CHALLENGES IN PARTICIPATORY DESIGN RESEARCH: REVIEW OF EMPIRICAL CO-DESIGN STUDIES FOR INTERGENERATIONAL CONNECTEDNESS IN FAMILY CONTEXT

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INTRODUCTION

Studies have indicated the benefits of strong intergenerational connectedness to the wellbeing of people. Technological designs have thus been explored and developed for improving intergenerational connectedness. Also, technologies have been increasingly integrated in our everyday life as parts of the daily infrastructure, requiring everyone's engagement in the design process to better meet the everyday needs.

Co-design has been a feasible method of participatory design research (abbr. PDR), since it emphasises people's direct, collective contributions to design ideas as design partners throughout the technological development.[1] Although empirical PDR studies of technological designs for intergenerational connectedness in the past two decades have engaged families, previous reviews in the related contexts indicate a lack of engagement of participants in the generative stage as design partner.

This review study aims to identify empirical studies that have adopted co-design approach with family members of different generations (i.e., (grand)parents and children, and collateral relations) to design technological artifacts for enhancing intergenerational connectedness. By organising the literature, this paper provides insights into the existing methodological considerations of co-designing with families for mediating their connectedness, with a focus on the issues design researchers encountered throughout the co-design processes.

Technologies as mediators of family connectedness

According to Lee and Robbins,[2] social connectedness refers to the "internal sense of belonging and is defined as the subjective awareness of being in close relationship with the social world." Similarly, other scholars have also defined social connectedness as a short-term, emotional experience of belonging and relatedness, or closeness, among people,[3] which can be assessed by dimensions of the frequency of the social contacts, the quality of the social encounters, the (dis)satisfaction with contact quantity and quality, the (dis)satisfaction with relationships, and so on.[4] Since human beings are born to be social beings, the importance of establishing social connectedness to the physical and mental wellbeing of people of all ages has been highlighted.

Since late 1990s, people have seen the possibility of using technologies to mediate social connectedness. A review study in 2011 shows an increasing trend of research in the first decade of 21st century about technological development in addressing social interaction and connectedness.[5] Another review study in 2012 suggests that the most common theme of technology design for/with families throughout 1996-2011 was "promoting togetherness and unity" in family context.[6]
However, there is a lack of review study in this field in the near decade, while previous studies have not presented a summary of the approaches to engage families as design partners[7] in devising technology for mediating intergenerational connectedness. Therefore, this study aims to address this gap to take a close look into PDR in this specific area to dig out the existing approaches and challenges of engaging active participants.

Existing theoretical frameworks of co-design methodology

There are three existing theoretical framework that we referred to for this review analysis. First one is Druin's framework for defining the roles of participants, in which she categorises children as users, testers, informants, and design partners in PDR depending on their relationships to adults, to technology, and the goals of inquiry.[8] The second is Sanders and Stappers' framework of co-design, where they divide the whole co-design process into pre-design, generative, evaluative, and post-design phases, and have highlighted the usages of various tools, such as probes, toolkits, and prototypes at each phase.[9] Finally, Hanington and Martin's handbook recording 125 universal methods of design has mapped out the correlations of design research methods with the phases of research,[10] which is more up-to-date and referrable for identifying the design phase each study locates at.
To figure out challenges of active participation of families in this specific area of technology design research, we combined the three frameworks with Druin's and Sanders and Stappers' as main references and Hanington and Martin's as support for our review analysis. With such an endeavour, we attempted to provide a matrix of methodological considerations that links together roles of participants (i.e., families), co-design phases, and research methods and tools, so as to inform the analysis of the challenges revealed in the previous empirical PDR projects.

Research questions

With the main goal of investigating how technologies were proposed and designed with families to achieve the intention of mediating intergenerational family connectedness, we have specifically considered the below two research questions:
1. What are the existing approaches of engaging people as co-design partners to develop technologies for mediating family connectedness?
2. What are the challenges of co-designing technologies with intergenerational families?
By answering these two research questions, we attempted to inform future research in this area, as well as other research related to society and communities that incorporate PDR with families.

