the design process by the pupils, their parents and teachers from one primary school in Finland. We used publicity via the news in local and provincial newspapers, radio, and TV to receive feedback and acceptance from the local society. The design process proved to be powerful and it enabled the gathering and receiving of valuable feedback from both end users and the local society.

Keywords Digital service · Service concept design · Participatory design · Owela · Scenario · SINCO

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1 Introduction

Future health and wellbeing services will only succeed if they respond to end-user needs, fit to everyday usage contexts and provide value for users. Too often services are generated without sufficient and early enough input and feedback from potential users and stakeholders. It is critical to the success of a service that the appropriate and representative users are involved in the development work (Kujala and Kauppinen 2004). The roles of users may vary from proactive participation, where users contribute to solving and framing design challenges, to an inactive role, where designers interpret user data without direct engagement with the user community (Keinonen 2009).

Design work should not be based on generic user models (Abras et al. 2004), since developers often have a vague or contradictory idea of the intended users of the service, and may base scenarios on people similar to themselves (Kujala and Mäntylä 2000). In addition, developers often underestimate the diversity of users (Kujala and Kauppinen 2004). However, design-based processes and methods can help in innovating customer-oriented service concepts.

Understanding about users often remains at a very basic level of user characteristics. Such an approach does not help designers in developing insight or identifying the

linkage for the users' in-depth service needs, motivations, and values to technology features (Kujala and Väänänen-Vainio-Mattila 2009), and, as a consequence, detail-level and fundamental design decisions are made without an explicit understanding of the relevant values that the users assign to the service. Therefore, one of the greatest challenges is to incorporate the "voice of the customer" into the design of new products and services (Van der Haar et al. 2001). The involvement of users and gaining a deeper understanding of them can ensure that the service will be suitable for its intended purpose in the environment in which it will be used (Abras et al. 2004).

To ensure good user experience—or even user delight—it is essential to gain an understanding of end-user needs, values, fears and concerns, and to turn this insight into user requirements. When the contexts of use and typical usage patterns are studied, design can be based on realistic use cases and scenarios, which help in selecting the right set of service features and creating natural use flows in the design. Finally, this helps in making technology that fits the users' everyday lives. Participatory design is a design approach where potential end users of the system have a critical role in designing it (Greenbaum and Kyng 1991; Muller and Kuhn 1993; Schuler and Namioka 1993). Further research is needed into the mechanisms of value facilitation and the co-creation of value, and the ways in which providers and customers conduct their roles and influence each other in these processes (Vargo and Lusch 2008a; Grönroos and Ravald 2011).

A service-centered view of marketing is customer-centric, which means more than simply being consumer-oriented; it means collaborating with and learning from customers and being adaptive to their individual and dynamic needs (Vargo and Lusch 2004). Accordingly, we invited the end users to participate in the design processes of the new service. The participatory design we used in this research work happens in that early phase of the design process. We see that it relates to the *co-production* stated in (Vargo and Lusch 2008a) which (1) is to be distinct from (but nested within) the *co-creation of value* [used to convey the customer's collaborative role in value creation (Vargo and Akaka 2009)] and (2) is a component of the co-creation of value that captures mere "participation in the development of the core offering itself" especially when goods are used in the value-creation process. Vargo and Lusch (2008a) also state that involvement in "co-production" is optional and can vary from none at all to extensive co-production activities by the customer or user, whereas the customer's role in value creation is not optional; value is always defined by and co-created with the customer on the basis of its "value in use" (Vargo and Lusch 2004; Vargo and Akaka 2009).

According to the service-dominant (S-D) logic (Vargo and Lusch 2008a), we understand the term *"service"* as the application of competences (skills and technologies) for the benefit of the customer, therefore focusing on the process of servicing (doing something beneficial for and in conjunction with another) rather than on the form of output (Vargo and Lusch 2008b). Accordingly, in the S-D logic, "service" is conceptualized as a *process* that represents the fundamental basis of value creation through social and economic exchange (Vargo and Lusch 2008a; Vargo and Akaka 2009). In this light, tangible outputs (*goods*), if involved, are seen as service-provision vehicles rather than ends in themselves (Vargo and Lusch 2004; Bedford et al. 2000). Service can thus be seen as a transcending concept; it can be provided to a customer directly or indirectly through a good (Vargo and Akaka 2009). Goods are appliances, which serve as alternatives to direct service provision (Vargo and Lusch 2008b). Accordingly, in our research work service is provided indirectly through a service vehicle (Vargo and Akaka 2009), the digital service. Due to the digital nature of our safety service, it is not constrained in a single physical service-provision vehicle, but is accessible through numerous different tangible devices (e.g. a teacher's computer, a parent's cell phone).

As a service-centered dominant logic implies, in our research work the service is defined in terms of customer-defined benefits where the ultimate goal is to satisfy the customer, i.e. the end user (Vargo and Lusch 2004). We determine the success of the service by the value it brings to the end user and all stakeholders, congruent to the S-D logic's terms of servicing for another's benefit (Vargo and Lusch 2008b). The service can also be seen as the means by which society is attempting to enhance its social well-being (Vargo and Lusch 2008b). However, we can only make value propositions, since value is always perceived and determined by the user (Vargo and Lusch 2004). According to the customer-centric view of S-D logic, firms always want to do better at serving customers, by improving the firm's offering to customers and improving financial performance (Vargo and Lusch 2004). Therefore, we strived to maximize end-user involvement in the service design processes to better fit user needs, also thereby acknowledging that the user is always a co-producer and co-creator of value (Vargo and Lusch 2004).

Children, as a service target group, have been mainly neglected in the development of technology even though their growing up environment has dramatically changed during the last decades. The change is due to the material welfare that has increased. At the same time, the welfare of the children has decreased. This change has increased both the mental and physical safety risks.

