Tangible Representation Tool of Perceived Risks using Personal Data in a Co-design UPPSS Process

Haoyu Dong
TU Eindhoven
Eindhoven, NL
h.dong@student.tue.nl

Huizhong Ye
TU Eindhoven
Eindhoven, NL
h.ye@student.tue.nl

Sanne Bassant
TU Eindhoven
Eindhoven, NL
s.bassant@student.tue.nl

Maik Nothbaum
TU Eindhoven
Eindhoven, NL
m.nothbaum@student.tue.nl

Tomas Gecevičius
TU Eindhoven
Eindhoven, NL
t.gecevicius@student.tue.nl

ABSTRACT

Within the co-design process for ultra-personalized products or services, personal data is constantly collected and used throughout the process. Former research focused on the relationship between data and final product, however, perceived risk in this context has not been considered. This paper proposes a tangible representation of perceived risk and explores its effect on participants in regard to using personal data in a co-design process for ultra-personalization. The findings present that the tangible tool increases awareness for the participants on possible risks and clarifies the most important ones. Consequently, participants willingness to share data decreased unless their conditions are met.

This research might provide insights for researchers and designers focusing on co-design, (ultra)-personalization and perceived risks in the field of design.

This paper first explains the theoretical background & related work, then will go through the design process and explain the final design, the methodology of the research, the findings and discussion will be presented and finished with limitations of the research, future work, and the conclusion.

Author Keywords

Perceived risks; Co-design; Personal data; UPPSS.

INTRODUCTION

As user experience has been playing a more and more essential role in the design field, designers have been more connected with their potential users [13]. The co-design process has been applied as one of the methods to boost this connection. Co-design describes a process in which a group of designers, manufacturers, consumers, and other stakeholders exchange ideas and develop a product, service or system together [10] In this case, the borders between the roles of designer, researcher, and user are blurred [13].

The active engagement of users in a co-design process contributes to the development of personalized products, which are getting more common and find their way to the market, for example, eyeglasses, fit lingerie and shoes [3,16,17,18]. Often in the process of designing personalized products, personal data is collected and used throughout the design process.

Within the scope of the European General Data Protection Regulation (GDPR), personal data is defined as "any information that relates to an identified or identifiable living individual" [19]. However, in the ultra-personalization design process, personal data is used as evident design material in generating the design of the product and has different meanings matching to various design topics [7].

A leading example is the Ultra Personalized Product and Service System (UPPSS) model as presented by Nachtigall et al. [12]. It describes a design process in which data for the ultra-personalized product is gathered before the design process and during product usage. This process allows the use of data of the individual user based on everyday usage to further improve the wearable.

Within the UPPSS model, the research focused on the relationship between data and the final product. However, perceived risks were not considered. An ethical viewpoint needs to be taken into account for the further development of the UPPSS model.

In the business field, some research demonstrates serious concerns about personal data and its sharing [9]. People tend to be more concerned about their privacy and possible risks due to the increasing security threats and examples of major security breaches [15]. Yet in the co-design context, there is a blank space for recognizing the perception of risks.

New tools and techniques regarding perceived risks lack research in the co-design landscape for ultra-personalized products [13]. Therefore, this project proposes a tangible representation of perceived risks, which can be used in the UPPSS process before co-design sessions. The objective of the research project is to explore its effect on participants in

regard to using personal data in a co-design process for ultra-personalization.

This research was conducted using the Field methodology [8]. We focused on the target group of cooks in the context of co-designing protective workwear. This research might provide insights for researchers and designers focusing on co-design, (ultra)-personalization and perceived risks in the design field.

RELATED WORK

Co-design
Co-design, as a design method, has been applied outside of the design domain [10]. For example, a field research project by Kim et al. explored the utilization of a participatory design workshop in the development of policy [6]. In this research, a tangible representation of the current policy was designed and implemented in the field context of a workshop session. This research aimed at providing insights into designing a participatory workshop in the policy context. In our research, we implement the tangible representation of the perceived risks and aim at connecting perceived risks with a co-design session.

Most of the tools for co-design are related to the generation of ideas and iteration of final results, such as Mindmap, Issue cards, Concept Walkthrough [14] However, tools for representing perceived risks and bringing the concept to the co-design session are not present in common co-design toolkits.