METHODS

The literature identification process has adopted the Title-Abstract-Keyword (TAK) searching strategy for efficiently find out the most relevant articles related to our research goal. Keywords for screening literature from the database *Scopus*, since it covers many interdisciplinary studies related to design, are listed in Table 1. There are mainly four steps of identifying literature as shown in Figure 1.

Key Concepts	Related Keywords
Connectedness	"Feelings of belonging", "belongingness", "relatedness", "social connectedness", "connectedness", "togetherness", "intimacy", "feeling of closeness", "closeness"; "awareness", and "love"
Participatory Design	"Participatory design", "co-design", "cooperative design", and "co-creation"
Technology	"Tangible technology", "tangible design", "more-than-digital technology", "technology" and "technological artifacts"
Family	"Family", "family members", "intergenerational", "cross-generational", "parent and children" and "grandparent and grandchild"

Table 1. Keywords for Identifying Literatures

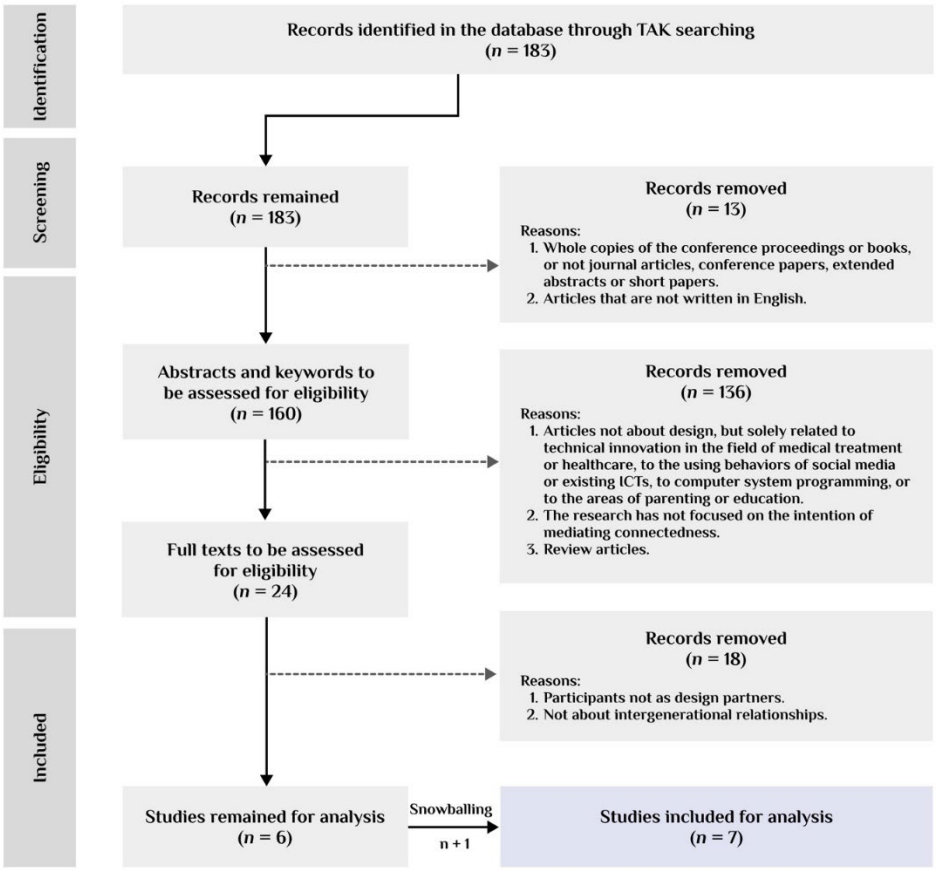

Figure 1. Diagram of Literature Identification and Screening Processes

We identified 183 research articles related to the topic at first. And then, literature screening was conducted, with some exclusion criteria set before and during the screening process. Firstly, we have screened out books or entire conference proceedings, as well as research that are not presented in English. Secondly, we have excluded those do not contribute to (technological) design or not focus on mediating connectedness and screened out review articles. Thirdly, through a thorough examination of the contents of the remined studies, we have excluded empirical studies where participants were not engaged as design partners according to Druin's criteria (i.e., participants who engage in all the stages of pre-design research and design generation to directly provide design ideas)[11] or where participants were not intergenerational families. There were 6 studies left for detailed analysis at this

stage. Throughout the process of analysis, we have snowballed one more research article through the examination of the reference lists of the included articles. In the end, there are 7 highly relevant articles included for thorough analysis.