In Finland, children typically travel to school largely independently, either on foot, by bicycle, or by bus. Therefore, parents of young pupils call to their child's cell phones to ensure that the child has made his/her way to or from the school safely. In a study, reported in (Fraser et al. 2006), family members saw journeys between home and school as an important transition and a big issue for parents in managing their children's time. Information sharing between home and school was also raised as an important matter. Families' reactions to technologies for co-operation between schools and homes were enthusiastic; they saw benefits in the increased availability of information that can be gained through these technologies.

New technology has already made it possible to monitor children, notably through their cell phones, and some parents use that technology deliberately in situations where their children are testing the boundaries of where they can go independently. Parental worry about a child's safety, particularly in an urban environment, constitutes a significant factor in acquiring cell phones for young children. Actual communication via cell phone between children and parents is actually fairly insignificant in quantity: families value the connection afforded by cell phones to ensure their children's safety (Oksman and Rautiainen 2002). Parents see their cell phones as a means to stay connected with their children in all kinds of situations. Transition times between children's activities are especially important moments for cell phone use between a child and a parent (Leysia and Hughes 2007). Monitoring children's movements from a distance seems to provide some parents with a feeling of control, and thus ease their worries, even though the parents' opportunities for remotely saving the child from any danger are limited (Fotel and Thomsen 2004).

Qvortrup (1994) and Rasmussen (2003) argue that the increased protection of children afforded by monitoring them is a central characteristic of modern childhood and we do not yet know all the consequences. Williams et al. (2003) asked whether society could now perhaps openly question whether (urban) parents are good parents if they don't know where their children are and what they are doing at all times and do not have control over them. Aitken (2001) shows how some parents employ a policy of constant supervision over their children, even up to the early teenage years, while in any outdoor space.

The use of mobile communication by children and young people has become common in different parts of the world. In Finland, the expansion of cell phone use to younger age groups began in 1997 as new, inexpensive handsets entered the market and operators introduced more competitive prices for their services. Most importantly, teens use mobile communication to maintain their social networks and to form new relationships. The cell phone has become an important instrument that young people use to define their personal space. The mobile handset is also used to fill the empty moments of everyday life. Activities, such as sending messages, reading content, listening to music and playing mobile games are helping teenagers to pass their time during breaks at school and they make waiting at the bus stop a little less tedious. The sense of being connected to others remains, as the cell phone is carried along everywhere (Oksman and Turtiainen 2004).

The study presented in this article will give real feedback from the children, their parents and teachers regarding the "monitoring" of the child on a situation basis. The new aspect in the study is to also involve the school to be an active part in "monitoring" the safety of the children. The main contribution of this article is the process of designing a situation-aware safety service for children by using brainstorming and scenario writing as design approaches, together with the participatory design tools: web-based design tool Owela (Friedrich 2013) of VTT Technical Research Centre of Finland and SINCO (Rontti et al. 2012a, b; Miettinen et al. 2012) of the University of Lapland. This work has been carried out in the research project that studies, in addition to user needs and experience gathering, technology solutions by which the health and wellbeing of children can be ensured from childhood to adulthood. The main goal of the project is to exploit sensor and social web technologies in the development of new kinds of digital services in order to answer the growing needs for fulfilling the safety of children and young people. The aim of the safety service would be to enable proactive and instantaneous assistance and guidance for children in their daily lives.

In the ongoing research project, SEWEB (Sensors and Social Web), we carried out a participatory study with 7- to 11-year old schoolchildren, their parents and teachers. We established a process for developing a situation-aware digital service concept for ensuring children's safety. We exploited the existing participatory design tools to collect and share information about the everyday contexts in which children feel most unsafe, and we used the collected information to specify the desired situation-aware safety service and the technologies required for its digitalization.

This article describes how we first applied the principles of participatory design to engage the potential end users in the design and evaluation of a situation-aware safety service for children. We took the relevant user groups—children, parents, and teachers—into account in the very early phases of the design process, focusing on the acceptability of the safety service and identifying any possible barriers for use, which might prevent end users from adopting the new service or technologies. We also gathered feedback and acceptance from the local society via publicity: by inviting local and provincial newspapers

and a national public-service broadcasting company, YLE, to make a piece of news from the SINCO day performed in the primary school, Linnakangastalo, in Kempele, Finland.

The structure of the paper is as follows: The next section presents the background of the study. Section 3 introduces the process of design for the situation-aware safety service for children, and the tools used. Section 4 presents the lessons learned during the design process. Conclusions and suggestions for future work close the paper.

2 Background

2.1 Design work with children

Interaction systems for children are usually designed by adults who often have very little idea of children's needs and desires (Kelly et al. 2006). Children have few experiences in their lives where they can contribute their opinions and see that adults take them seriously (Druin et al. 2001). When respect is fostered, it changes how children see themselves (Alborzi et al. 2000). Several authors (Kelly et al. 2006; Alborzi et al. 2000) have identified that involving children in product development is beneficial. Previous study findings have revealed that children value that they are able to participate and be active in the design, use and evaluation processes (e.g., Ervasti et al. 2010). By participating, they can have their voices heard and influence the decisions that affect their school days. Additionally, Williams et al. (2003) have proven children to be valuable, adaptive and creative users in the participative design of ubiquitous computing experiences and devices that might enable them. Furthermore, previous experiences (Ervasti et al. 2010) indicate that by participating in the design and use processes the children became aware of, and internalized, the functionalities and goals of the system, which can lower the barriers for adoption and use. Druin et al. (2001) argued that design work in a school is subject to difficulty due to the school setting and the embedded power relations between adults and children. This work is going to break that relationship by forming design groups, hence children are in their own groups and adults form the other groups during the SINCO day. Thus, the children can freely share their ideas, thoughts and concerns about the service with the researchers.

