Approaching design for development from a capability perspective

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To improve the well-being of disadvantaged and marginalized populations by product design, deep contextual insight is required. However, literature does not specify which topics to discuss or which questions to ask. To address this issue, we used Sen's capability approach to develop question categories and adopted a semi-structured interview approach called the *Opportunity Detection Kit.* This kit has been tested by evaluating the impact of the Philips Chulha in rural South India. By using the kit, a comprehensive picture could be drawn about the participants' lives, which indicated opportunities for product improvement. The integration of the capability approach and product design therefore seems to be promising.

Keywords: Capability approach, design for development, product design, well-being.

Design for development and the capability approach

Design for Development (DfD) is described by Donaldson[1] as 'product design aimed at disadvantaged or marginalized populations' in order to advance social, human, and economic development. Product design refers to the 'creation of tangible products and services that induce change to a new context'[2]. DfD is not only considered to be relevant for poverty alleviation in developing countries[3,4], but they also represent a huge consumer market. Moreover, insight into designing products for these markets might be an important source of innovation and beneficial for all markets[5,6]. While this field has been growing rapidly in the last few years, it is growing in 'haphazard ways'[7]. Until now, only a few guidelines are available to develop products for these underserved markets[8].

Designers face several challenges to come up with innovative designs for the disadvantaged and marginalized populations. These challenges include; more complicated information gathering for this market than for mature markets[9] and difficulty to identify people's true needs.[8,10–12]. To combat these and other challenges, several valuable design methods and toolkits have been developed for NGOs, social enterprises or community workers[13–19]. Although these toolkits and methods do specify different methods, tools and examples, they do not explicitly specify which topics to discuss or which questions to ask when exploring the user context. This is left to the designer or the design team.

To address this issue we have used Sen's Capability Approach (CA). According to Robeyns[20], this approach takes into account all dimensions of human well-being and offers a 'broad normative framework'. As products and services have the ability to shape opportunities for the people using them, technology and design are directly or indirectly linked to people's real opportunities. However, this connection has been mentioned by several authors[21–23].

To practically apply this conceptually rich approach remains a challenge[23,24]. The meaning of *capability* in this approach 'diverges from everyday language'[25] – the focus is on 'attainable outcomes' (opportunities), and not solely on trained potentials (as skills, abilities and aptitudes)[25]. Capability is therefore a hypothetical concept[25]. Thereby, the approach includes a broad variety of dimensions that differ per situation[24,26,27], capabilities have an interdependent nature[28], change over time[24,29], and differ per person and per region[24,26].

The relation between the product design process and the capability approach is visualized in Figure 1, which shows that the CA makes a clear distinction between what people are free to do to improve their well-being (their capabilities) and the actual achieved components of a person's life (their functionings). The existence of capabilities does not only depend on the availability of people's resources[30], but also depend on personal, social and environmental conversion factors[31]. Finally, the actual achievement of capabilities depends on people's personal choice[30]. The product design process is schematically represented in the lower rectangle. The actual design process is not linear but is an iterative, fuzzy, chaotic trial-and-error process[32,33]. However, according to Cross [34], the basic structure of the design process can be divided into three phases: (a) analysis; (b) synthesis and (c) evaluation. During the analysis phase the design problem is analysed and defined. In the synthesis phase ideas

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Table 1. Capability categories extracted from literature

Capability category (pragmatic)	Capabilities (ideal/aspirational)
Health	Feeling of sufficient long life expectation, of being obstructed by health limitations, and of the ability to reproduce, feelings of worry, stress and strain. Feeling of ability to visit doctor and dentist and to obtain medicine/medical care.
Nutrition	Feeling of having sufficient food to feed yourself and your family, feeling of ability to enjoy a meal whenever needed, feeling of being able to eat sufficient meat, chicken, fish and vegetables.
Safety	Feeling of safety inside the house and in your living area, feeling of being discriminated or bullied.
Education	Feeling of proper education possibilities, feeling of having sufficient knowledge, feeling of having sufficient access to knowledge.
Meaningful work	In day to day activities: feeling of ability to enjoy, feeling of ability to use imagination and reasoning/skills and talents, feeling of playing a useful part, feeling of being appreciated.
Leisure	Feeling of having sufficient spare time in which you can decide yourself what to do, feeling of enjoyment of recreational activities.
Mobility	Feeling to go out of the house whenever you want to, feeling of ability to go wherever you want to go, freedom to use and operate any kind of transportation which you would like.
Partnership/family	Feeling of sufficient affection from and happiness with partner, feeling of freedom to leave partner, feeling of involvement in family decision making, feeling of appreciation by family.
Friends	Feeling of acceptance and appreciation within your community, ability to establish friendships, ability to express feelings of love, grief, longing, gratitude and anger.
Self-determination	Feeling of being able to evaluate the way you lead your life and where you are going, feeling of living your life satisfactorily, feeling of ability to decide about reproduction.
Cultural and spiritual life	Feeling of freedom to practice your religion, feeling of freedom to express political views and participate in political activities, feeling of freedom to life according to cultural habits.
Products, plants, animals	Feeling of having ownership of attachment to products, plants, animals.
Accommodation	Feeling of ownership of the house, feeling of involvement in choice of house, freedom to move to another house, adequateness of house for current needs.