RESULTS AND FINDINGS

Even though the included studies are limited in the amount (n=7), there is an obvious one-decade gap found between 2006 and 2016 where there is no related research publication (see Figure 2). Possible reasons can be the emergence of communication technologies like smartphones[12] and the global hit of social media that led to more research on how media technologies have influenced social behaviours or why people use these media technologies. Examples are the studies of Biemans et al.,[13] Sagoo and Rhee,[14] Sherman et al.,[15] Wei,[16] Whiting and Williams,[17] and Stuedahl and Lowe.[18] And thus, there can be less interests in exploring additional technologies for social connectedness in general. Another gap between 2019 and 2023 is also revealed, with the outbreak of COVID-19 as one of the possible factors. Even though there were still many research looking into measurements of and coping strategies for social connectedness and mental wellbeing during that time,[19] it can still be hard for design researchers to involve families in-person for co-design activities during that special period.

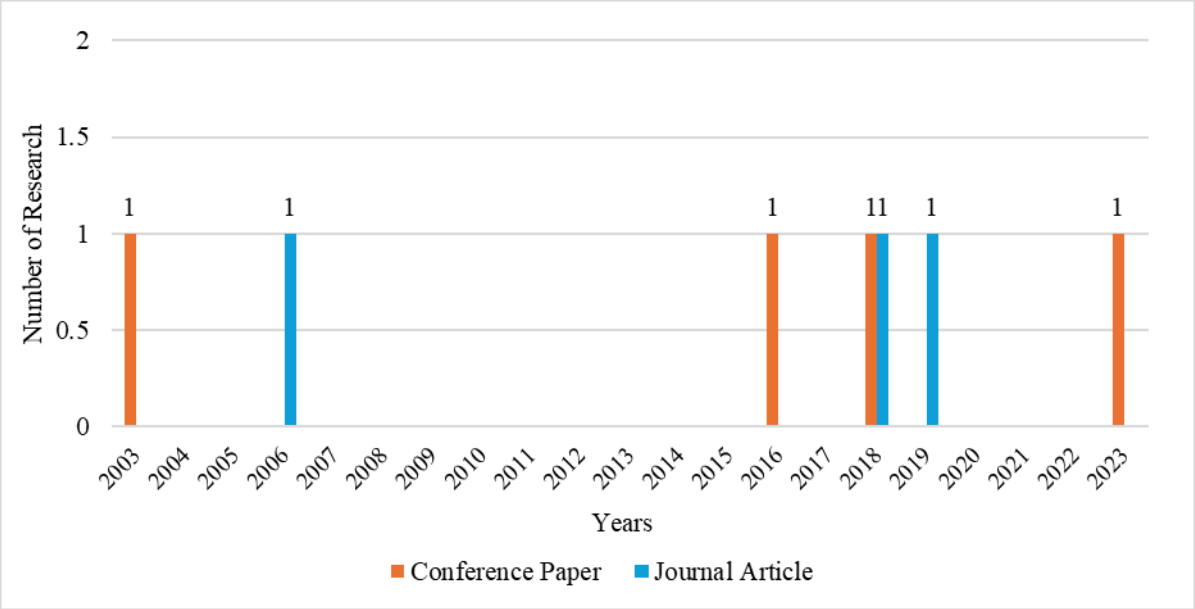

Figure 2. The Number of Conference Paper or Journal Article Published in Each Year

Among the included articles, three are journal articles and four are conference papers (see Figure 2). It seems that conferences welcome a bit more design research in relevant field than journals. But whether this insight is valid can be further investigated in future studies.