Druin (2002) 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 adults, the relationship to the technology and the goals for inquiry. The role we sought in this study 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 project objective was concerned with the potential of the safety service, it was essential for the children to participate in the design process in the most concrete and illuminating way possible in order to be able to articulate the service's potentiality and serve as informants. In this case the children's role was therefore both that of a design partner and an informant. Before we started implementing any service prototypes, we included children in the early design process by at first studying their daily situations and the things that increase fear and unsafe feelings. However, there are not any certain methods on how to get children to talk to researchers about their fears and potentially unsafe situations so we experimented with a combination of different participatory methodologies that included Living labs, online discussion groups, brainstorming, and storytelling-based methods. In the following sections we will describe the participatory design methods and tools we used to get children and parents involved in the early design process.

2.2 Participatory design tools

In recent years, various participatory research methods have been developed to engage users more deeply in the technology design process. Especially when working with special user groups such as children, cooperative and storytelling-based methodologies have been proven thought-provoking and fruitful (Druin et al. 1997; Druin 1999; Bedford et al. 2000). The SINCO approach used storytelling but also used visualization and drama techniques to make a real environment for the story. The service can be "lived" during a SINCO session.

2.2.1 Open Web Lab (Owela)

There is a growing interest in web-based methods for the collaborative design and development of new products and services with users. Online tools provide a means for interacting with users in their everyday environments and they involve different stakeholders in all stages of the innovation process (Friedrich et al. 2012).

Owela (2013) is an online living lab that builds on social media features for co-design activities and open innovation (Näkki and Antikainen 2008). It provides tools for understanding user needs and experiences as well as designing new products and services together with users, customers, developers, and other stakeholders in a participatory manner (Näkki and Koskela-Huotari 2012). Owela project spaces may be used as a co-design space from the very first ideas until the final product testing, or only in selected phases of the innovation process (Owela 2013). It is a web-based, co-design platform that has been designed and developed at VTT Technical Research Centre of Finland.

The Owela workspace consists of blog-based discussion tools, user diaries, chats, questionnaires and polls that can be combined for different innovation and design purposes (Friedrich 2013).

Earlier experiences with Owela, e.g. (Karppinen et al. 2011) proved that this kind of online co-design allows quick and easy contact for geographically distributed end users. Compared to other end-user research methods, such as interviews and focus groups, Owela is more flexible, as it allows participating end users to give their input whenever they have some extra time, without having to leave their home or office. For the research organizer, it enables defining various research goals during the study, reacting to feedback, and modifying the goals accordingly.

2.2.2 Scenario writing work

Scenario writing is a well-suited and fruitful way to generate ideas for new systems and products. Scenarios also help to identify the possible users and contexts of use for the systems or products. They are appropriate to the design of new prototypes and concepts, where the context of use may widely vary. Descriptions of people using technology help different participants to discuss and analyze how new technologies, applications and services could influence the daily lives of the people involved, their communities, and society (Rosson and Carroll 2002). Thus, the basic elements of the scenarios should include the following: users, context of use, and a story with details such as goals, tasks, and activities.

Scenarios describe users in usage situations in a story format, but they are not meant to describe the whole functionality of a system. The value of scenarios is that they concretize something for the purpose of analysis and communication. The descriptions enable designers and users to deal with complicated and rich situations and behaviors in meaningful terms, and to better understand the implications of particular design solutions for performing realistic tasks (Carroll 1995).

2.2.3 Service innovation corner (SINCO)

Mock-ups and prototypes are basic tools for designers when developing products, and nowadays also services. The main purpose of prototyping is to concretize an idea (Fulton Suri 2008). A prototype can quickly and inexpensively communicate a service proposition and prompt questions on technical feasibility, consumer desirability, and business viability (Samalionis 2009). Prototypes should represent product, technological and social interactions (Kurvinen 2007).

SINCO (2013) is a prototyping laboratory for service prototyping, located at the University of Lapland, Rovaniemi, Finland. The initial idea for SINCO originated from a discussion: "*Mock-up is an excellent way to concretize a product design idea in the early phase of the design process, so what would be an equivalent for a mock-up in designing services?*" The first project began in 2009 with the aim of building a laboratory that could be used in experience prototyping (Buchenau and Fulton 2000; Oulasvirta et al. 2003) and the development of services (Rontti et al. 2012b).

The SINCO laboratory consists of an environment and a set of tools, which aim at collaborative service development. SINCO uses technological equipment and digital material, such as photos, videos, and sounds, to create an atmosphere of actual service moments for prototyping and re-enactment. This helps to concretize different aspects of service concepts and ideas to participating users' by giving them a better idea of what the service might contain and feel like.

As an environment, the laboratory could be classified as a mixture of a showroom, theater, craft workshop and a modern meeting room. The technology used in service prototyping at SINCO includes the following (Rontti et al. 2012a): interactive whiteboards (for notes, sketching and user interface prototyping); props and building blocks (used in role-play and rough modeling of physical environments); a scene computer (for controlling service scene backgrounds and service journeys); rear projection displays (for the quick creation of service scene backgrounds); multi-color spotlights and loudspeakers (for creating the desired atmosphere at the service scene); craft equipment (tools for creative hands-on building and mock-ups); and user interface (UI) devices (for producing interaction design mock-ups and visual touch points).

With SINCO, prototyping is iterative, concrete, agile and co-creative. Through SINCO prototyping and co-design workshops it is possible to study and analyze existing service journeys, visualize ideas and evaluate concepts collaboratively. It offers a multi-sensual environment to experience and present new, abstract service ideas and develops them iteratively. In SINCO, the design team can live through the future services and evaluate them based on their subjective experiences.

SINCO prototypes are rapid and easy to develop and vary because prototypes are strongly based on digital material, such as photos, videos and sounds. This is ideal for hands-on service development, but it also supports the co-creational culture, where anyone can build on the ideas of others. Technology-aided representations help teams to understand situational factors, emotional aspects and the appeal of new service ideas.