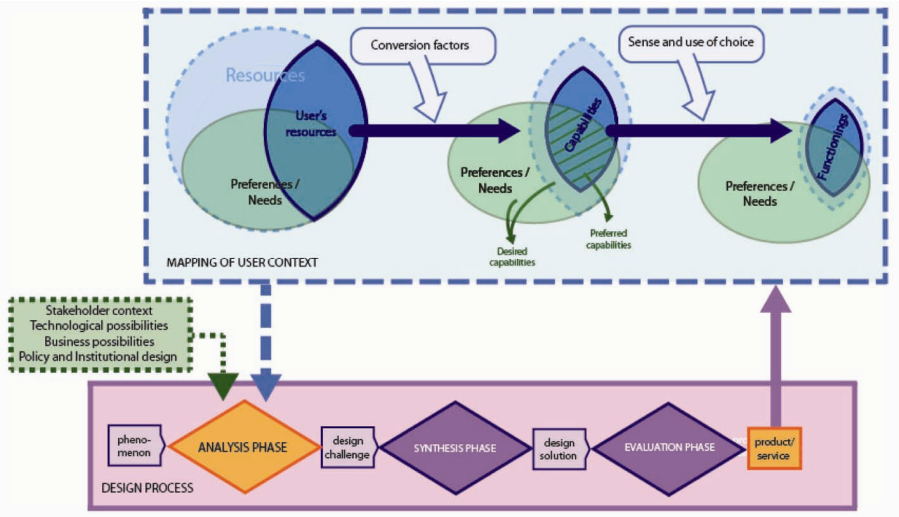

Figure 1. Relation between the product design process and the capability approach.

are formed, chosen and conceptualized, after which a preliminary design is made, derived from the best concept. In the evaluation phase the preliminary design is tested and its value or quality is determined.

In this paper, we describe how we practically applied the CA in the field of DfD to guide the designer during the context analysis phase to assist them during the remainder of the design process to come up with products and services that improve people's capabilities. To do so, we identified a set of capability categories. We then developed an *Opportunity Detection Kit* (ODK), a method that assists the designer to conduct semi-structured interviews with potential users. This kit consists of thirteen capability categories, a set of questions per category and

several tools. By questioning people about all aspects of their lives, instead of focusing on the product and product-related aspects, a comprehensive insight in people's lives is generated, which assists designers in detecting design opportunities and in decision making throughout the product design process. To validate the effectiveness of this kit, we used it to interview product users of a cooking stove implemented in South-India: the Philips Chulha.

Establishing a capability inspired design method

With a goal to develop a method to generate broad and deep insight into people's capabilities, functionings, values, needs, and desires, qualitative methods are a good way to gather this data about the user context[9,15]. To specifically obtain *deep* insight IDEO[15] propagates an individual in-context interview, and Larsen and Flensborg[16] argue for a semi-structured interview. We conducted semi-structured interviews with individuals.

Generating questions and question categories

Within the CA community there is an ongoing debate on the establishment of a capability list. Sen deliberately refrained from the use of a standard list of capabilities[27]. Nussbaum[35], who significantly developed the CA, formulated an abstract list of ten central human capabilities. Our focus is not on establishing a list of capabilities but a list of categories that can be used to detect people's capabilities, functionings, needs and desires. To make such a list, we used two of the five selection methods mentioned by Alkire[36]: established lists generated by consensus or formed through empirical analysis. We considered the lists established or mentioned by Nussbaum[35], Alkire[36], Hulme and McKay[37], Burchardt and Vizard[38], Chiappero Martinetti and Roche[39] and Walker *et al.*[40].

We deployed IDEO's[15] *find themes* method to make a list of capability categories. We started by noting down all listed items and exploring 'the commonalities, differences, and relationships between the information'[15]. We then deleted all doubles, and started to categorize all unique items. After grouping and re-grouping all items fitted into thirteen categories listed in Table 1.