Except for one research article from India, all the rest included are from western countries or regions (see Table 2). This indicates another research gap for future research in the area, that is, to conduct PDR and co-design activities in countries and regions of different socio-cultural contexts to collect first-hand data about the insights of people from various backgrounds to avoid cultural biases or overgeneralization.

Research Article	Year	Country / Region
Technology Probes: Inspiring Design for and with Families	2003	Sweden, France, and the U.S.
Shared Family Calendars: Promoting Symmetry and Accessibility	2006	Sweden, France, and the U.S.
Confidence & Control: Examining Adolescent Preferences for Technologies That Promote Wellness	2016	Boston, the U.S.
Participatory Design for Creating Virtual Environments	2018	Mumbai, India
"I Just Let Him Cry…": Designing Socio-Technical Interventions in Families to Prevent Mental Health Disorders	2018	Oxford, the UK
Storywork In Stem-Art: Making, Materiality and Robotics Within Everyday Acts of Indigenous Presence and Resurgence	2019	the U.S.
Designing for in-Home Long-Term Family-Robot Interactions: Family Preferences, Connection-Making, and Privacy	2023	the U.S.

Table 2. Cultural Backgrounds of The Included Research Articles

Co-design methodologies and roles of participants

Looking into methodologies, all seven articles record at least one co-making process throughout co-design research. Details about the correlations of the methods and tools adopted and the phases of design research are shown in Figure 3. The descriptive data about the situations of each tool been adopted at each phase of co-design research in the included studies are displayed in Figure 4, while those of the methods applied are synthesised in Figure 5.

Specifically, two studies have reported research design throughout pre-design, generative, and evaluative phases; three studies have depicted the pre-design and generative phases; and for the rest two research articles, authors have recorded the generative phase only. No study has covered the post-design phase.

The most frequently adopted tools are low-tech materials (n=8), followed by technological probes (n=5), and then low-tech prototypes (n=4). Correspondingly, it is not surprising that co-design workshops (n=10), which have close relations with low-tech materials and low-tech prototypes, are the most applied research method, followed by interviews (n=7), an ethnographic method commonly used for digging deeper insights from people, and then technological probe deployment (n=5), closely attached to technology probes.

However, across the seven studies, there are only eleven methods adopted for PDR studies in this specific area, while way more methods for design research listed by Hanington and Martin[20] remained to be examined and incorporated in PDR studies.