3 Design process and used tools

After the brainstorming workshop for the future networked safety service, the design process proceeded with four other

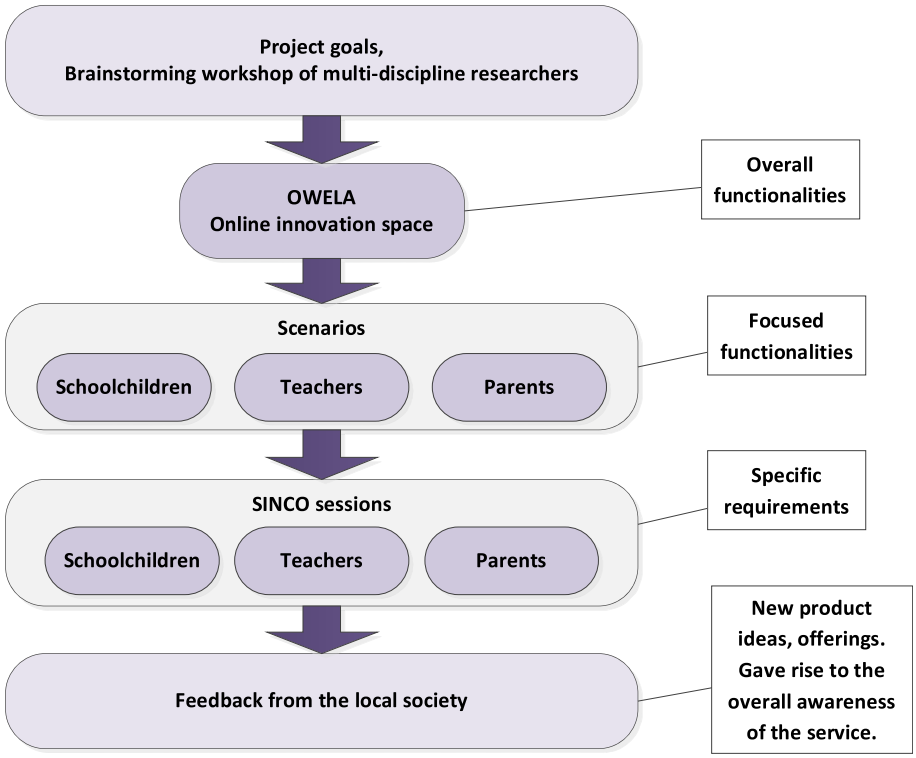

Fig. 1 Phases of the design process and their outcomes

phases. The expected outcomes after each phase of the process are presented on the right hand side in Fig. 1. Given the difficulties to be overcome in describing and understanding user needs and experiences, we decided to combine a variety of complementary data collection methods (Yin 2003) for engaging and participating users in the design work in order to increase the reliability and validity of the results (Isomursu et al. 2007).

Owela was used for gathering people's thoughts, concerns, ideas and real-life events related to the schoolchildren's safety. The Owela results were utilized during the scenario-writing phase and overall three scenarios were written, targeted at different user groups. In the fourth phase of the process, the SINCO participatory tool was utilized with the three different user groups. The final phase for acquiring feedback from the local society was performed by inviting the local and provincial newspapers and the public-broadcasting company, YLE, to make a piece of news from the SINCO day performed in a primary school, Linnakangastalo, in Kempele, Finland. The participatory design tools used and the data collected at the various phases of the project work are described in more detail in the following.

3.1 Brainstorming workshop

The co-design and innovation started by brainstorming the situation-aware safety service for children in a workshop where multi-science expertise was exploited. Researchers from five different teams of three competence areas gathered together. The researchers were grouped and each group brainstormed around a safety service for children that is usable either at home, in the school or during free time. The co-design was expanded by the sixth team to create the workspaces in Owela based on the brainstorming results.

3.2 Owela

VTT's conversation and innovation online space, Owela (Friedrich 2013), can be utilized by receiving feedback and ideas from selected target groups and in engaging users in co-design activities, and it was used in the early phase of the process of designing the situation-aware safety service for children. The need for using Owela arose from the realization that input and feedback from potential users and stakeholders is important since the developers' world view may not be similar to the one of the potential users of the service.

Two similar workspaces were created in Owela, see Fig. 2. The target user group of the future service being planned was schoolchildren. However, this phase of the process was mainly targeted at adults, i.e., the parents, teachers and other caretakers of the schoolchildren. They were also encouraged to ask about the opinions of the children. The people invited to the first online workspace consisted of different stakeholders in Linnakangastalo, the primary school in Kempele, Finland, and they were also

Fig. 2 Front page of the Owela workspace

used as a target group later in the design process. For the second workspace we invited any adult participants who were interested in the safety of children and who wanted to contribute and give their ideas on how it could be enhanced. The same discussion themes and questions as used in the online study were also sent in paper form to the relevant stakeholders of Linnakangastalo, since not all the stakeholders in the school had the possibility or interest in responding online.

The Owela study lasted for 3 weeks, and altogether 54 participants took part in the discussions in Owela workspaces. In addition 35 persons filled in the paper form answer sheets. The discussion in Owela workspaces was clustered under the following five predetermined themes, all of which had a few questions as food for thought in their introduction section:

1. Recommendations, instructions and rules given by parents to children.
2. Collaboration between school and home.
3. Safety from a child's point of view.
4. Negative brainstorming (related to e.g., incidents threatening child safety).
5. Real-life events (related to child safety).

There was also a possibility for the participants to add their own discussion themes related to the safety topic in the workspace and this possibility was used by one study participant. This sixth theme was called, "*Is frightening the children dangerous to them?*" Interestingly, one theme that came from an end user, rather than from the researchers, received the largest number of comments in its discussion field compared to all the other themes. In addition, a real-time chat was available in both workspaces. Other tools, e.g., polls, supported by Owela were not used in this case as they were not seen as relevant for this study.

The discussion in the workspaces was facilitated daily. There was the possibility to ask further questions about an interesting topic or request further explanations about any comment that seemed to require it. After three weeks, when this Owela part of the study was ended, the online discussions were processed and similar types of comments were clustered together. The results were analyzed and elaborated with the scenario-writing team in order to feed the end-user points of view to the scenarios. Figure 3 illustrates the most prevalent statements for these topics.