Perceived risk
The first concept of perceived risk was suggested by R. A. Bauer [2]. In his opinion, perceived risk is a concept in which users' actions will have outcomes that they can not estimate with high confidence and some of which are likely to be unpleasant. Depending on the situation, perception of risk is subjective and usually does not reflect reality, people tend to overestimate or underestimate the risks and possible outcomes [4] influencing the choices that they make.

Perceived risk in co-design
Kaveh et al. conducted research on the perceived individual risks in co-innovation in the business domain [1]. The researchers realized that in the co-innovation session, not only the risk assessment on the company's level is important, but the individual level as well. George et al. developed a typology of personal data based on perceived risks from consuming industry in order to raise awareness of policy and regulation problems [11]. However, within the design domain, there is a gap between co-design and perceived risks. This research was used to provide a basic line for the development of perceived risk lists in a co-design process while using personal data.

DESIGN PROCESS

Pre-interview
The methodology applied in this project is a Field constructive design research methodology [8]. A proper condition, where the prototype is used in a natural setting, should be created following the four guidelines from Kurvin [8]. A pre-interview with an experienced cook was conducted, aiming at 1) defining the design goal for the co-design process and 2) generating the perceived risks list within this certain process.

A participant with 8 years of experience of working as a professional cook participated in the pre-interview. The interview was divided into two parts. Firstly, the participant answered questions (Appendix 1. Pre-interview questions) about his work and expressed his opinion about personal data. Secondly, the participant read three scenarios and got interviewed after reading each scenario (Appendix 2. Pre-interview Scenarios). The three scenarios described different stages of working: applying for a job, in a job and quitting a job. The scenarios gave some limitations for helping participants imagine themselves under specific conditions. After each scenario, the participant was invited to present his attitude sharing personal data for an ultra-personal product that detects personal information related to health and work.

Each part took 10 minutes. In the interview, one team member was conducting the interview, and another team member was responsible for observing and recording the answers.

Evaluation
The participant put forward two main problems related to his work: limited working space and back pain caused by long-time working posture. Therefore, the goal of the co-design process was decided to design a garment that detects their health.

Additionally, the participant mentioned several possibilities for using personal data. He explained why sharing some of his personal data such as medical history is risky. "...*regarding medical history, mental health data, these kinds of things, it would just, like, to be spread out, and every company could find it*."

Based on the results of the pre-interview, the perceived risks list, which was generated from George et al.'s research [11], was analyzed and customized to this certain co-design process - ultra-personalization wearable design with data collection for cooks (Table 1. Conceptualized Perceived Risk) [11].

PROTOTYPE
The prototype is a tool used before co-designing ultra-personalized products (Figure 1). The role of the prototype is to clarify the perceived risks for the participants by visually mapping them and raising discussion between the participants and designers.

The tool consists of three parts - the perceived risk cards (Figure 1. (1)), the blocks representing the importance level of each perceived risk (Figure 1. (2)) and the role blocks for participants to think about the other stakeholders (Figure 1. (3)).

	Perceived Risks	Description
1	Public surveillance	Locations and behaviors are always monitored in public space
2	Online surveillance	Online behaviors and opinions are always monitored
3	Data leakage	Relevant data is unwillingly leaked to an unauthorized party
4	Data transaction	Relevant data is being sold
5	Data misuse	Relevant data is misinterpreted, used with bad intentions.
6	Social disapproval	The data saw by other people reduces your social image.
7	Monetary risks	Can be used to hack the bank account etc.