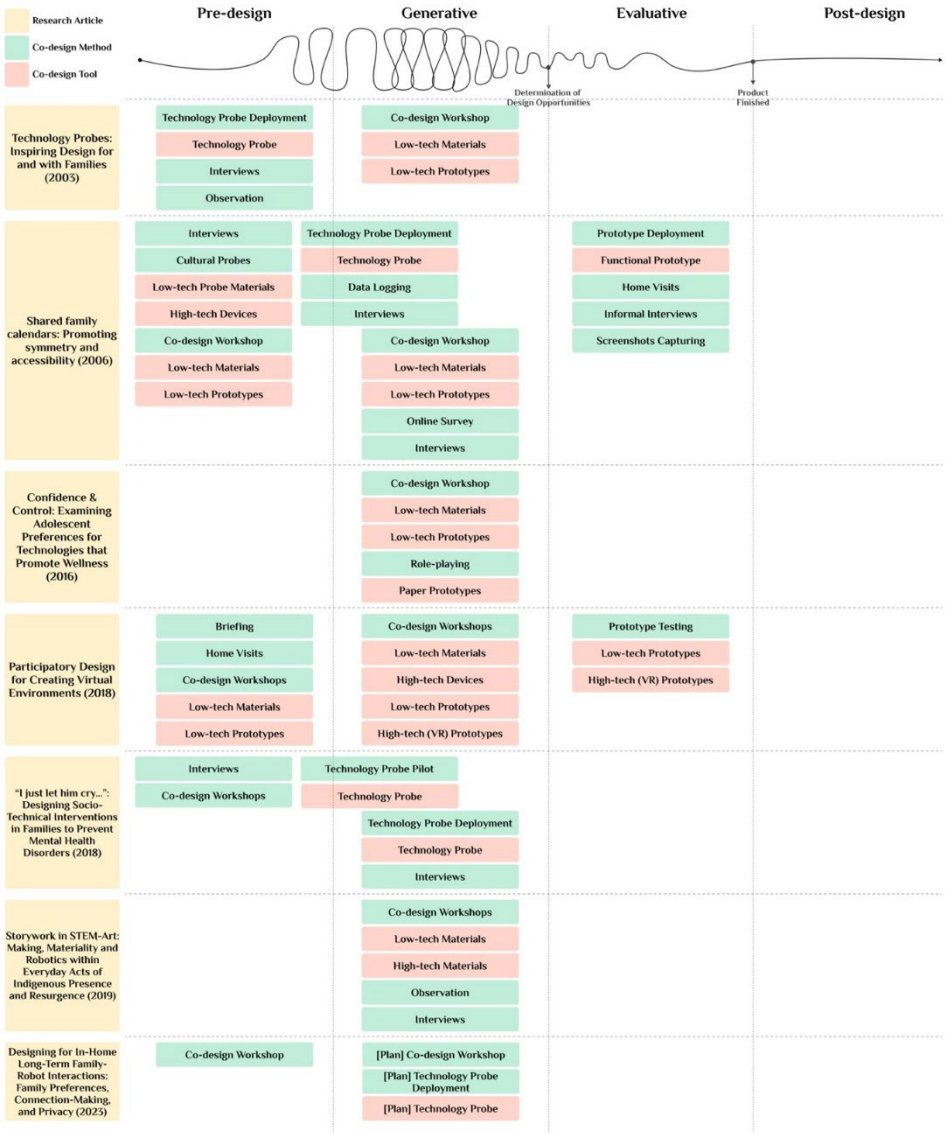

Figure 3. Matrix: PDR Methodologies of the Included Research

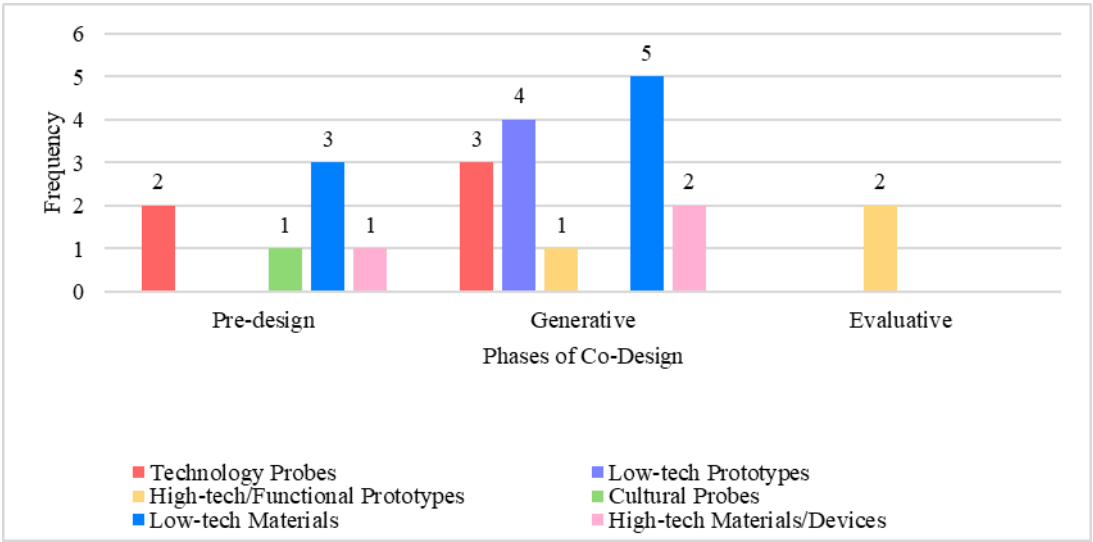

Figure 4. Frequency of Tools Adopted at Each Phase of Co-Design of the Included Research