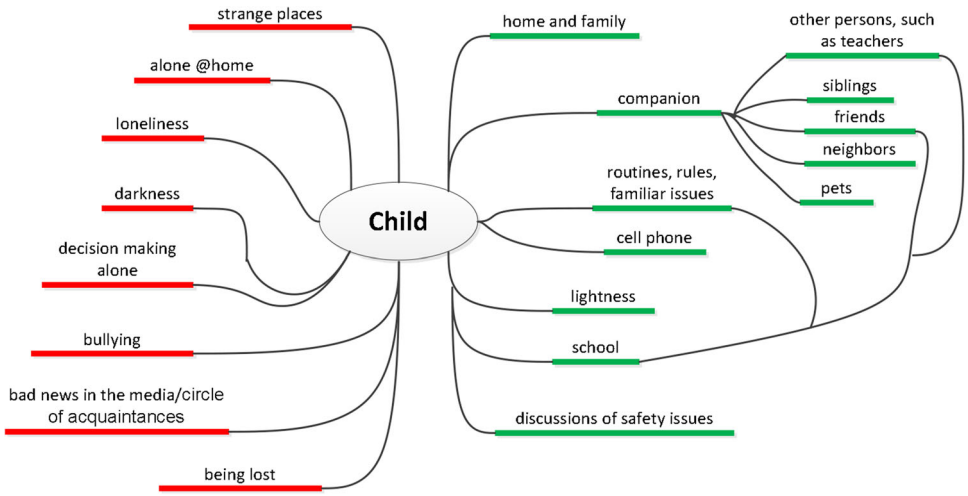

Fig. 3 Topics that increase or decrease the feeling of safety from the child's point of view

The issues causing insecurity are placed on the left-hand side and are highlighted in red. The safety enhancing items are written in green and are placed on the right-hand side.

The results included, for example, identification of situations where school-aged children felt safe or when they were scared. In addition, the most common concerns of the parents regarding their children's daily life, and numerous very detailed stories about incidents that had caused anxiety either for the child or for the adult were recorded.

3.3 Scenarios

The baseline for the scenario-writing process was the idea of a future digital service which enables the monitoring of locations for schoolchildren and any possible unusual activities. The service could be implemented, for example, on a small stick, sticker or key fob. The typical safety service situations are related to school journeys: when schoolchildren are not at home or in the school yard. Technically the idea is to collect and share the safety gadget's location and sensor information via a network safety service that could be integrated into other education services. Parents and teachers are able to see the locations of children and they can draw up safety routes and mark forbidden areas on the map. It is also possible to define certain times of the day when the service is activated and give permissions for different users to access the child's collected data.

Overall three scenarios were written and they all described the same story from the viewpoints of the three different user groups: schoolchildren, parents, and teachers. *The main story* outlines a 10-year-old schoolgirl's trip from school back to home. The schoolgirl does not follow her daily and safe route, but decides to visit her friend and forgets to tell her parents about the visit. She leaves the safety gadget in her jacket pocket while she is at her friend's house. The girl's mother gets concerned because the daughter is not at home on time and finally the mother tries to call the child, but cannot reach her. The mother checks her daughter's location on the Safety Service map and notices that the girl is at an unknown address. The mother calls the school in order to get more information about the worrying situation. The girl's teacher is able to check her location through the system and notices that the location address belongs to another girl from that school. Thus the teacher can be pretty sure that everything is fine and gives girl's mother her new friend's contact information. The mother is then able to call the new friend and ask her child to come home.

In the later design process phases scenarios tailored for each user group were presented and evaluated in conjunction with the corresponding user groups. The following user group topics represent how the main story was modified to be more understandable and targeted at the different actors presented in the scenarios.

3.3.1 Scenario for schoolchildren

The scenario from the schoolchildren's perspective focused on telling how the school girl goes to visit her friend and what they are doing there. Also, the scenario describes how the safety gadget service was introduced in the school and what kind of functionalities it includes. At the end of the scenario there is content which tells that the pupils have had a discussion related to the system e.g., what is the most appropriate age for school children using the service and what kind of new features the system could include.

3.3.2 Scenario for parents

This scenario starts by describing how the mother tries to call her daughter to ensure that she is at home. Due to an

unsuccessful call, the mother logs into the system to check her daughter's status and location. Then she notices an unusual location and contacts the teacher. This scenario also illustrates how the mother has marked the school trip route, safe areas and forbidden areas on the map during the service adoption phase a few months previously.

3.3.3 Scenario for teachers

The scenario story directed at education professionals starts with a teachers' coffee break, where an active conversation about the new safety service is taking place. The discussion includes details about how the teachers have had lot of concerns about the usefulness and privacy issues of the system, and the required workload for the school personnel. The teacher described in the scenario is an advanced Internet user and he has been skillful and motived to use the service. The missing schoolgirl event is described by telling how the concerned mother calls and asks help in finding her daughter's location. The teacher checks the location of the schoolgirl and notices that the address is the same as the address of the girl's new friend. In the end the teacher shares the needed contact information with the concerned parent and makes sure that everything is fine.

3.4 SINCO take away

After scenario building the aim was to get feedback, opinions and ideas from potential users of the planned service. The participatory design tools, especially service prototyping, were applied in Linnakangastalo, a primary school in Kempele, Finland. Three groups of pupils, one group of teachers and one group of parents participated in the prototyping sessions. The pupils were selected by the teachers of the selected class. These classes were selected by the teachers and the head of the school. Parents were asked to register themselves with the project manager. Five people were deemed to be the optimum amount for each group by the SINCO team. The pupils' groups were from the second class (five people, eight or nine years old), the fourth class (eight people, ten or eleven years old) and the first class (three people, seven or eight years old). The teachers' group consisted of five people and the parents' group had three people. Hence, in total 24 people participated to "the SINCO day". Beforehand, we asked for written permission from the parents for their children's participation in the project and the related research. The data collection activities performed during the SINCO day resulted in a set of transcribed observations, session video recordings, photos, and researchers' notes. Data collection was performed by four researchers.