Table 1. Conceptualized Perceived Risks

Perceived risks are written on seven cards with short descriptions, and additional or more concrete aspects can be written on the blank cards (Figure 1. (1)) (Appendix 3. Perceived risks list).
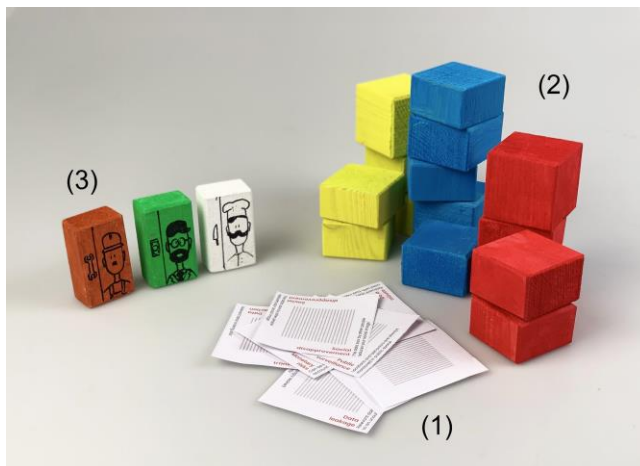
Figure 1. Tangible tool to represent perceived risks: (1) perceived risks cards (2) blocks (3) role blocks.

Each user gets five blocks to oblige participants to choose which risks are more important to them (Figure 1. (2)). Four of the blocks are the same height, while one is 1..5 times higher. It is done to reduce the opportunity to divide all blocks evenly and force the user to choose which risk is most relevant to him.

The role blocks consisted of different stakeholders: manufacturer, chef (manager) and businessman (client) (Figure 1. (2)), which help the users to think about other stakeholders. Role blocks should be changed depending on which kind of context the tool is going to be used in.

How to use

While using the tool, designers play the role of facilitators. The tool can be used in several rounds. In the first round, the participants are introduced to the perceived risk cards and select the most relevant ones. Then, the blocks are provided. The participants are requested to think for one minute and then distribute the blocks on the perceived risk cards at the same time. The limitation of the thinking time and simultaneous distribution is done to reduce the influence among the participants. Afterward, participants are asked to explain the reasons behind the decisions and have a discussion with other participants and designers. Additional aspects should be written down by the designers on the blank cards. When everything is discussed, the blocks are returned to the participants and a new round of the block distribution begins. After the assigning of blocks and a new discussion, the designers and participants can decide together if more rounds are needed to complete clarifying the perceived risks.

PILOT TEST

A pilot test was conducted to analyze the feasibility of the user test protocol and improve the setup (Appendix 4. Protocol I). The data from the pilot test was not used for the final analysis.

Setup

One cook participated in the pilot test. Two team members were involved in the pilot test as designers. The other three observed via Livestream video in a separated room. The pilot test lasted for 45 minutes.

The participant walked into the room with an empty table. After signing in the consent form (Appendix 5. Consent Form II), designers gave the participant a short introduction of the co-design process and this user test.

To start, the designers conducted the first interview, the interview questions can be found in the appendix 4 I. Then, the participant was informed that a personalized wearable would be designed to reduce the back pain problems for cooks and thus some personal data will be collected. Afterward, perceived risk cards were introduced, from which the participant was asked to select the relevant ones. After the blocks were introduced, the participant was guided to use the tool for the first round, placing the blocks and explaining the reasons to place the block in this way. There were some new insights during the first round which were written on the blank perceived risk cards. Hereafter followed the second round.

In the end, the designers conducted another interview to gain insight into how the tool affected the participant. The questions can be found in Appendix 4 I.

Evaluation

The process was reflected upon and the gained insights were used to adjust the user test.

Firstly, one participant might lack natural social factors while using the tool. In the user test, at least two participants will be involved.

Secondly, the participant mentioned the value of the final product three times, which has a major influence on his perception of the risks " *if I see the value in sharing the data, then I think it's no problem*" (Appendix 6. Video transcripts I). In order to avoid the focus on the value of the final product, a more open-ended design case will be presented in the user test.

Furthermore, the interview questions during the pilot test were based on intuition rather than research. The interview questions were improved by adding more in-depth questions about the participants' motivations (Appendix 4. Protocol II).

Lastly, in order to trigger the participants to actively consider the usage of personal data while selecting the perceived risks, a print-out of personal data was presented during the user test with the following personal data on it:

- Medical history
- Body measurements
- Posture
- Working times
- Location
- Work environment
- Work and leisure time-related habits
- Heart rate

These relevant personal data were selected based on the pre-interview feedback and by checking through the full personal data list, which was generated from George et al.'s research [Information Sensitivity Typology]. (Appendix 3. Personal Data List)

USER TEST

Setup

Based on the evaluation of the pilot test, the user test was adjusted and conducted (Appendix 4. Protocols II). The user test lasted for 60 minutes, with two designers involved in the user test, two observers observing via Livestream (after their consent) and two participants at the same time. One of the participants works full time as a chef and the other one is a part-time cook. The interviews before and after using the tool were conducted in different rooms.