For each capability category, we brainstormed and developed a set of questions, based on the questions developed by Anand[41–45], who in collaboration with other authors published extensively about questions developed to obtain quantitative capability data on various life domains and issues. Although these questions have been developed to collect quantitative data while we intend to collect qualitative data, they have been a useful guidance. We divided our questions into: (i) *ideal* questions that represent what we are actually after, and (ii) *sensitizing* questions which work as conversation starters (Figure 2).

Establishing an Opportunity Detection Kit

To stimulate discussion and encourage reflection, we selected tools to support our interview. We considered the tools described in Participatory Rural Appraisal[19,46], the Human Centered Design Toolkit and Field Guide[15,47], the BoP Protocol 2nd Edition[14], the Bootcamp Bootleg[17], and the Market Creation Toolbox[16]. We also included the participatory design tools described by Sleeswijk Visser *et al.*[48], as these techniques specifically aim at revealing people's dreams for the future. Three tools were selected: life mapping, visualizing and drawing, and ranking.

After conducting four pilot studies - two in the Netherlands and two in India – we established what we call the ODK. The ODK consists of:

(1) An interview set-up which describes the interview flow, instructions for the interviewer on how to use the ODK, how to instruct the interpreter, how to select participants, and tips to conduct the interview. Inspiration for these instructions was taken from the selected toolkits.

(2) A timeline to map a day of the participant's life. Mapping life aspects is a good way to start understanding the lives of the participants[16,17,19].

(3) Pictures of the interviewer that give an insight into the interviewer's life. Sharing helps in making interviewees feel relevant as participants[16].

(4) A question cardset, each card contains a pictograph that symbolizes the capability category on one side and the related questions (both ideal and sensitizing) on the other side (Figure 2).

(5) Sensitizing cards, drawing cards, drawing sheets and a set of markers. This drawing equipment is intended to stimulate the participants to share their dreams and hopes for the future. Creations, such as visualizations stimulate answering, help in collecting rich stories[15,16] and 'enables people to access and express their experiences'[48].

(6) An importance sheet. This sheet consists of four categories – very important, important, little bit important, not important – indicated with exclamation marks, on which the participants can prioritize between the different capability categories. A ranking exercise helps in learning what and how people value[16].

(7) A gift for the participant, as a token of appreciation for their time and effort[16].

(8) A camera and voice recorder to document the interview.

The contents of the kit are shown in Figure 3.

The interview comprises several steps, which are:

(1) Identification and instruction of an interpreter.

(2) Introducing the interview, the interpreter and the interviewer and asking for consent[16].

(3) Showing photographs of the interviewer's life and surroundings to break the ice.

Figure 2. The question cards visualizing the capability categories and the developed questions.

Figure 3. The contents of the Opportunity Detection Kit.

(4) Presenting the timeline to uncover insights in daily routines and finding starting points for the conversation.

(5) Starting a conversation by posing capability questions of all categories and visualizing the answers by using drawing cards or markers.

(6) Asking the participants to rank the different categories.

(7) Thanking the participant for taking part and handing over a small gift.

Deploying the method

Sen[49] specifically emphasized that both poorer economies and rich countries have disadvantaged people who lack basic opportunities. However, the Multidimensional Poverty Index[50,51] indicates that most multidimensional poor with the greatest intensity of poverty live in South Asia and Sub-Saharan Africa[52]. Given this fact and our experience, we deployed the ODK in India. We selected the Philips Chulha, an award-winning, clay cooking stove, as a case to test our developed method. We specifically looked for a product that was designed for development and had already been implemented in the market. Right now, over a hundred Chulha's are currently being used in South India.

We used the ODK to explore the user context and the product impact by posing the participants questions about their lives before and after implementation of the Chulha. Apart from asking ODK questions, we also included questions related to the product. These product related questions were asked after the first introduction and after the ranking exercise. In this way, we were able to identify the change in perception of the participants towards the product during the interview. We also tried to validate the usefulness of the ODK by comparing the interview outcomes with an existing impact study on the Chulha[53].

From February to April 2012, the second author – at that time a master's student at TU Delft – interviewed the developers, manufacturers, and users of the Philips Chulha. In this way, he gained insight into the reasons behind the product's development and implementation, and a view of the stove's impact. An Indian Ph D student, who executed an impact study on the Chulha a year before, was selected as an interpreter. The interview was discussed with the interpreter and with one of the stove installers, living in one of the explored villages.