In the sessions portable SINCO Take Away was used as a tool for service co-design and innovation. The SINCO laboratory's one downside is that it is fixed into the location inside the University of Lapland. Sometimes it is necessary to have SINCO's equipment somewhere else and this was the case in designing this situation-aware safety service for children. Students, teachers and parents could all participate to prototyping during one day, so it was more efficient to send a few members of the SINCO staff to Oulu than to ask over 20 people to visit Rovaniemi, over 200 km away. Thus, the SINCO team was the seventh research team that took part in the co-design of the digital safety service.

Along with the SINCO fixed laboratory, a take-away version of it was developed, which is basically a lighter and more movable version of SINCO. SINCO Take Away is big enough to give nearly the same experience as in the SINCO laboratory, but it is small enough to fit nicely in the back seat of a middle-sized sedan. The set has simplified versions of all the main elements to form the prototyping environment (see Fig. 4). The main equipment fits into two crates: fast-fold frames for two rear projection screens, two short-throw projectors, two speakers and a laptop. Additionally, digital tools, like tablets, and props and prototyping accessories, like hats and foam tubes, belong to the Take Away set and are packed, depending on the case.

It takes about one hour for two persons to build SINCO Take Away. During the prototyping day in Kempele, the preparations took two hours followed by five one hour prototyping sessions. Each prototyping session started with a short introduction game where participants chose a smiley card that most resembled the emotional state that they usually have while traveling to school. Teachers and parents chose a card that reflected their feelings when their pupils or children are coming to school. A small conversation regarding the reasoning behind the chosen cards was held after choosing the cards. This worked as a warm-up to prototyping and also as a short introduction for the group of parents who didn't already know each other.

The SINCO team members had prepared a prototype of the schoolchildren's normal school day. This prototype had six different moments in chronological order starting from leaving home, going to school, being at school and coming back home, especially highlighting the moments when children were without guidance of the parents or teachers. The challenges that had arisen in the Owela conversations, such as walking alone, a stranger asking for help, and a somewhat scary underpass, were brought to life in the prototyping sessions with pictures, sounds and props.

The participatory design tool helped the participants to talk about what normally happens when coming to school and returning home. The prototype worked as a storyline and participants could share their concrete-level views, experiences and thoughts about certain situations. Ideas that came up during discussions could be easily concretized into a

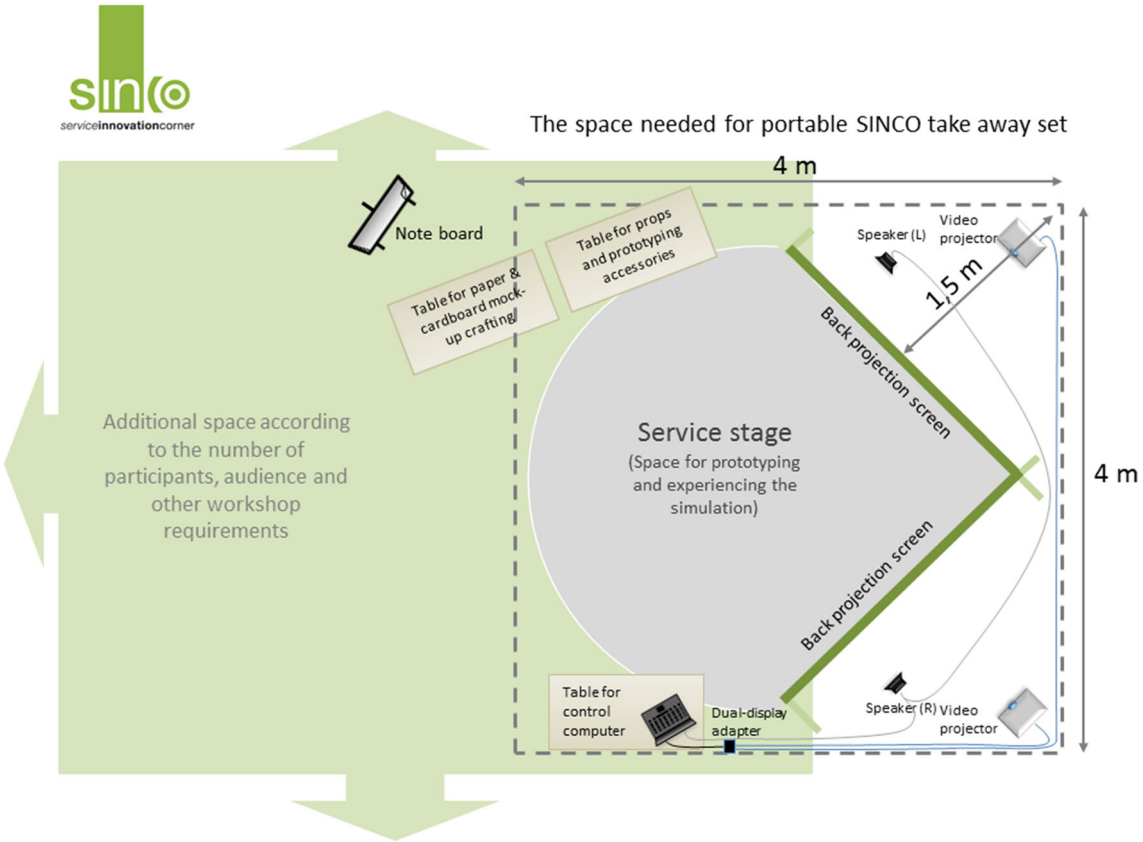

Fig. 4 SINCO Take Away requirements

prototype, by bringing new visual elements to the screens or building an instant "quick and dirty" model using the props and accessories. Then the situation in question was acted out just as it would happen if the idea became concrete in real life. Prototyping made it easier for all participants to share their opinions, discuss together, build on ideas of others and experience and evaluate the ideas.