Data Collection

The user test results were collected, consisting of 1) perceived risk mapping, 2) discussion transcripts, 3) interview notes and 4) observation notes. The full data collection can be found in the Appendix 6,7,8.

Perceived Risks Mapping

The chosen perceived risks were Data leakage, Misuse of data, Social disapproval and Data transaction. The results of putting down the blocks are summarized in Table 2 and Table 3.

Risk	User 1	User 2	Total
Data leakage	3	0	3
Misuse of Data	1 big	2	**2 + 1big**
Social Disapproval	0	2	2
Data Transaction	1	1 big	1 + 1big

Table 2. Results of Round 1

Risk	User 1	User 2	Total
Data leakage	3	2	5
Misuse of Data	1	1 big	1 + 1big
Social Disapproval	0	1	1
Data Transaction	1big	1	1 + 1big

Table 3. Results of Round 2

Discussion Transcripts

The video recording of the user test was transcribed for analyzing (Appendix 6. Video Transcripts II). The discussion between the participants and with the designer after the first round motivated the participants to make individual decisions.

Interview Notes

The interviews before and after using the tool are summarized as interview notes (Appendix. 7 Interview notes).

Recordings & Observation notes

An integrated observation note was made based on critically watching the video recording of the user test, and combining it with input from both designers and observers (Table 4. Observation note).

Researchers focus on the stage of putting blocks because the users were asked not to talk at that time. The table shows two kinds of data: 1) the duration between two key points. The first duration is from start thinking how to put the blocks to touch the blocks, and the second duration is from start putting blocks to finish putting the blocks down. 2) users' behavior, especially when they put the blocks.

		Round 1		Round 2	
		User 1	**User 2**	**User 1**	**User 2**
Thinking how to put the wood blocks	**Time**	50 seconds for thinking without touching the blocks	58 seconds for thinking without touching the blocks	Held blocks in hand, 15 seconds for thinking without moving the blocks	31 seconds for thinking without touching the blocks
	Behavior	Then he separated three wood blocks and held them, ready to put.	Then he held all the wood blocks.	Then he separated three wood blocks and held them, ready to put.	He took out a block and put it aside firmly
Putting blocks	**Time**	10 seconds for putting all the blocks	9 seconds for putting all the blocks	15 seconds for putting all the blocks.	17 seconds for putting all the blocks
	Behavior	He quickly put down 3 blocks (which is the most) on a plate. Hesitating for a while, he placed the remaining two blocks on different risk plates.	He quickly put down 2 blocks (which is the most) on a plate. Hesitating for a while, he placed the remaining two blocks on different risk plates.	Participant 1 put down 3 blocks (which is the most) on a plate. Participant 2 stacked 2 blocks (which is the most) on the 3 blocks that participant 1 placed. Hesitating for a while, participant 1 changed a block. Participant 2 put block on a plate, and participant 1 put a block on the same plate. They had some words and saw each other's behavior. They both looked at one plate for a while. Participant 1 hesitated, and participant 2 put a block, then participant 1 put a block. It seems participant 1 is waiting for participant 2 to put first. Participant 2 put the left block quickly.

Table 4. Observation notes

Analysis

The perceived risk mapping is analyzed with a comparison graphic (Figure 2). Meanwhile, the comparison results are actively linked with the analysis of qualitative data, which results in a deeper understanding of the reasons behind certain behaviors.

Figure 2. Comparison of Perceived Risks Mapping Round 1 & 2

The full transcripts and interview notes can be found in Appendix 6 Video Transcripts II.

The discussion transcripts and interview notes are analyzed by the content analysis method [5]. Through reading the written sentences actively, meaningful characteristics of the participants' comments can be spotted [5]. The discussion transcripts are color-coded for categorizing (Appendix 8. Content analysis and color-coding). Six big themes emerged - Important personal data, Concerns about the data, Data misuse, Data leakage, Consequences of the data misuse/leakage and Others. The content analysis provided a basis to interpret the interviews and the extracted sentences are used to reason our insights in Finding & Discussion part.