This discussion and a pilot study executed with five participants led to adjustment of the interview. The interpreter and installer considered questions regarding affection, the possibility of choosing a partner, happiness, procreation, and life expectation to be offensive or too strong a taboo to bring up. During the pilot study, a few respondents found it difficult to understand some of the questions, which were therefore simplified. The respondents were also reluctant to answer questions related to politics or accommodation (due to an ongoing conflict with the government). Lastly, three capability categories were divided: the 'health' category turned out to be too broad and was divided into health (physical and mental) and healthcare, the 'plants, animals, and products' category was divided into three separate categories as they were discussed as separate topics during the pilot study. The 'cultural life' category was changed to religion, as politics could not be discussed.

In total, 31 interviews were conducted with Chulha users in four different villages. In each of these villages, the installers had to first give an introduction to encourage people to participate due to an ongoing conflict with the government and superstition because of a local prophecy. Participant's characteristics are tabulated in Table 2.

Detected product impact and design opportunities

The Opportunity Detection Kit was tested by applying it to the case of a clay cooking stove developed by Philips. The results of using the ODK to explore this case are described in this section.

Impact of Chulha on users

Based on the responses to the questions, several effects of the Chulha on its users and their lives were identified. Most participants indicated that with the Chulha they spend less time cooking and collecting firewood. The additional time is used to do household chores, take care of animals, plants or trees, spend time with family or friends, relax or undertake spiritual activities. Four participants shared that, due to quicker and easier food preparation, they try new recipes and three others that they now cook special meals more often. Moreover, six participants mentioned that the Chulha prevents blackening of vessels while cooking, which saves vessel washing time.

Table 2. Participants and their characteristics (number of participants in parentheses)

Characteristics of interviews	
No. of interviews	31
Individual interviews	11
Duration (minutes)	16 to 54
Average duration (minutes)	33
Interviewer	Graduating student, male
Interpreter	Student, male, lower class, known to the area
Characteristics of participants	
Gender and presence of other people	2 female individuals, 4 female individuals with children present, 7 female individuals with other adults present in the background (family members or friends), 13 female individuals with other adults actively present, 3 male individuals with other adults actively present (family members or friends), 1 couple with children present, 1 couple with adult family members actively present
Profession	14 farmers, 6 housewives, 7 landowners, 2 livestock caretakers, 1 student, 1 school cook
Age (asked to 20 participants)	16 to 75 (2 younger than 20, 5 between 20 and 30, 6 between 30 and 40, 2 between 40 and 50, 3 between 50 and 60, 1 between 60 and 70, 1 older than 70)
Average age	37
Rural/urban	All rural, from four different villages
Income (INR) per month	Taboo to discuss, during 4 interviews revealed: INR220/230, INR 100, INR 100, INR 70 (+ INR 80 per basket)

Ten participants indicated less smoke formation and sixteen participants mentioned they now suffer from less health problems, such as eye burn, cough and headache. Finally, seven participants shared that their feeling of safety has improved, as they now can go less often into the forest to collect firewood.

However, not every participant experienced the same impact. Although twenty four participants indicated less fuel consumption, four participants did not experience a difference. Two respondents even shared that their fuel consumption had increased, which was primarily because they fill the whole fuel compartment, which is bigger than required. Those six participants do therefore not get additional time or an improved feeling of safety.

During the interview, it became clear that some participants do not cover the second pothole when using only one pothole, which allows smoke to enter the house. It was also found that a few chimneys were broken or not properly installed. Most of these participants did, however, indicate their health improved. Lastly, the improved feeling of safety does not apply to every participant. Five of them indicated that they have always felt safe when collecting firewood.

In this particular case, the experience of using the Philips Chulha is influenced by its implementation. First of all, the region of development is different than the region of implementation. The stove is developed in collaboration with an NGO based in northern India. The design of the Chulha does not fully match the habits of the people in this southern region and the design has not been adjusted to fit the type of vessels and fuel of this region. Second, most users installed the stove because they were advised to do so. Thereby, most participants received the Chulha for free (sixteen). Four of them paid for the Chulha, of eleven participants it is unknown whether they paid or not. It can thus be concluded that the users' sense and use of choice were overlooked, and this certainly influenced their product usage and thus their experienced impact.