After prototyping the future situation-aware system concept, a "Safety Gadget Service" was presented from the point of use of schoolchildren, parents and teachers (Fig. 5). USB sticks in necklaces (in this case mock-ups of safety sticks were used) were given to children to make it easier to empathize with the concept idea. The participants evaluated the concept from their points of view and also discussed other possible solutions that could be even more useful for them.

During the discussion phase the lights of the prototyping environment were dimmed down to create a safe and open atmosphere to encourage the sharing of ideas and thoughts for every participant. The overall attitude in the prototyping groups was positive, although for some children it was hard to focus on prototyping after a long school day. The topic of prototyping was in all sessions based on the participants' everyday activities, thus making the prototyped situations more familiar. This helped the participants in understanding and empathizing with the situations, but also in daring to openly share their opinions and ideas.

3.5 Feedback from the local society

We already had experience of the previous research related to children's monitoring and security which created a lot of publicity in the Finnish media and discussion in society. The previous research work directed at pupils' school attendance supervision (Ervasti et al. 2010) had raised the debate on the issue of surveillance and privacy invasion. For example some private persons expressed their biases and opinions about the attendance supervision system on the local newspaper's website. Therefore, we decided to gather feedback from the local society regarding the children's monitoring, even though for their safety, is a sensitive issue. This happened via publicity based on the news in the local and provincial newspapers in both paper and digital forms, and in the news production of YLE (radio, TV, digital news). YLE (http://www.yle.fi) is a public-broadcasting company in Finland. Most of the feedback came to the project manager of the SEWEB at VTT via phone discussions or e-mail messages.

Fig. 5 SINCO Take Away in use

The feedback varied between new product ideas received from the private person or promotions from company representatives to use existing applications as a part of the "Safety Service for Children". The publicity also resulted in an enquiry from the Finnish authority for investigating the accidental death of children on whether the technologies to be created can minimize the amount of deaths, and if there is a need to set new regulations to use these technologies in environments where children are "located" during weekdays. We also received a contact from a manufacturing company. They were keen on producing the "Safety Gadget Service" for children.

The importance of the "Safety Service for Children" was emphasized in the leading article of the provincial newspaper. In addition, the TV news program was firstly distributed at provincial level, but that was soon expanded to the whole country of Finland during a morning TV broadcast. The feedback, in aggregate, gave us a lot of confidence to further develop the "Safety Service for Children".

4 Lessons learned from participatory design

This section summarizes the findings of the participatory design process, especially focusing on the roles and contributions of the three participatory tools utilized in the different phases of the design work. The work would have been faster, but would have provided a notably narrower view if only one research team had been involved. Combining the usage of Owela and the SINCO Take Away to co-design the service with the end users was a new and successful experience. The novelty value is due to the interaction between a traditional research method and the service design point of view, as the SINCO is developed in the University of Arts.

This work has some concrete implications for practice and research related to technology design processes in a school setting. Our findings revealed that children valued that they were able to participate and be active in the design and evaluation processes. By participating, they could have their voices heard and influence the decisions that affected their lives.

Each design phase iteratively increased the understanding of the most prevalent safety themes and contributed to the design and improvement of the situation-aware safety service for schoolchildren. Each different phase helped to define and reach functionalities, specific requirements, and new ideas for safety products. Overall functionalities were found by Owela and then more focused functionalities were achieved by the scenario work. The usage of SINCO moved the safety service toward more concrete functionalities by providing specific requirements, such as product needs like being easy and unobtrusive to carry. The last step in the participatory design process, feedback from the local society, provided new product ideas to consider: promotions of the, e.g., existing software product to be used as a part of the safety service for children. The last step gave rise to the overall awareness of the safety of children and the related services.

4.1 Owela

As the Owela study was the first main phase of this design process the discussions were targeted at getting an understanding of the schoolchildren's parents and other stakeholders' thoughts, needs and experiences related to the safety of children. The preliminary idea of the service was not meant to be delivered to the participants during the Owela study to guarantee unbiased feedback. The online study was also sent in paper form to the same stakeholders

and that increased the usage and discussion in the Owela study.

The results from the Owela study were then shared in the next step of the design process with the scenario-writing team, which internalized the main facts, situations and concerns that had risen in the Owela discussions, and utilized this accumulated understanding in the second phase of the design process.

4.2 Scenario work

Traditionally, scenarios are written by the design team at the very beginning of a design process. In some cases end users or other stakeholders are asked to write scenarios by themselves. With the use of Owela the first ideas and opinions related to the children's safety issues were generated before the scenario-writing phase. This approach helped to focus on useful topics related to the situation-aware theme and facilitate the main features of the safety-service concept. The Owela study results confirmed the need for a situation-aware safety service for school journeys, which usually caused safety concerns among schoolchildren and their parents.

The use of the three different scenarios helped the scenario writers to carefully consider the different user groups' needs and perspectives. It also supported speaking in the user's language, which in this process was fruitful because there were remarkable differences between the user groups. Young children see and understand safety issues and technologies in very different way from their parents or teachers.

4.3 SINCO day

SINCO was utilized mainly for two purposes, firstly for getting to know the challenges and possibilities of the school journey's safety and to ideate how to improve that based on the expertise and everyday knowledge of pupils, teachers and parents, and secondly for going through the service concept and getting feedback about it. Participants brought the needed new perspective to the development of the service concept based on their everyday lives. With SINCO it was possible to illustrate these situations to participants as an experiential storyline which made commenting and ideation more concrete than it would have been with mere text documents or pictures.