FINDINGS & DISCUSSION

In this section, the findings and interpretations are discussed per topic. Several topics are discussed - Increase awareness within the context, clarifying the most important perceived risks, willingness to share personal data, social impact during a discussion and projected stakeholder blocks.

Increase Awareness within the Context

The participant's awareness of perceived risks increased in this situated context of the co-design process. This conclusion can be drawn by comparing the interviews conducted before and after the user test. The participants actively expressed to have more awareness regarding why the data is being collected, what they define as personal data, what data was important for them, where it could be used and how this use can affect them.

"After talking about the costs and stuff, and losing the job. It (sharing personal data) could have a bigger impact than I thought before" Participant 1

Since the participants were situated in a context of co-design using personal data, and the tool introduced the participants

to perceive the risks of sharing personal data as a highly relevant issue. Additionally, it should be emphasized that their awareness only increased regarding this certain topic.

This increase could also be suggested by observation while placing the blocks. A difference in thinking time was observed (Table 4. Observation Notes). Participant 1 spent 10 seconds putting blocks in the first round and 15 seconds in the second round. It took 9 seconds for Participant 2 putting blocks in the first round and 17 seconds in the second round. Both of them spent more time to put blocks in the second round. The video observation shows that they had more hesitation while putting down the blocks in the second round. In the second round, they looked at the definition of the risks they chose and the records of previous discussions. In this setup, their awareness of perceived risks in the co-design context could be increased while considering and judging different risks, and the connections between them.

Clarifying the most important perceived risks
The discussions, which emerge due to the use of the tool, helped to inform the participants about the range of risks and clarify how they perceive them. The tangibility of the tool provides the option to cluster the perceived risks make them more understandable.

Participants 1 has placed the most blocks on one risk in round one, which is data leakage. *"A lot of me in one second to a lot of people"*. Participants 2 has not placed one block on this risk but did so in the second round (Figure 2). As a reason, participant 2 stated that since the discussion of the first round the risk of data being leaked is influencing other risks.

Though both participants agreed that data leakage is the most important perceived risks after the discussion, they mentioned a tight connection between data leakage and data misuse. One participant said: "*I don't like it if it is leaked and I don't like it if it is misused. In one way it is a bit the same. When it is leaked then it is already misused, I believe.*" and the other participant nodded at the statement. "*Maybe a combination between these two.*"

Willingness to share personal data
The analysis of the video revealed that the participants first rank personal data based on their importance and take that into account before they determine which risk deserves more attention. In this case, the tool helped designers to get a clearer understanding of the conditions under which a user would be willing to share data.

Table 5 shows the personal data mentioned in the discussion after the first round placing the blocks. Participants highlighted that the most important personal data for them is medical data "*When you have all that information of me and you leak it, especially the medical history and my heart rate.*" This data is relevant to participant 2 because it can lead to

social disapproval - "*If my data about my body measurements are leaked or about my medical history and it is misused then this could lead to social disapproval and we are all social beings*". This user motivated his statement based on his education in social sciences. Further, he stated that leaked medical data could lead to job loss "*I think the medical stuff (data), which could cost a cook his job.*" After usage of the tool participants did not change the understanding of personal data, it remained the same. From this, designers can assume that medical data is more important for participants to keep safe than other data, hence they expressed through the tool under what condition they would be willing to share this data.

Rank	Category	Count	Personal data from quotes	Count
1	**Medical data**	7	Medical data	2
			Heart rate	2
			Medical history	2
			Diabetics	1
2	**Location & time data**	4	Location	2
			Working/leisure related time	2
3	**Personal preference**	1	Habits	1
3	**Physical data**	1	Body measurement	1

Table 5. Important personal data ranking.

After the second round, the participants stressed the fact that data, mostly the medical data, should not leak at all and that there is no selling of information to third parties, such as insurance companies, then they are more willing to share the data. In this case, the tool could help designers to get a clearer understanding of the motivations why a user is less willing to share data.