Detected design opportunities

By deploying the ODK, we learnt that the kit stimulated participants to think deeply about the Chulha and its impact on their lives. When first posing the product questions participants did not share many problems or possible improvements. However, when posing the capability questions participants started to share their problems and experiences. At the end of the interview, when the product questions were posed again, participants often revealed more information about the Chulha usage and impact. For example, during the first set of product questions only one person suggested that the potholes could be made smaller to fit their old vessels, while during the capability questions five other participants also indicated that their vessels do not fit or fit well in the potholes of the Chulha. Another example is that during the product questions it was not indicated that no chimney caps were provided due to which rain water enters the house through the chimney. It was only during the capability questions that six interviewees mentioned this problem. Most of them made some adjustments or cover the chimney when it rains.

Some other suggestions to improve the Chulha design included: to have a small fuel opening making Chulha to consume less fuel (mentioned by three participants), to make a bigger stove enabling the users to cook for visitors and laborers (one participant), and a simple design for easy cleaning (one participant). Lastly, three participants showed the interviewer self-made decorations on the Chulha, one of them changed these decorations daily.

Table 3. The percentage of time that each topic is discussed during the interviews that these topics were actually discussed

Main theme	Total time discussed in all interviews x	Amount of times discussed n	Average time discussed (min) μ	Average time discussed (percentage) μ	Standard deviation (percentage) σ
Product questions	4 : 20 : 49	31	0 : 08 : 25	25.8	4.6
Introduction	1 : 19 : 13	31	0 : 02 : 33	8.6	2.1
Round up	0 : 40 : 21	31	0 : 01 : 18	6.5	4.0
Meaningful work	0 : 59 : 26	29	0 : 02 : 03	5.9	3.1
Importance	0 : 56 : 02	31	0 : 01 : 48	5.6	1.3
Nutrition	0 : 55 : 27	31	0 : 01 : 47	5.4	2.1
Explanation interview	0 : 45 : 24	31	0 : 01 : 28	4.9	2.1
Timeline (daily rituals)	0 : 46 : 27	31	0 : 01 : 30	4.7	1.9
Partnership/family	0 : 43 : 03	31	0 : 01 : 23	4.1	1.8
Leisure	0 : 41 : 57	31	0 : 01 : 21	4.1	1.8
Friends	0 : 39 : 18	31	0 : 01 : 16	3.8	1.5
Health	0 : 35 : 04	31	0 : 01 : 08	3.6	1.9
Mobility	0 : 34 : 25	30	0 : 01 : 09	3.2	1.6
Education	0 : 29 : 47	29	0 : 01 : 02	3.0	1.9
Products	0 : 25 : 43	30	0 : 00 : 51	2.6	1.6
Religion	0 : 30 : 02	26	0 : 01 : 09	2.6	2.3
Self-determination	0 : 15 : 56	17	0 : 00 : 56	2.4	0.9
Plants	0 : 23 : 20	28	0 : 00 : 50	2.3	1.4
Safety	0 : 21 : 00	29	0 : 00 : 43	2.1	1.3
Animals	0 : 20 : 01	29	0 : 00 : 41	2.0	1.3
Healthcare	0 : 13 : 34	28	0 : 00 : 29	1.6	1.2
Accommodation	0 : 06 : 24	11	0 : 00 : 35	1.3	1.4
Land	0 : 03 : 19	17	0 : 00 : 12	0.6	0.3

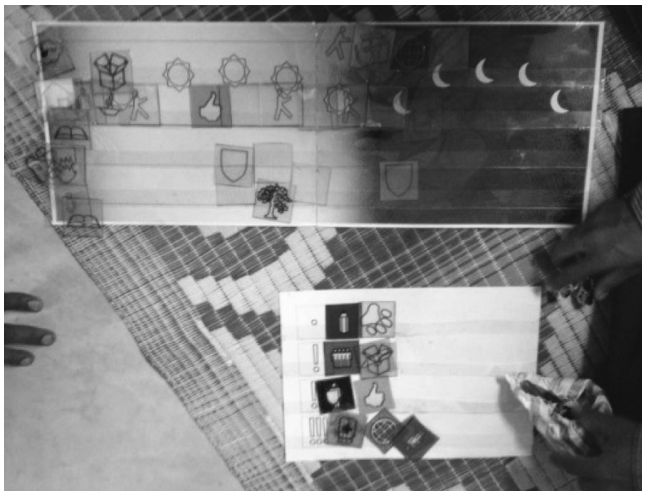

Figure 4. Timeline and ranking exercise.

There are therefore several opportunities for product improvement. They can be sought in the fuel compartment and pothole size, a chimney cap, bigger versions or expansion possibilities, a pothole cover, easier cleaning, and decoration possibilities. Not all of these adjustments might be useful for all users in this or in other areas, but they do indicate interesting areas of improvement that can be further explored.