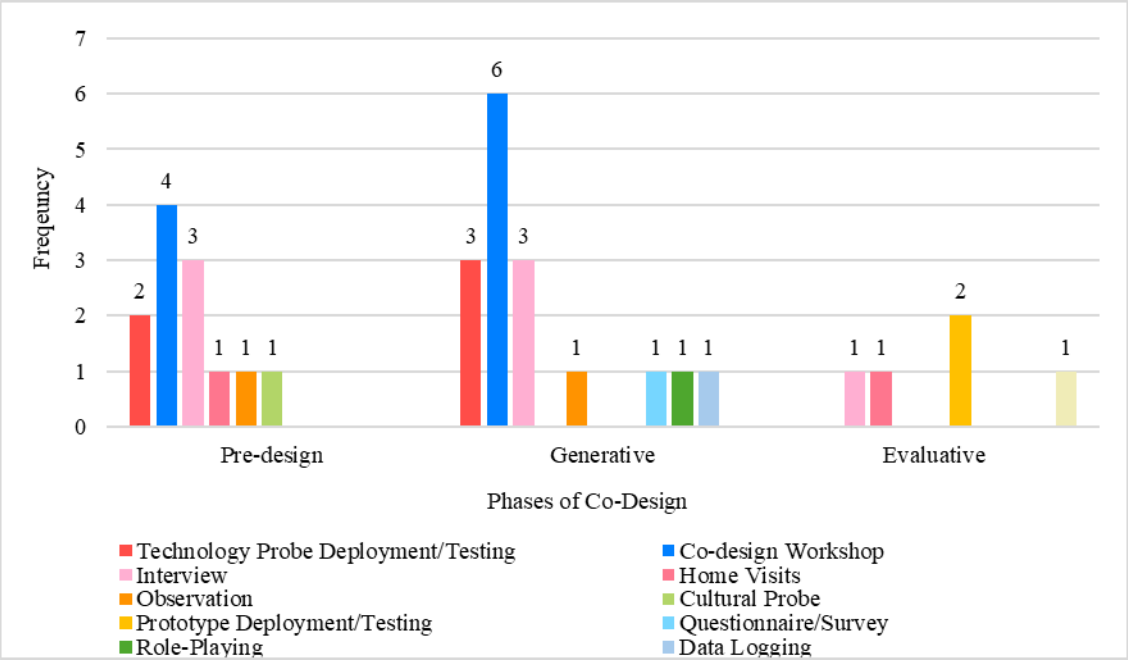

Figure 5. Frequency of Methods Adopted at Each Phase of Co-Design of the Included Research

As for the roles of participants, only four articles indicate how their authors define the roles of participants, while there is no clue about how the authors of the rest three studies define their participants (as sorted in the third column of Table 3). However, according to our revision of the roles based on the descriptions of the methods, tools, and the families engaged as in the final column of Table 3, we found that only in two articles can the authors correctly reflect role of their research participants, i.e., design partners, by the terms they use like “active partners” or “design partners”. Viewing together with the keywords of each research article (see the second column of Table 3), only one article explicitly positions its study as “participatory design” and “cooperative design”, and two involve “participatory design” as one of the keywords, while the rest four research articles have not provided any relevant indicators. These phenomena indicate that understandings of co-design as design research approach in the area is still lacking from both epistemic and methodological aspects.