SINCO prototyping is made possible with innovative use of a combination of new technologies, but also the central role of the facilitator(s) is evident. The SINCO team members led the prototyping, concretized the ideas from participants, and stimulated discussion by asking questions and altering the prototype in situ. The SINCO prototype worked as an information-sharing tool between participants and researchers, and also gave a better perspective of the current situation of safety during school days. The "quick and dirty" prototyping represents a rapid way to concretize ideas, and when combined with the advanced technology elements of the SINCO prototyping environment, it enables agile ways of working in collaboration with end users.

We noticed that SINCO is better suited for the service co-design with the children as it supports active and concrete participation. The Owela study provided the filtered voice of the children as the feedback came via their parents or teachers. Children are usually more courageous than adults in playing along and engaging in different roles, and that is advantage while prototyping a future service.

The SINCO day's scenario-related results indicated that the idea of a safety gadget service was well accepted by all three user groups. Especially the youngest schoolchildren aged 7–10 years appeared to be the most suitable users for the wearable safety gadgets. Schoolchildren over 10 years old already use cell phones actively and they usually know the safe routes and understand possible risks. They also mentioned that to be monitored by their parents might tempt them to cheat the system and e.g., leave the gadget intentionally behind. Schoolchildren from all ages ideated possible new features for the service and they gave suggestions of what kind of gadget it could be. Ways for rewarding children were also suggested in cases when the children use the service regularly and properly.

Parents agreed that the safety gadget service is appropriate for the youngest schoolchildren and that the age is very critical factor for the acceptance of the system. It was also mentioned that in the age of 7–10 children easily forgot or lost their belongings and thus the safety gadget should be easy and unobtrusive to carry along. From the adults' point of view game-like features could be a good way to motivate children to use the system. Parents and teachers mentioned the fact that new smart phones have already features and service for locating phone's owner. Smart phone locating services are usually cell phone operating system related or they might require a special application, which does not support the idea of an equal system where schools co-operate with the children and parents in the safety service.

SINCO prototyping is advantageous in many ways, as it:

- is concrete, enabling the testing of a new service in practice,
- is iterative, making it possible to test ideas almost immediately,
- decreases the design risks as the service is concretized in the early phase and there is time to change the design before the launch,
- increases the value and quality of the service, and

- directs feedback from the end users, especially from the children.

4.4 Feedback gathering via publicity

Feedback gathering via publicity was a new step in our design process and it was performed by inviting local and provincial newspapers and the national public-service broadcasting company, YLE, to make news item from "the SINCO day" when we used the SINCO Take Away as a tool for service co-design and innovation in the primary school. Our invitation was accepted by all media representatives. As a consequence of this publicity our research work gained attention in the Finnish media: we received new product ideas from the private companies/people and were offered by company representatives to use their existing applications as a part of the "Safety Service for Children". The companies made contact mostly based on the news in the provincial newspaper. The feedback from private individuals was based on the all the news coverage but mostly based on the news (TV, radio, website) created by YLE.

In addition to product ideas and offerings, we were contacted by the Finnish authority for investigating the accidental death of children. This contact was extremely interesting because of its societal meaning. YLE's digital news also inspired conversation, for example in the discussion forum on the website of commercial newspaper and in a tabloid newspaper. The same news has spread in the media diary of a tele-medical course. In the discussion forums the comments were mixed in their support for the new situation-aware safety service, but in the media diary it was seen as valuable, especially for children having diseases such as diabetes or epilepsy. The publicity helped us to get new ideas, thoughts and services to be exploited in our research work, giving us more valuable insights than initially expected. Feedback gathering via publicity was a valuable step in our design process. It acted as a productive means to get genuine public feedback on the project itself and on our research. The public discussion and its analysis were useful as the "Safety Service for Children" is fundamentally intended to be a public service.

5 Conclusions

In this study, information about users' needs, values, fears, and concerns was obtained by combining different participatory design tools and data-collection methods. The findings were analyzed from the viewpoints of three end-user groups: namely children, parents, and teachers. The importance of the role of children in the design process was emphasized throughout the research project to overcome the problems associated with children as research subjects. The children were respected as users of new technology and their contributions and ideas were sought out and valued. For many children the possibility to participate in this design process seemed to be a boost to their self-esteem. The children were very excited that they were shown respect and interest by the adults by involving them as active members in the design process of the safety system. Our findings revealed that for the children at this age, as well as for their parents, the concept of being monitored by the technology is not something they reject, but possibly welcome.

After the brainstorming workshop, in the second phase of the participatory design process, using the Owela online living lab, we accumulated important understanding and knowledge of the most prevalent safety issues related to children and especially their school journeys. In the third phase of the design work these gained insights were utilized to create better-informed scenarios and target them at the three user groups, which were discovered to have very different views and approaches for issues causing insecurity or enhancing the safety of the children. The fourth phase in the design process took advantage of the SINCO Take Away laboratory to further deepen the understanding and help acquire more concrete ideas and opinions for the improvement of the situation-aware safety service concept and its main properties. During the SINCO day, the three user groups were treated separately in their own groups according the group-specific scenarios. The children were expected to speak more freely and honestly without the adult "authorities" present. Additionally the parents and teachers were kept as separate groups so that they would not influence each other's opinions due to underlying power relations and responsibilities related to the school environment. The final phase took into account the acceptance of the local society for the safety service. Private individuals and companies contacted the research team to bring new ideas and services to be taken into account for the next phases to come.

The design process and used tools turned out to be usable: they worked well together and supported each other. We consider them useful whenever there is a need to design services closely together with the end users. It was valuable to also seek feedback from the local society. This work gave us real feedback on the situation-aware safety service. The feedback was gathered from (1) the children, their parents and teachers by using participatory design tools, and (2) the local society via news publicity. Although cell phones and especially the latest generation of smartphones already enable methods for tracking children's mobility, there are some cases and situations where additional safety services could be useful. Location will be the

main attribute to be monitored but the aim is to have more attributes in the future to enhance the safety of the children. For example, attributes related to health or bullying. The next steps are (1) to survey the technology enablers that are usable in the creation of the service concept, and (2) to take into account the business point of view as the product-based business is moving towards services.

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