Experiences with the Opportunity Detection Kit

The interviews lasted between 16 to 54 minutes, on average 33 minutes. This was less than the anticipated hour, due to the excluded categories and questions. As shown in Table 3 the product questions took most of the interview time (on average 25.8%) compared to the introduction (8.6%), interview explanation (4.9%) and conclusion (6.5%). Interview time taken for ranking and the timeline took on average 5.6% and 4.7% of the total interview time and the discussion of the different capability categories ranged from 0.6% to 5.9%. Not all categories came forward during all interviews and these percentages cover only the average interview time of the interviews during which the categories have actually been discussed.

From the data, we can conclude that in this area profession plays a role in the discussion of different categories. Most of the participants were farmers (14), landowners (7), or housewives (6). The remaining four were livestock caretakers (2), a student and a school cook. It was apparent that 'land' came up during almost all interviews with farmers and landowners, the livestock caretakers more elaborately discussed 'animals' and the housewives spoke longer about 'health'. We cannot draw very firm conclusions about the importance of different categories per profession as we did not interview a representative sample of each profession. No significant difference could be detected for difference in age, gender or village.

Interviewing experiences

This study revealed the following interviewing experiences that will be taken into account to improve interview setup of ODK.

- Some general knowledge about the context is useful to save explanation time and to keep the conversation going (e.g. about the education and healthcare systems, and some knowledge about local language and habits).
- The interviewer must consider and deal with local sensitivities and circumstances. The interviewer encountered several local issues (e.g. a conflict with the government, a prophecy discouraging people to participate, cultural taboos, and higher class people who refused to participate because lower class people were interviewed first), which influenced the selection of participants, the willingness to participate, and the eagerness to answer questions. Local circumstances, such as illness, a recently departed family member, and work pending caused interviews to be conducted at different times a day, prohibited some participants to fully open up, and prevented the discussion of all capability categories.
- Conducting a pilot study beforehand is essential to adjust the interview to local circumstances and to become familiar to these circumstances. The pilot also gets the interviewer and interpreter acquainted with the interview flow and their roles.

Figure 5. Ranking exercise.

Figure 6. Comparison sheet.

- The pictures of the life of the interviewer often worked well to 'break the ice'. Only during the first interviews in each of the four villages the installer had to get along with the participants to make them feel at ease.
- The interpreter plays a major role and must be selected carefully. The interviewer noticed several times that the interpreter made up responses, rushed the interviews, and translated loosely. The interviewer tried to control the interpreter as much as possible, and noted down when he noticed the above behaviour of the interpreter to indicate unreliable results.
- Interview outcomes are always influenced by interviewer and interpreter skills. The second author did follow training and conducted several pilot studies, but being a designer he is not specifically trained to conduct interviews. He came across participants being silent, uncomfortable or very talkative, and had to deal with the presence of curious villagers and family members and distracted participants – due to work, children or mobile phones. The ODK does assist in conducting a semi-structured interview, but is not able to prepare a designer or design team for everything they will encounter.
- There are aspects affecting the interview outcomes of which the influence cannot be completely determined. For example, the interviewer being from the Netherlands, the interpreter being from another community, gender differences, and the mood, haste or suspicion of participants. Interview details were noted down to indicate these outcome affecting aspects.
- The interviewer needs to know the interview categories and questions to be flexible enough to conduct the interview. As stated in the introduction, capabilities concern a broad variety of dimensions that have an interdependent nature, therefore, the topics discussed have a broad range and are often connected. The interview itself therefore jumps from one topic to another, and the interviewer has to keep track of the topics discussed and to be discussed.
- Recording is essential to enable the interviewer to focus on the interview. During one of the pilots the first and second author conducted the interviews together, which turned out to benefit the full usage of the ODK tools – especially the drawing and visualizations part. Moreover, it was valuable to discuss and interpret the outcomes with each other and to keep better track of the questions. A second person could potentially also assist in pulling away the audience.