Research Article	Keywords	Roles of participants (Author-defined)	Roles of Families (Revised)
Technology Probes: Inspiring Design for and with Families (2003)	Computer Mediated Communication, Home, Ethnography, Participatory Design, Cooperative Design	Active partners; Design partners	Design partners
Shared Family Calendars: Promoting Symmetry and Accessibility (2006)	Design, Experimentation, Human Factors; Home, Calendar, Digital Paper, Universal Usability, Family Technology, Elderly, Privacy, Layered Interfaces	Design partners	Design partners
Confidence & Control: Examining Adolescent Preferences for Technologies that Promote Wellness (2016)	Health Technology, Adolescents, Participatory Design, Socio-Ecological Model, Relationships, Healthy Eating.	N/A	Design partners
Participatory Design for Creating Virtual Environments (2018)	Participatory Design, 360-Degree Video, Intergenerational Storytelling; Methodology, User-Centred Design, Prototyping	Users	Design partners
"I just let him cry…": Designing Socio-Technical Interventions in Families to Prevent Mental Health Disorders (2018)	Prevention Science, Families, Mental Health Promotion, Emotion Regulation, Social-Emotional Learning, Interventions	Users	Design Partners
Storywork in STEM-Art: Making, Materiality and Robotics within Everyday Acts of Indigenous Presence and Resurgence (2019)	N/A	N/A	Design partners
Designing for In-Home Long-Term Family-Robot Interactions: Family Preferences, Connection-Making, and Privacy (2023)	Child-Robot Interaction, Social Robots, Interaction Design, Family-Centered Design, Multi-Party	N/A	Design partners

Table 3. Roles of Participants: Author-defined Ones versus Revised Ones

Co-design Challenges

There are methodological challenges disclosed related to the co-design activities. First is about scheduling the research activities. Design researchers have faced difficulties planning activities like interviews, home visits, or co-ideation since some family members were busy while some other older members of the family had unexpected travel plans or illness.[21] The participatory study had to be delayed in the end. Explorations on how we can coordinate our research plans and the schedules of our participants, especially the intergenerational ones, would be needed in the future empirical studies.

The second issue is related to instructions of co-design activities. Even though too much guidance from the facilitators of co-design workshops can hinder the creativity of the participants, without a clear goal in mind, participants would also be confused about what to do at the beginning, resulting in an initial failure of imaginative co-making.[22] Also, families may not have clear idea of the "who" they should be designing for. Families need a far better method of specifying with whom they communicate to constrain the context for their imaginations.[23] These situations suggest a need of a briefing session before each co-design session to make clear the goals to be achieved, so as to better set free of the imaginations and creativities of participants.

There are also issues related to participants recruitments and cultural diversity for co-design. It is hard to recruit people from various cultural backgrounds, hence not being able to evaluate the cross-cultural applicability of the design ideas for mediating family connectedness.[24] Also, two studies have identified the language barriers in co-design session for understanding the instructions and co-creating with people speaking a different language, and thus the co-design outcomes would be limited.[25] One of the studies has tried to deal with the issue by recruiting two bilingual student helpers to assist the participatory study,[26] but the feasibility of such a solution needed further examination since some information may lose during the translations and transmission.

There are some issues that may not directly affect the co-design planning but can influence co-creation. Firstly, a study indicates a "general distrust of speaking to 'authorities'" for young children,[27] which makes them not dare to talk to adults, including design professionals and other adult participants, who are considered as the "authorities" in their minds. As a result, they may not speak out what they actually imagine or concern about. This insight is in line with previous research suggesting the need of empowering the children and calling for figuring out strategies to enable equal power of children and adults in co-design.[28] Secondly, family coordination is important but difficult since different family members have different coordination needs, and everyone makes use of different methods and tools.[29] Such problems can lead to conflicts in opinions during discussion, which further hinder the people's capability to agree on final ideas. Thirdly, both design researchers and participants can have concerns regarding the functionality of technologies.[30] Although this seems to be a pragmatic perspective, such concerns reflect that these practical factors will also affect people's creativity.

DISCUSSIONS

Key findings

Through this review study, we found that all PDR studies in this research area have covered at least the generative phase with one or more co-making activities. And families' engagement can span from the pre-design stage to design evaluation, which is in line with Druin's statement that design researchers can involve participants whenever they feel like needed.[31] Also, there are eleven methods found that have been applied for conducting and supporting co-design research, with co-design workshops, interviews, and technological probe deployment applied most, but the tools adopted are not that adequate, with low-tech materials and technology probe mostly used.