Social impact during discussion
During the session, the tool raises discussion among participants and designers. The participants exchanged ideas, often agreed on each other and build upon each other's thoughts in the discussion. For example, participant 1 stated *"I think as well for the insurance companies. Now in the future time, people see: Oh, now you are a cook, you have a lot of stress. You know what? You have to pay more per month"*, participant 2 added, *"Yes, you have a bigger risk for*

a heart attack". They both nodded at each other's statements and showed mutual agreement. In the second round of placing blocks, they stacked the most blocks together on the *data leakage* card, while they put them on different cards in the first round. The participants showed more agreements in the second round (Figure 2). Moreover, they put the blocks down with more hesitation than in the first round, one participant seemed to wait for the other one, to place the blocks on the same risk card.

Even though they did not place the blocks in exactly the same way, the perceived risk mapping still shows the influence on each other (Figure 2). In Figure 2, the small blocks are defined as height 2 and big blocks as height 3. Comparing the difference in height between the two participants in both rounds, the difference between the first and second round decrease from 12 to 6. Their perception of risk is converging after using the tool.

Projected stakeholders
Although stakeholder blocks are included in the tool, the other stakeholders were not taken into account by participants throughout the user test. The participants noted that all statements and decisions made from their own perspective "*I did not think about them", "Me neither. Not that much at least. That was totally from my own perspective*". Therefore, further discussion of the necessity of the stakeholder blocks is needed.

Limitations
In this section, the limitations of the research are discussed, which could be used to define the relevance of this research but also as a basis for research into future directions.

Firstly, the research does not include enough target users in the pre-interview and the user test. Only one participant was involved in the pre-interview and two in the user test. Only one or two participants could not be concluded as the optimal scenario for using the tool.

Secondly, the other stakeholders, such as manufacturers or managers, were not involved in the research. Thus we can only speculate about their influence on this process.

Furthermore, the time span of this research is insufficient to some extent. Field methodology requires enough time span in a social context in order to analyze the data [13] and the general co-design process has a much longer time span, while in this research only the early stage in the co-design process was taken into consideration [13]. No further test was conducted regarding the long-term influence of the tool on the participants and the implementation in other stages within UPPSS loops.

Another limitation could be the influence of feeling safe in the environment of the university gives. The designers were quite vague about the goal of the research and to whom the data would go, nevertheless, the participants did not question the nature of the research for a second. We assume that during a co-design session outside of this educational context the willingness to cooperate, share data and give opinions will be different and less.

Future Work
This paper presented research on the possibilities of using a tangible representation to bring the concept of perceived risks into the co-design process. This research can be used as a stepping stone for further research in the re-consideration of perceived risks in the co-design process.

Within the UPPSS frame, the tool can be implemented in other stages. More research could be done on the impact on participants in further UPPSS process.

Additionally, the research could be a pilot for developing principles regarding using personal data in the co-design process. The clarification of their subjective perceived risks of share personal data might be a good example of users contribute to the co-design process, other than to provide functional data.

A method to connect members of a stakeholder group with one another and give them a possibility of the spectrum of perspectives they can take into account when thinking about the proposed design. Vice versa we see potential when this is explored to connect the various stakeholder groups with one another and enable a discussion of informed groups.

CONCLUSION
In this research, the objective was to explore the possible effects by using a tool to represent the perceived risks in the UPPSS co-design context.

The findings show that the tangible representation tool has effects on the participants by clarifying the perceived risks and personal data. The awareness of personal data usage in the co-design process increased, though the participants tend to focus on their own perspectives and opinions instead of taking consideration of other stakeholders. The willingness to sharing personal data might decrease, nevertheless, under which conditions they are willing to share personal data seems clearer for the participants.

The prototype can be developed to assist designers and researchers to better collect and use personal data from users. Within the UPPSS frame, it also provides some insights of mapping personal data and perceived risks based on a different design concept.

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APPENDICES

Appendix 1. Pre-interview questions

Appendix 2. Pre-interview scenarios

Appendix 3. Perceived risks list

Appendix 4. Protocols

    I.   Pilot test
    II.   User test

Appendix 5. Consent forms

    I.   Pre-interview
    II.   Pilot test and User test

Appendix 6. Transcripts

    I.   Pilot test
    II.   User test

Appendix 7. Interview notes user test

Appendix 8. Content analysis and color coding