Capability categories

The capability categories intend to concern general, incommensurable aspects, which can be applied to different people in different contexts. This study pointed out that a

change in capability categories is useful to achieve this target. The pilot interviews already indicated a division of the categories 'health', 'plants, animals, and products' and 'cultural life'. Those categories have been separately considered during the interviews. Following the 31 interviews some new changes are proposed, although more case studies must be executed to validate these proposed changes. The proposed changes and recommendations are:

- The topic 'land' could be added as a category. This topic was not pre-defined, and therefore we cannot draw conclusions about it. But it came up during seventeen interviews.
- The categories 'meaningful work' and 'nutrition' can be divided into multiple categories. As can be seen in table 3 those categories have most elaborately been discussed. For 'nutrition' this might not be surprising as the product investigated concerns a cooking stove.
- The identification of cultural specificities deserves further attention. The category 'cultural and spiritual life' currently consists of only 'politics' and 'religion', and did not reveal much cultural specificity.
- The topics 'accommodation' and 'politics' need further exploration. Currently, we cannot draw any conclusions about these topics, as 'accommodation' is only shortly discussed during most interviews, and 'politics' not at all (see Table 3).
- The category names deserve additional thought. The names of different categories did not always cover the full topic or were not specific enough. 'Self-determination' for example was often introduced as 'dreams and plans', or 'life-planning' for better understanding. 'Leisure time' was often indicated as 'relaxation', as most participants indicated that in their leisure time they work extra, take care of animals or do household activities, while the category is meant to uncover things people do when they do not work.

Capability questions

The capability questions are intended to stimulate conversation about the different categories. During this study experience was generated in posing the questions and the type of answers they generate. Unfortunately, sensitive topics for this region were excluded during this study, and therefore no experience is generated in posing questions about accommodation, politics, procreation, affection, or choice of partner. Following this study, several of the remaining questions deserve additional thought:

- Questions of the category 'self-determination' were sometimes difficult to understand for participants. Thereby, participants had often never thought about their dreams and plans in life and found it a difficult topic to discuss.
- The questions about 'leisure time' need more focus on time in which participants do not have to work and can relax. Often leisure time was understood as extra time for work.
- In the category 'safety' the questions relate to feeling safe inside and outside the house, but not to feeling safe during day and night. This latter distinction turned out to be relevant for several participants.
- The questions in the categories 'cultural and spiritual life' and 'education' are too straightforward to stimulate conversation.
- The amount of questions can be reconsidered. Due to the large number of questions and the time pressure on the interviews the interviewer had to hurry. This resulted in posing fewer supplementary questions, while questions as 'why?', 'what for?', and 'what else?' are pre-eminently suitable to show interest and generate a good conversation.

Tools

The three tools deployed in this study were mapping life aspects, visualizing and drawing, and ranking, which are discussed below. After the pilot study, another tool was designed to help participants indicate or rate the amount of change in their lives before and after installing the Chulha. This 'comparison sheet', however, turned out to be even more difficult to understand and explain. Because its contribution did not make up for the extra time required it was used only during seven interviews and left out during the other interviews. Figures 4–6 show the design tools in use during the interviews.

Mapping life aspects

Each interview started with a timeline on which participants' lives were mapped and drawn. In almost all interviews visualizing and drawing tools were used in combination with the timeline. Only in two interviews cards were not placed because it was too windy. The box containing pictures and questions already generated interest and curiosity, which also helped in making the participants, feel more comfortable. The timeline was used throughout the interviews in combination with the question cards, as several capability categories were touched upon when participants described a typical day of their live. The timeline worked well to start the conversation and to obtain understanding about the daily lives of the participants.

Visualizing and drawing

To facilitate mapping and drawing of participants' lives, different sensitizing cards were developed containing pictographs of possible answers. Also drawing tools were

brought to stimulate this process. This study pointed out that the amount of cards were often overwhelming and confusing, and most icons were understood only after explanation from the interviewer. Participants did not take out cards to map their lives themselves, and were hesitant to draw. Children liked the cards and sometimes started drawing, but the participants did not.

Therefore, the interviewer placed and drew cards himself due to which he had to divide his focus between both interviewing and visualizing the answers. Although the mapping and drawing of participants' lives did not work out as intended, the exercise did aid in conducting the interview, because:

- The moment of placing the cards turned out to be a good validating moment where the participant could see what the interviewer understood to be the answer. It functioned as a direct means of communication between the participant and the interviewer.
- It took the rush out of the interviews and encouraged participants to share more stories.
- By placing the cards himself, the interviewer could oversee which items of each capability category had been addressed and which had not. During the interviews often the conversation shifted to other categories. For example, when discussing 'mobility', items from 'family' or 'products' came up, as some participants explain they own a motorbike which they use to travel to distant family members. The placed cards reminded the interviewer which items of each category had been discussed and which ones remained.