However, the matrix of the methodologies mapped out through the review and the limited amount of research indicate that this area of study is still under-exploration. Both epistemic and methodological understandings are lacking. This can be due to the lack of cognitive preparation of both sides of design professionals and research participants that acknowledges the needs and benefits of engaging families in research to directly contribute ideas. Both parties need to know the importance of conducting co-design[32] – to provide equal voice to people and allow them to contribute directly to ideation for themselves – and hence the possibility to prepare for related research activities from the cognitive aspect.

Challenges in co-design practices can be another reason why there is limited research in this area. According to our review, we found difficulties related to scheduling participatory research, especially the co-design activities, recruiting intergenerational participants from diverse cultural backgrounds, building trust of children, coordinating different opinions, and setting free people's imagination. People's busy schedules make it hard to create a firm plan of participatory research which may affect the research progress, requiring a more flexible model of research design. As for engaging people of various cultural backgrounds and ages, issues are not limited to languages but also mindsets. Questions remained to be answered are how to make people engaged in the research understand each other, how to build trust between participants and design professionals of various generations and diverse backgrounds, and how we can integrate different ideas and coordinate those with different capabilities in manipulating technologies. Two factors can constrain people's imagination in co-design – instructions from the design experts and limitations of current technologies. Too many instructions would limit people's wondering, while people would not know where to start if there is no guidance at all. Even though people are supposed to speculate possible technological futures through co-design, their creativity can somewhat be constrained by what they know about the existing technologies. A balance needs to be explored in the future.

Finally, most of the identified research studies are conducted in a western context, whose possible reason could be lacking historical base of civic movements related to claiming the human rights and equality in other regions, especially in Eastern and Southeast Asia. But a deep understanding of the reason why and how we can incorporate and practice the co-design research approach that is originated from the western society to other regions require further investigation.

Limitations

Since the scope of this study has been constrained in a specific group (i.e., intergenerational families as design partners) with a strict screening and exclusion criteria, the sample size for review analysis is small. This can create potential biases in analysis and hence relatively weak validity and reliability. The theoretical frameworks for guiding our research analysis are from 2002, 2014, and 2019 respectively, which are a bit outdated hence affecting the overall soundness of the research findings. However, the limited frameworks that we can refer to also suggest a need of more up-to-date empirical studies in this area to refresh the epistemological knowledge and methodologies.

Future research opportunities

Viewing from the findings about limited exploration in design research methods, methodological challenges, and other factors that can affect co-design outcomes, further investigation about feasible methodology for co-design, especially for engaging people of diverse cultural background and various age groups will be needed. Difficulties in scheduling participatory research activities inform future endeavour on exploring how we can plan our participatory design research in a more flexible manner to better coordinate people's time schedules.

In terms of aspects related to cultures, current challenges in recruiting and engaging people from different cultural backgrounds and the lack of research in non-western regions indicate a need for more research in the area with cross-cultural collaborative investigation. Collaborative research can not only help with the issues but also make it possible to conduct comparative study to see whether and how cultural and demographic aspects influence people's ideation. Moreover, methods for helping people examining and combing each other's ideas requires further research as well, since the situations of multiple conflicting ideas coming up can happen easily in the research with various generations or of diverse backgrounds.

CONCLUSION

In conclusion, this review study investigated the existing approaches and challenges of engaging intergenerational families as co-design partners to develop technologies for enhancing family connectedness. By analysing seven relevant empirical studies following the theoretical frameworks of Druin, Sanders and Stappers, and Hanington and Martin, we identified the methods, tools, and phases involved in co-design with families. However, the matrix of methodologies of and challenges revealed in previous studies indicate the lack of epistemic and methodological explorations of participatory design research and co-design approach in this area. This review provides insights for future research to explore feasible methodologies for diverse cultural contexts and age groups. More studies are needed to address challenges like scheduling, trust-building, and idea coordination. Overall, this review sheds light on engaging families in technology design for connectedness through, mainly, a co-design approach.

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