Ranking

The ranking exercise concluded each interview. In some cases this exercise caused confusion, but after a thorough explanation of the exercise and by mentioning and explaining the categories one by one, participants were able to perform this task. While the ranking exercise gives a clear overview of the priorities per person, no general conclusions based on gender, age, profession or village could be attached to the results of this exercise. The only thing that stood out is that mobility has a low priority to almost all participants. Still, insight into people's priorities provided additional insight into their values, needs and desires and stimulated participants to share more detailed information about their lives.

Exploration of the user context

The ODK has been developed to explore the user context. During this study, we specifically investigated the impact of the Chulha to detect capabilities, functionings, needs and desires to explore design opportunities. We have to keep in mind that the interview outcomes differ per person, situation and region, and change over time. Therefore, the outcomes are difficult to generalize and remain a snapshot in time.

Improvements to better explore the user context

There are some aspects that deserve more attention in the ODK. In above sections, we pointed out possible improvements in categories, questions and tools. However, to better explore the user context, we noticed that the detection of resources and conversion factors, and maybe even more important, *missing* resources and conversion factors, need more consideration. In this way, the underlying reasons for unfulfilled desires can be better detected. In one case a participant indicated a desire for a power connection. Further questioning revealed that this power connection was desired to water trees and watch television. However, the underlying reason for not having electricity was not revealed. Asking the questions, 'why', 'what for', and 'what else' turned out to be essential.

Also the concept of choice is important to sufficiently take into account: why do people make certain choices and how do they make these choices. The decision making question in the category 'family' is an important question in this respect, and by knowing people's priorities choices can also better be understood. To reveal more information about people's sense and use of choice the focus during the interviews should be more on asking 'why'.

Insights into the lives of users

Compared to a local impact study, similar, but also different impact aspects of the Chulha were detected. Findings of the previous study that did not come up during our study are: less firewood storage which results in additional space, better preservation of nutrients when cooking on the Chulha, and a preference for cooking in squatting position. Our present study, on the other hand, revealed that users got additional time to spend, try to cook new dishes and have less blackened vessels. Our study also revealed that some vessels in this region do not fit the potholes of the Chulha and that different participants use the Chulha in different ways.

The ODK thus reveals impact of the Chulha and specifics about its usage but does not reveal all required information. The environmental impact of the stove, political and social power structures, and health statistics did not clearly come forth by using the ODK. They were revealed by talking to other stakeholders; a local doctor provided health statistics, power relations were identified during conversations with the installer, and environmental conversion factors such as climate conditions and pollution could be obtained from secondary sources. Asking supplementary questions and deploying other methods and tools, in combination with the capability categories, is

useful to improve the completeness and the validity of the detected information.

Keeping the above in mind, we can state that the ODK did make it possible to learn a lot about the lives of the participants in a short time span. We obtained a good view of participants' real opportunities (capabilities), their achieved capabilities ('functionings') and their valued capabilities for the future ('needs' and 'desires'). Capabilities and desires were harder to identify, but due to the capability questions, and by mapping and drawing their lives, the participants started to think more deeply about their own lives and desires, and also started sharing more.

Conclusion

This study indicates that by questioning people broadly about capability categories, a holistic and comprehensive picture about their lives can be drawn. The questions of the deployed ODK not only broadened the insights of the interviewer, but also made the participants themselves more aware of their own functionings, opportunities, and aspirations. The study also indicates that the deployed kit encourages participants to share stories, which aids in revealing underlying reasons for choices and behaviour, generating valuable user feedback and opening up new design perspectives. In this sense, merging the fields of the CA and DfD to construct a semi-structured interview approach has proven to be effective in generating deep and comprehensive insight in participants' lives.

However, it turns out that the ODK should pay more attention to resources, conversion factors, and the concept of choice. Thereby, this case indicated possibilities for improvement of categories, questions, and tools. More case studies will confirm or reject these possible changes. Still, the list of categories and questions will remain open to critique and modification, as it should be, according to Alkire[54]. The ODK needs continuous development and adaptation, based on experiences of using it[16]. We also have to keep in mind that the ODK is not a magic kit making all other methods and tools redundant. The designer still has to look further and apply different tools and methods in order to obtain a full picture, and, according to Chambers[13], to crosscheck qualitative data.

Based on this case study, we preliminary conclude that using the CA to detect design opportunities appears to be promising and holds the potential to add value to the field of DfD, as it assists in exploring the user context. The CA provides the designer a broader view than just focusing on the product. This broad view, combined with tools from the field of DfD and participatory design, provides the designer a more comprehensive insight into the lives of their potential target users. This information leads to insights that can, after proper validation with a bigger user group, be used throughout the design process in order to develop products and services that improve the well-being of their users.

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